ESRI
Geodatabase
Overview

The geodatabase is the common data storage and management framework for ArcGIS. It combines "geo" (spatial data) with "database" (data repository) to create a central data repository for spatial data storage and management. It can be leveraged in desktop, server, or mobile environments and allows you to store GIS data in a central location for easy access and management.

The geodatabase offers you the ability to

- **Store** a rich collection of spatial data in a centralized location.
- Apply **sophisticated rules and relationships** to the data.
- Define **advanced geospatial relational models** (e.g., topologies, networks).
- Maintain **integrity** of spatial data with a consistent, accurate database.
- Work within a **multiuser access and editing** environment.
- Integrate **spatial data** with other IT databases.
- Easily **scale** your storage solution.
- Support **custom features** and behavior.
- **Leverage** your spatial data to its full potential.

Multiuser Geodatabase

Multiuser geodatabases leverage ArcSDE technology implemented on a relational database management system (RDBMS) platform to

- Provide organizations with a **central, scalable data storage** and management system.
- Utilize **additional functionality** that is not available in user geodatabases.
- Provide **better data security** (such as access permission control for individual datasets), backup, and recovery.
- Maintain **data integrity** with features such as data backup and recovery, rollback, and failover.

There are three types of multiuser geodatabase: enterprise, workgroup, and desktop.

<table>
<thead>
<tr>
<th>Application Scenario</th>
<th>Enterprise</th>
<th>Workgroup</th>
<th>Desktop</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Storage</strong></td>
<td>Enterprise RDBMS Platform</td>
<td>SQL Server Express</td>
<td>SQL Server Express</td>
</tr>
<tr>
<td></td>
<td>DB2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Informix</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oracle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PostgreSQL</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SQL Server</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Management Interface</strong></td>
<td>ArcCatalog RDBMS ArcSDE command line</td>
<td>ArcCatalog</td>
<td>ArcCatalog</td>
</tr>
<tr>
<td><strong>Storage Capacity</strong></td>
<td>Depends on the server</td>
<td>10 GB</td>
<td>10 GB</td>
</tr>
<tr>
<td><strong>Supported OS Platform</strong></td>
<td>Any platform</td>
<td>Windows</td>
<td>Windows</td>
</tr>
<tr>
<td><strong>Number of Concurrent Users</strong></td>
<td>Unlimited editors and readers</td>
<td>10 editors and readers</td>
<td>1 editor and 3 readers</td>
</tr>
<tr>
<td><strong>Network</strong></td>
<td>Intranet and Internet</td>
<td>Intranet and Internet</td>
<td>Desktop and local</td>
</tr>
</tbody>
</table>
## Multiuser Functionality

### Versioning

Versioning is the mechanism that enables the geodatabase to manage and maintain multiple states while preserving database integrity. It is the basis for multiple users accessing and editing data simultaneously. Versions explicitly record the object states of a geodatabase.

The options for versioned editing in a multiuser geodatabase are

**Versioned Editing**

- Ability to manage conflict resolution
- Supports undo/redo capability
- Supports the full geodatabase model
- Supports geodatabase archiving and replication
- Supports long transactions
- Persistent record of changes
- Versioned editing with the option to move edits to base
  - Edits made to DEFAULT version automatically migrated to base tables

*Note: Prior to ArcGIS 9.2, ArcSDE was a stand-alone software product. At the ArcGIS 9.2 release, ArcSDE was integrated into both ArcGIS for Desktop and ArcGIS for Server. ArcSDE technology manages spatial data in an RDBMS and enables it to be accessed by ArcGIS clients.*
- Supports undo/redo capability
- Supports editing simple data only
- Not compatible with geodatabase archiving and replication

**Nonversioned Editing**
- Editing of source data directly
- Last edit is final
- No ability to undo/redo changes

Please refer to the following versioning white papers for more information:

- [Versioning—A conceptual overview](#)
- [Versioning Workflows—How versions support a series of common GIS workflows](#)

**Geodatabase Replication**

Geodatabase replication enables data to be shared across two or more geodatabases. Data changes can be made in each geodatabase, then synchronized.

- Is built on top of the versioning environment
- Supports the full geodatabase model, including topologies and geometric networks
- Can work in an asynchronous model (The replication is loosely coupled so that each replicated geodatabase can work independently and still synchronize changes with one another.)
- Does not require a uniform DBMS across replicas
- Works in a connected or disconnected environment
- Can utilize local geodatabase connections as well as geodata services (through ArcGIS for Server) to access the geodatabase over the Internet

Please refer to the following podcasts for more information:

- [Geodatabase Replication: An Overview](#)
- [Geodatabase Replication: Working with Replication](#)

Please refer to the following white paper for more information:

- [An Overview of Distributing Data with Geodatabases](#)

**Geodatabase Archiving**

Geodatabase archiving allows you to record and access changes made to all or a subset of data in a versioned geodatabase. Using it, you can capture, manage, and analyze data changes.
Within a multiuser geodatabase, ArcGIS provides

- A framework to archive data that captures all changes in the DEFAULT version of the geodatabase
- An additional archive class preserving transactional history
- A record of the change at the moment edits are saved or posted to the DEFAULT version

Please refer to the following archiving podcasts for more information:

- **Geodatabase Archiving: Introduction to Concepts and Capabilities** [MP3]
- **Geodatabase Archiving: Working with Archived Data** [MP3]

### Single-User Geodatabases

The single-user geodatabase is for individual GIS work in a desktop environment. It is available as either the file geodatabase or the Microsoft Access personal geodatabase. Both are available with all license levels of ArcGIS for Desktop.

<table>
<thead>
<tr>
<th></th>
<th>File</th>
<th>Personal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Storage Technology</strong></td>
<td>Uses local file structure</td>
<td>Microsoft Access (Jet Engine)</td>
</tr>
<tr>
<td><strong>Licensing</strong></td>
<td>ArcGIS for Desktop Basic, Standard, and Advanced</td>
<td>ArcGIS for Desktop Basic, Standard, and Advanced</td>
</tr>
<tr>
<td><strong>Differentiating Characteristics</strong></td>
<td>No versioning support</td>
<td>No versioning support</td>
</tr>
<tr>
<td></td>
<td>1 TB per table size limit (default)</td>
<td>Max. of 2 GB of data</td>
</tr>
</tbody>
</table>
File Geodatabase

- Stored in a file system
- Has no theoretical size limit (A table can store up to 256 TB of data using a configuration keyword.)
- Can have more than one concurrent editor (provided they are editing in different tables, feature classes, or feature datasets)
- Can function as a child geodatabase in both one-way and checkout/check-in geodatabase replication

Read [The Top Nine Reasons to Use a File Geodatabase](#).

Microsoft Access Personal Geodatabase

- Stored in a single Microsoft Access .mdb file
- Has a 2 GB size limit
- Supports only one editor at a time; no concurrent editing
- Can function as a child geodatabase in both one-way and checkout/check-in geodatabase replication

Multuser geodatabases provide additional functionality that is not available in single-user geodatabases.

Data Storage

The geodatabase supports all the different elements of GIS data that can be used by ArcGIS. By storing data within a geodatabase, you can take advantage of its data management capabilities to leverage spatial information. ArcGIS has a comprehensive suite of data conversion tools to easily migrate existing data into the geodatabase. The geodatabase is a more robust and extendable data model compared to shapefiles and coverages. It is designed to make full use of the capabilities of ArcGIS for Desktop and ArcGIS for Server.

Read an ArcNews article to find out more about data storage in the geodatabase.

GIS Data in a Geodatabase

The geodatabase supports all the different elements of GIS data used by ArcGIS. The structural elements of a geodatabase, listed below, are some of the elements used to develop a rich GIS, such as

- Attribute data
- Geographic features
- Satellite and aerial images (raster data)
- CAD data
- Surface modeling or 3D data
- Utility and transportation systems
- GPS coordinates
- Survey measurements

Geodatabases can represent these types of data as the following data objects:

**Annotation**
A specialized feature class that stores text or graphics that provide information about features or general areas of a map. An annotation feature class may be linked to another feature class so that edits to the features are reflected in the corresponding annotation (i.e., feature-linked annotation).

**Dimension**
A special type of geodatabase annotation that shows specific lengths or distances on a map. A dimension feature may indicate the length of a side of a building or land parcel, or it may indicate the distance between two features such as a fire hydrant and the corner of a building.

**Feature Class**
A collection of geographic features with the same geometry type (i.e., point, line, or polygon), the same attributes, and the same spatial reference. Feature classes allow homogeneous features to be grouped into a single unit for data storage purposes, for example, highways, primary roads, and secondary roads can be grouped into a line feature class named "roads." Feature classes can also store annotation and dimensions.

**Feature Dataset**
A collection of feature classes stored together that share the same spatial reference. Feature classes in a feature dataset share a coordinate system, and their features fall within a common geographic area. Feature datasets are used to help model spatial relationships between feature classes.

**Geometric Network**
Edge and junction features that represent a directed-flow system network, such as a utility or hydrologic system, in which the connectivity of features is based on their geometric coincidence. A geometric network does not contain information about the connectivity of features; this information is stored within a logical network. Geometric networks are typically used to model directed-flow systems.

**Locator**
A dataset that manages address information for features to enable geocoding, which is a process to transform addresses to a geographic location to display on a map.
Mosaic Dataset
A new data model within the geodatabase that enables collections of images and rasters to be stored as a catalog with the option to associate metadata, dynamic mosaicking, and on-the-fly image processing. It is accessible as a raster dataset (with all required processing done on the fly) or as a catalog of footprints and metadata.

Network Dataset
A collection of topologically connected network elements (e.g., edges, junctions, and turns) that are derived from network sources, typically used to represent an undirected-flow system network such as a road or subway system. Each network element is associated with a collection of network attributes. Network datasets are typically used to model undirected-flow systems.

Parcel Fabric
A dataset for the storage, maintenance, and editing of parcels. It is a continuous surface of connected polygon features, line features, and point features. Parcel Fabric replaces the Cadastral Fabric and Survey Dataset.

Raster Catalog
A collection of raster datasets defined in a table of any format, in which the records define the individual raster datasets that are included in the catalog. Raster catalogs can be used to display adjacent or overlapping raster datasets without having to mosaic them together in one large file.

Raster Dataset
Any valid raster format organized into one or more bands. Each band consists of an array of pixels (cells), and each pixel has a value (e.g., a Landsat satellite image). Raster datasets can be stored in many formats, including TIFF, ERDAS Imagine, Esri Grid, and MrSID.

Relationship Class
A class similar to relationships that exist within an RDBMS. Relationship classes manage the associations between objects in one class (e.g., a table or feature class) and objects in another. Objects at either end of the relationship can be features with geometry or records in a table.

Schematic Dataset
A dataset used for graphically representing network connectivity. It also represents sets of relationships.

Table
A set of data elements arranged in rows and columns. Each row represents a single record. Each column represents a field of the record. Rows and columns intersect to form cells,
which contain a specific value for one field in a record. Tables typically store stand-alone attribute information or information associated with a spatial location such as addresses.

**Terrain**

A triangulated irregular network (TIN)-based dataset that uses feature classes as data sources to model multiple resolution surfaces using z-values.

**Toolbox**

A collection of dataflow and workflow processes. These are used for performing data management, analysis, and modeling.

**Topology**

The arrangement that constrains how point, line, and polygon features share geometry within a geodatabase. For example, street centerlines and census blocks share geometry, and adjacent soil polygons share geometry. Topology defines and enforces data integrity rules, topological relationship queries and navigation, and sophisticated editing tools. It also allows feature construction from unstructured geometry.

**Data Models**

**Geodatabase Schemas: Data Models for GIS Users**

Esri has established a set of best practices geodatabase designs for various application domains. These database design models are intended to help GIS users rapidly become productive with the geodatabase and share what really works among users and our developer communities.

**What’s Included in an ArcGIS Data Model**

The content of the data models can vary, but each data model should include

- A case study implementation that includes a small sample database
- A geodatabase template for importing the data model as a template on which to base a system
- A white paper explaining the design
- A data model poster
- Tips and tricks on how to utilize the data model from the case study and how to use it in your work

Note: Some of the data models also have important community-based Web links for particular domains to allow collaboration in developing designs and concepts.
Sharing GIS Data Models

Esri ensures that ArcGIS data models implement relevant standards as they evolve. For example, the land records and the Arc Hydro data models are based on proven standards over the past decade. Esri also monitors and participates in many standards-based efforts at ISO, OGC, FGDC, Geospatial One-Stop, and ANSI. All appropriate standards are incorporated into the data model work.

Each ArcGIS data model uses commonly adopted spatial representations (e.g., points, lines, and polygons), classifications, and map layer specifications that can be implemented in any GIS. Each data model specifies the commonly used integrity rules for key data layers and feature classes. ArcGIS data models can be widely adopted regardless of the system architecture.

Downloads

Downloads for Data Models gives you access to tools, white papers, case studies, and design templates. You can join the developer community by participating in the Data Models Discussion Conference or joining the Data Model User Group.

Storage in a Relational Database Management System

A multiuser geodatabase utilizes a multitier architecture that implements advanced logic and behavior in the application tier (e.g., ArcGIS software) on top of a storage tier (e.g., relational database management system [RDBMS] software). The responsibility for managing geographic data in a multiuser geodatabase is shared between ArcGIS and the RDBMS software.

A relational database management system provides a straightforward formal structure for storing and managing information in tables. Data storage and retrieval are implemented with simple tables. The multiuser geodatabase utilizes the power of the RDBMS. Certain characteristics of geographic data management, such as disk-based storage, definition of attribute types, query processing, and multiuser transaction processing, are delegated to the RDBMS.

The multiuser geodatabase uses an RDBMS to provide you with

- Flexibility to store your data in a supported RDBMS of your choice
- Ability to apply your existing IT knowledge and experience to manage the environment through common RDBMS practices
- Spatial types to enhance data storage and interoperability
ArcSDE Technology

Prior to ArcGIS 9.2, Esri sold ArcSDE as a core product. At ArcGIS 9.2, ArcSDE is no longer a separate product. It is now ArcSDE technology and integrated into ArcGIS Desktop and ArcGIS for Server products.

ArcSDE technology serves as the gateway between GIS clients and the RDBMS. It enables you to easily store, access, and manage spatial data within an RDBMS package such as

- DB2
- Informix
- Oracle
- PostgreSQL
- SQL Server and SQL Server Express

ArcSDE technology is critical when you need to manage long transactions and versioned-based workflows such as

- Support for multiuser editing environments
- Distributed editing
- Federated replicas managed across many RDBMS architectures
- Managing historical archives

The responsibility for defining the specific RDBMS schema used to represent geographic data and for application logic is retained in ArcGIS, which provides the behavior, integrity, and utility of the underlying records.

Geodatabase Application Logic

While the RDBMS manages simple data types and tables and ArcSDE technology enables communication between GIS clients and the RDBMS, additional application logic is required to implement more complex object behavior and integrity constraints. ArcObjects is an example of application logic that enables the behavior in a geodatabase. ArcObjects is a library of software components that make up the foundation of ArcGIS.

Spatial Types

A spatial type is an object type that describes and supports spatial data such as points, lines, and polygons. It allows you to create columns capable of storing spatial data such as the location of a landmark, a street, or a parcel of land. A spatial type

- Provides a spatial index that supports spatial queries, functions, and predicates
- Is a seamless component of your GIS data
- Provides the flexibility that enables you to issue SQL-level spatial queries

**Supported Spatial Types**

```
Microsoft
| Geometry for SQL Server |
| Geography for SQL Server |
```

Note: Esri also supports binary storage for spatial data in SQL Server and Oracle (prior to 11g).
### Supported Spatial Types

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oracle</td>
<td>Esri for Oracle</td>
</tr>
<tr>
<td></td>
<td>Oracle Spatial</td>
</tr>
<tr>
<td>IBM DB2</td>
<td>DB2 Spatial Extender</td>
</tr>
<tr>
<td>IBM Informix</td>
<td>Spatial DataBlade</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>Esri for PostgreSQL</td>
</tr>
<tr>
<td></td>
<td>PostGIS</td>
</tr>
</tbody>
</table>

*Note: Esri also supports binary storage for spatial data in SQL Server and Oracle (prior to 11g).*

---

### Interoperability

#### Esri File Geodatabase API

The File Geodatabase API allows you to develop apps that interact with a file geodatabase without using ArcObjects. The API is available as a C++ library (.dll), which provides access to low-level file I/O modules.

With the API you can:

- Create new file geodatabases.
- Read a file geodatabase’s schema.
- Create new schemas for simple feature objects.
- Read and write data.
- Perform attribute and (limited) spatial queries.

The File Geodatabase API supports 32-bit and 64-bit Windows and Linux platforms.

[Download the API](#)

#### Geodatabase XML

- Export and import geodatabase schemas.
- Tabular data is interpreted as XML by ArcGIS Business Logic.
- Geodatabase XML represents Esri’s open mechanism for information exchange between geodatabases and other external systems.

The geodatabase defines a generic model for geographic information and is implemented as either a collection of files in a file system or a collection of tables in a DBMS. The benefit of this generic model is that the geodatabase and its...
contents are multipurpose, shareable, and standards based.

Esri openly publishes and maintains the complete geodatabase schema and content as an XML specification and provides sample implementations to illustrate how users can share data updates between homogeneous systems.

XML interchange of geospatial information to and from the geodatabase is greatly simplified using the geodatabase XML specification. External applications can receive XML data streams including:

- Exchange of complete lossless datasets
- Interchange of simple feature sets (similar to shapefile interchange)
- Exchange of change-only (delta) record sets using XML streams to pass updates and changes among geodatabases and other external data structures
- Exchange and sharing of full or partial geodatabase schemas between ArcGIS users

Refer to the following XML white paper for more information.
**Appendix – 1**

**ESRI Products**

**ArcGIS**

ArcGIS helps you use spatial information to perform deep analysis, gain a greater understanding of your data, and make more informed decisions. It's a platform for:

### GIS Professionals

Professional GIS enables you to design and manage solutions through the application of geographic knowledge.

- ArcGIS for Mobile
- ArcGIS for Server

### Location Analytics

Location Analytics provides data visualization and geographic intelligence for business analytics systems.

- Esri Maps for Dynamics CRM
- Esri Maps for MicroStrategy
- Esri Maps for SAP BusinessObjects

### Developers

Developers can quickly add location to apps using cloud services or get a developer license for all ArcGIS software.

- Esri Developer Network
- ArcGIS for Developers

### ArcGIS Solutions

- ArcGIS for Local Government
- ArcGIS for Maritime
- ArcGIS for Transportation Analytics
- ArcGIS for Aviation
- ArcGIS for Electric
- ArcGIS for Gas

### ArcGIS Content

- Imagery
- Basemaps
- Demographics and Lifestyle Data

### ArcGIS Apps

- Operations Dashboard for ArcGIS
- Collector for ArcGIS
- Esri Production Mapping
- Esri Redistricting
- Esri Roads and Highways
- Esri Business Analyst
- Esri Community Analyst
- Esri CityEngine
- Esri Defense Mapping

### Free Mapping Software

- ArcGIS for AutoCAD
- ArcGIS Online Free Public Account
- Apps for Smartphones & Tablets
- ArcGIS Explorer Desktop

### Open Source Products

- Geoportal Server
- ArcGIS Editor for OpenStreetMap
- ArcGIS Viewer for Flex