ArcGIS® 8:
The Complete Geographic Information System

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An ESRI White Paper

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ArcGIS 8: The Complete Geographic Information System

ESRI® ArcGIS® is a scalable system of software for geographic data creation, management, integration, analysis, and dissemination for every organization, from an individual to a globally distributed network of people. The 8.x releases introduce a comprehensive, integrated system designed to meet the needs of a wide range of geographic information system (GIS) users.

Background

Using substantial consultation with and feedback from our users, ESRI recognized the need to build a single, scalable architecture for its GIS software. While these software programs were interoperable at the data level, all were built on different code bases supported by separate development teams.

As technology evolved, it became apparent that this new software should be

- Easy to use—Offer generic mapping, analysis, and data management applications that are usable out of the box and yet easily customized.
- Rich in functionality—Incorporate strong feature editing, advanced cartography, improved data management, and sophisticated spatial analysis.
- Scalable—Built out of modern object-based comp onents, the range of software shares the same core applications, user interface, and operating concepts.
- Web enabled—GIS clients and servers can use the Internet for data and application services.
- Developer friendly—Built using open industry standards, functionally rich, well documented, and completely customizable/extensible with common programming languages.

The ESRI family of software that was developed to meet these principles is known as ArcGIS. The ArcGIS line of software is being released in phases . The first phase occurred with the releases of ArcInfo™ 8.0.1 and ArcSDE® 8.0.1 software that introduced new desktop GIS applications and the geodatabase model.

The ArcGIS 8.1 release was the second major phase and included three major developments.

- ArcView® 8.1 software, built on the same architecture as ArcInfo 8
- ArcEditor™ 8.1 software, a new release positioned between ArcView and ArcInfo
- ArcGIS extensions that operate with ArcView, ArcEditor, and ArcInfo

The ArcGIS 8.2 release was the third phase and included three major developments.

- Improved integration with ArcIMS®
- ArcReader™ 8.2 software, a free product for viewing and sharing maps
- New ArcGIS extensions, ArcGIS Publisher and ArcGIS StreetMap™ Europe

The ArcGIS 8.3 release is the fourth phase and focuses on data maintenance and creation with the following new capabilities:

- Rule -based topology support for the geodatabase
- ArcEditor Single Use with a focus on disconnected editing
- Complete linear referencing functions
- New ArcGIS extensions: ArcGIS Survey Analyst, ArcGIS Tracking Analyst, and ArcScan™ for ArcGIS

ArcGIS Overview

ArcGIS is a scalable system for geographic data creation, management, integration, and analysis for every organization, from the individual to the global enterprise. Built using standards such as Component Object Model (COM), Extensible Markup Language (XML), and Structured Query Language (SQL), ArcGIS can be integrated into the core information systems infrastructure of any organization.

As GIS expands into new applications and user communities, ArcGIS meets the challenge of providing the data and services to a geographically literate world. Strong editing, analysis, and modeling, along with cutting-edge data models and management, continue to distinguish the ArcGIS software family as the leading GIS software.

The ArcGIS Desktop software is ArcReader, ArcView, ArcEditor, ArcInfo, and ArcGIS extensions. ArcSDE and ArcIMS are the ArcGIS server products, and ArcPad® is the mobile technology.

Figure 1
The Software of ArcGIS
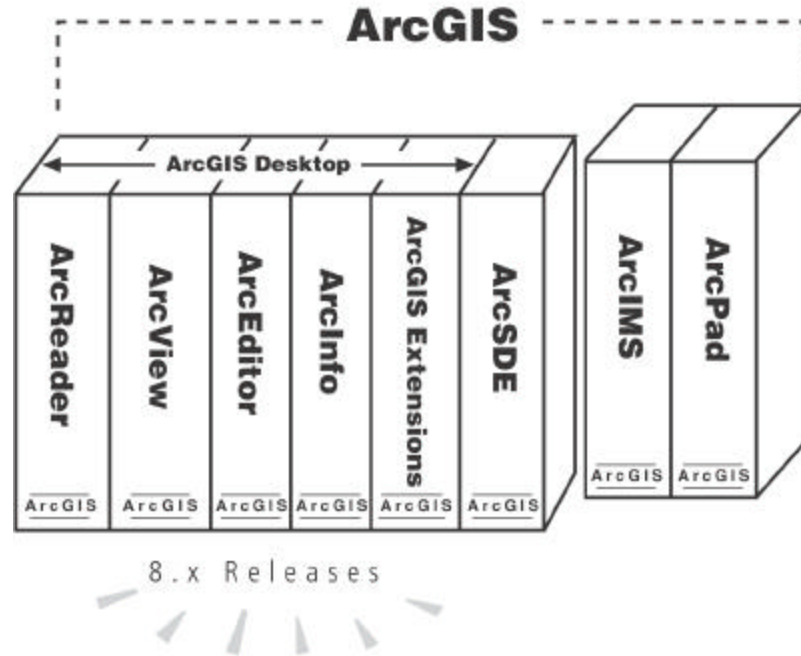
ArcGIS Desktop   The creation and management of geographic data is demanding. ArcGIS Desktop
provides the complete set of required tools. ArcGIS Desktop is a scalable set of
state-of-the-art software for geographic data creation, management, integration, analysis,
and presentation. While practical and within the abilities of inexperienced GIS users,
ArcGIS Desktop includes sophisticated functionality and is readily customized by
advanced GIS users.

The term ArcGIS Desktop refers to ArcReader, ArcView, ArcEditor, ArcInfo, and
ArcGIS extensions. Although licensed separately, ArcGIS Desktop is a scalable set of
software with the same core applications and user interface. ArcReader is a free product
with a single application that allows anyone to view, explore, and print published map
files (PMF).

The core applications for ArcView, ArcEditor, and ArcInfo are ArcMap™, ArcCatalog™,
and ArcToolbox™. ArcMap is for working with spatial data and creating cartographic
output. ArcCatalog is for locating and managing spatial data. ArcToolbox provides data
conversion and geoprocessing tools. ArcGIS Desktop software programs (except
ArcReader) share these three applications. Additional functionality is enabled in each
application as you move from ArcView to ArcEditor to ArcInfo.

As a result, ArcView and ArcInfo are now merged into a single, integrated platform built
on a common architecture with an identical user interface. This dramatically increases

usability and interoperability between what were two very different environments in the past.

ArcView, ArcEditor, and ArcInfo share the following core functionality:

- Advanced construction tools
- High-quality cartography
- Internet-enabled
- On-the-fly projection
- Geocoding
- Wizard-driven tools

- Support for metadata standards using XML
- COM-based customization
- Extensible architecture
- Direct read of more than 40 data formats

Figure 2 illustrates the scalable nature of ArcGIS Desktop. ArcReader is a free, lightweight product for viewing and sharing maps. ArcView includes all the functionality of ArcReader and provides core mapping and GIS functionality. ArcEditor includes all the functionality of ArcView and adds the ability to edit multiuser geodatabases. ArcInfo includes all the functionality of ArcEditor and the ability to edit coverages in addition to unsurpassed geographic database automation, maintenance, and conversion tools. Users select the software package that meets their needs depending on the required functionality. If you choose ArcView and find that your needs grow in the future, it is easy to upgrade to the next level of ArcGIS Desktop since the user interface, operating concepts, and underlying applications are identical.

Figure 2
ArcGIS Desktop Software
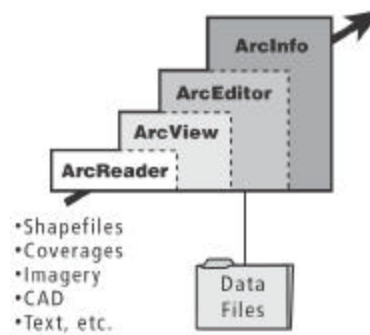
In addition, this figure illustrates the use of file-based data sets. This is the most common data deployment method currently in use. When more than one user needs data access, files are either copied or mounted across a network. In work group editing situations, operational procedures have to be implemented since file-based data sets do not support joint editing. Characteristics of the file-based data set approach include

Advantages

- Easy to implement
- Database management system (DBMS) experience not required
- Low cost

Limitations

- Single-user editing only
- Spatial and attribute data managed in many, potentially disjointed files
- Requires disk mounts or copies distributed on various disks
- Network performance sometimes an issue

ArcReader   ArcReader is a free product with a single application that allows anyone to view, explore, and print PMFs. ArcReader was designed for viewing and sharing maps that access a wide variety of dynamic geographic data and are created using the ArcGIS Publisher extension to ArcView, ArcEditor, and ArcInfo.

ArcView   ArcView includes all the functionality of ArcReader and provides high-quality visualization, query, analysis, integration, and basic geographic data automation. ArcView 8.x retains the same base functionality as ArcView 3.x while adding notable improvements such as ArcCatalog for browsing and managing data, on-the-fly coordinate and datum projection, customization with built-in Microsoft® Visual Basic® for Applications (VBA), new editing tools, support for creating annotation, and much more. ArcView allows you to create and edit shapefiles and simple features in personal geodatabases.

ArcEditor   ArcEditor includes all the functionality of ArcView and adds the power to edit features in a multiuser geodatabase. Additional functionality includes support for topology, multiuser editing, versioning, custom feature classes, feature-linked annotation, dimensioning, and rasters in a multiuser geodatabase. ArcEditor allows you to create and edit ESRI-supported vector data formats including shapefiles, personal geodatabases, and multiuser geodatabases.

ArcInfo   Within the ArcGIS software family, ArcInfo is the most comprehensive GIS available. It includes all the functionality of ArcView and ArcEditor and adds the advanced geoprocessing and data conversion capabilities that make ArcInfo the de facto standard for GIS. ArcInfo is the complete GIS data creation, update, query, mapping, and analysis system. ArcInfo is composed of ArcInfo Desktop and ArcInfo Workstation.

ArcInfo Desktop includes all the functionality of ArcEditor and adds a complete set of data management, analysis, and conversion tools to the ArcToolbox application. With these tools, you can perform data conversion, generalization, aggregation, overlays, buffer creation, statistical calculations, and much more. Each of these tools has a menu-driven interface with wizards where appropriate. ArcInfo allows you to create and edit all ESRI-supported vector data formats including shapefiles, coverages, personal geodatabases, and multiuser geodatabases.

ArcInfo Desktop operates on Windows NT®, Windows® 2000, and Windows XP (Home Edition and Professional).

ArcInfo Workstation provides geoprocessing via the classic user interface (ARC, ArcEdit™, ArcPlot™, ARC Macro Language [AML™], and more). In addition to providing the user environment familiar to many ArcInfo users and found in countless existing GIS applications, ArcInfo Workstation includes fundamental and matchless geoprocessing functionality. ArcInfo Workstation operates on Windows NT, Windows 2000, Windows XP (Home Edition and Professional), and several UNIX® platforms.

ArcView, ArcEditor, and ArcInfo Compared

Table 1 compares the major features and functions of ArcView, ArcEditor, and ArcInfo.

Table 1
ArcGIS Desktop Software Compared

	ArcView	ArcEditor	ArcInfo
View shapefiles and coverages	✓	✓	✓
View geodatabases	✓	✓	✓
Create/Edit shapefiles	✓	✓	✓
Create/Edit coverages			✓
Create/Edit personal geodatabases	✓[1]	✓	✓
Create/Edit multiuser geodatabases		✓	✓
Create/Edit feature-linked annotation		✓	✓
View feature-linked annotation	✓	✓	✓
Direct support of many raster formats	✓[2]	✓[2]	✓[2]
Data conversion and management	✓[3]	✓[3]	✓[3]
Advanced geoprocessing			✓
Includes ArcInfo Workstation			✓
License type	Single and concurrent use	Single and concurrent use	Concurrent use only
Operating Systems	Windows NT, Windows 2000, and Windows XP[4]	Windows NT, Windows 2000, and Windows XP[4]	ArcInfo Desktop supports Windows NT, Windows 2000, and Windows XP[4]. ArcInfo Workstation adds UNIX support.

1   ArcView supports simple features (points, lines, polygons, and static annotation) in a personal geodatabase, not rules and relationships.

2   ArcView and ArcEditor support more than 25 raster formats. ArcInfo supports more than 30 raster formats.

3   ArcToolbox in ArcView and ArcEditor contains more than 40 basic data conversion tools. ArcToolbox in ArcInfo contains more than 170 data management, analysis, and conversion tools.

4   ArcGIS Desktop supports both Windows XP Home Edition and Windows XP Professional.

Software licenses are either single use (previously known as fixed) or concurrent use (sometimes known as floating). Single use licenses permit software operation on one computer and do not use a license manager. Concurrent use licenses are controlled by a license manager operating on an organization's network and can be shared by any computer on the network. One license manager can administer the different concurrent use ESRI software.

ArcView and ArcEditor are available as either single use or concurrent use licenses. Regardless of the license type, the functionality of the base product is identical. ArcInfo is only available as a concurrent use license.

Separate from licensing issues, all the ArcGIS Desktop software can be installed on a single computer—ArcView single use, ArcView concurrent use, ArcEditor single use, ArcEditor concurrent use, and ArcInfo. ESRI provides the Desktop Administrator tool for controlling which software is operational on that machine and listing additional concurrent use licenses available on the network. This strategy gives flexibility to individuals and organizations. Users can easily switch between software depending on their role or daily tasks.

ArcGIS Extensions

The 8.x releases introduce a new set of extensions built on the same architecture. ArcGIS extensions add functionality to the core capability of ArcView, ArcEditor, and ArcInfo. ESRI reengineered the extensions to incorporate the best features of the earlier ArcView and ArcInfo extensions.

One of the key features of these extensions is that they operate with the entire line of ArcGIS Desktop software. Prior to the 8.1 release, if ESRI users needed to perform raster analysis they licensed different software depending on their core GIS software. They used ArcView Spatial Analyst with ArcView or ArcGrid™ with ArcInfo. In contrast, ArcGIS Spatial Analyst 8.3 can operate with ArcView 8.3, ArcEditor 8.3, or ArcInfo 8.3. This feature significantly reduces training, operating, and acquisition costs.

Table 2 lists the extensions that are now available. Additional extensions are planned for the future.

Table 2
Available ArcGIS Extensions

Name	Features
ArcGIS Spatial Analyst	Surface creation, raster analysis, and grid algebra; combines the capabilities of ArcView Spatial Analyst and ArcGrid.
ArcGIS 3D Analyst™	Three-dimensional visualization and analysis; combines the capabilities of ArcView 3D Analyst and ArcTIN™.

Table 2, Continued

Name	Features
ArcGIS Geostatistical Analyst	A new extension for advanced surface interpolation and exploratory spatial data analysis.
ArcGIS Survey Analyst	Works with survey data observations from field notes, survey equipment, and data collectors and stores the survey data directly in a GIS database.
ArcGIS Tracking Analyst	Visualization and analysis of time-related data.
ArcGIS Publisher	Makes maps for everyone via ArcReader by converting map documents (MXD) to published map files.
ArcGIS StreetMap	Family of software for street display and geocoding of different geographical areas. (United States and Europe are available.)
ArcScan for ArcGIS	Supports vectorization and simple raster editing.
ArcPress™ for ArcGIS	Graphics metafile rasterizer that improves color output control and printing speed; combines ArcPress for ArcInfo and ArcPress for ArcView.
MrSID™ Encoder for ArcGIS	Produces MrSID images from input images up to 500 MB; mosaics MrSID images.

ArcGIS extensions are licensed as either single use or concurrent use. The host determines the type of license required. Single use extensions only operate with the single use version of ArcView or ArcEditor. Concurrent use extensions operate with ArcInfo and the concurrent use versions of ArcView and ArcEditor. This feature adds a new degree of flexibility because ArcGIS extensions can either be licensed to operate with a single use version of ArcView or ArcEditor or shared on a network.

Some of the extensions add capabilities to ArcInfo Workstation. For instance, ArcGIS Spatial Analyst adds ArcGrid and ArcGIS 3D Analyst adds ArcTIN, while ArcPress for ArcGIS adds commands and tools in ArcInfo Workstation.

ArcObjects

ArcGIS Desktop is built on a technology framework known as ArcObjects™. ArcObjects is a collection of software components with GIS functionality and programmable interfaces. ArcObjects technology is based on the COM protocol. Customization is performed using the built-in VBA scripting capabilities or a COM-compliant programming language such as Visual Basic, Visual C++®, or Delphi™.

Figure 3
ArcObjects Features and Sample Diagram Key

- Well-documented data model
- Unlimited extensibility
- Highly scalable
- Easy to interface
- More than 1,100 unique
  COM-based components
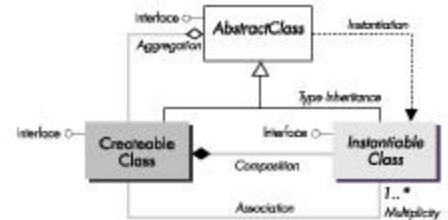
The ArcObjects components that make up ArcView, ArcEditor, ArcInfo, and the geodatabase data model are open to users and developers. You can add new tools or work flows to the ArcGIS Desktop applications without purchasing an additional Software Development Kit (SDK). In addition, ArcObjects allows you to extend the geodatabase data model by creating custom feature types and building a schema for your geodatabase design.

Geodatabase

Although ArcGIS 8 operates with existing data formats, it is fundamentally based on a new data model called the geodatabase (short for geographic database). ESRI introduced the geodatabase with ArcInfo 8.0.1, and its use is strengthened in the 8.1, 8.2, and 8.3 releases.

The geodatabase has two major concepts. First, a geodatabase is a physical store of geographic information inside a DBMS. Second, a geodatabase has a data model that supports transactional views of the database (versioning) and also supports objects with attributes and behavior. Behavior describes how an object can be edited and displayed.

Behavior includes, but is not limited to, relationships, topology rules, subtypes, and default values. Three key features of a geodatabase are

1. Centralized management of a wide variety of geographic information in a DBMS

2. Versioning that allows simultaneous editing by multiple editors and transactional views of the geodatabase

3. Custom (or intelligent) features that have behavior, topology rules, editing rules, and relationships

Versioning allows simultaneous editing by multiple users and also allows transacted views of the geographic database. This framework lets you create versions of a geodatabase for the states of a project, reconcile differences between versions, and update the master version of a geodatabase with the design as-built. Custom features can be enhanced with properties including behavior, editing rules, and relationships. As a result, they can more closely resemble real-world objects such as parcels, buildings, and transformers.

The chief purpose of the geodatabase data model is to make it easier and more intuitive to use GIS across many applications. As such, the geodatabase is sometimes referred to as the next-generation coverage. It is that, and much more. The geodatabase data model centralizes data management and opens up the use of GIS to applications that were not feasible before. See Appendix E for more information on the geodatabase.

ArcGIS Data Models

The geodatabase data model allows the creation of common or essential data models for specific industries and applications. ArcGIS data models provide ready-to-use nonproprietary frameworks for modeling and capturing the behavior of real-world objects in a geodatabase. They are built on the accepted standards in each field and provide data models that can be configured and customized using ArcEditor or ArcInfo. Data migration is the longest and most expensive part of a GIS project. These data models provide "quick start" solutions that optimize performance and establish industry standards that improve data sharing.

Figure 4
A Small Portion of the ArcGIS Water Facilities Model
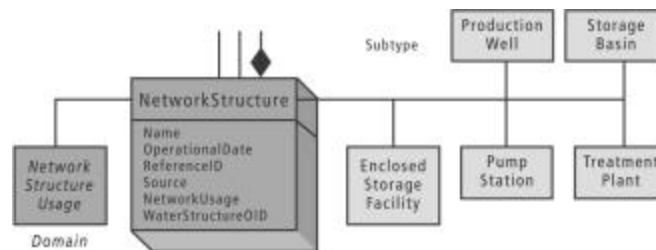
ESRI has initiated a series of programs to facilitate creating these data models in close collaboration with our user groups for each industry. These data models involve the development of a series of books with CDs that provide each industry or application discipline a standardized collection of data classifications and object models.

ArcGIS Water Facilities Model was the first data model released. It provides an industry standard for modeling and managing water network systems and comes with a manual, a graphical model, a physical database design, and a test database. Other available data models include hydrology, land parcel, roads/transportation, energy networks, conservation, environmental facilities, telecommunications, forestry, and defense data models. These efforts allow GIS users to spend less time designing and developing data models.

ESRI's goal is to make these data model extensions open and widely available. In some cases, we are cosponsoring their development. The ArcGIS Water Facilities Model is an example and can be downloaded from the ESRI Web site at www.esri.com/datamodels.

## ArcGIS Application Services

The rich offering of ArcGIS Desktop is complemented by two application services: ArcSDE software, for storing and managing data in a multiuser environment, and ArcIMS software, for distributing GIS data and services across the Internet. These two

application services are server based and are designed to operate on both UNIX and Windows.

ArcSDE   ArcSDE is an application server that facilitates storing and managing spatial data (raster, vector, and survey) in a database management system. By allowing concurrent multiuser editing and providing transacted views of a geodatabas e, ArcSDE plays a fundamental role in collaborative GIS systems. ArcSDE 8.x supports Oracle®, Microsoft SQL Server™, IBM® DB2®, and IBM Informix®.

ArcSDE is tightly integrated with ArcEditor and ArcInfo for designing, creating, implementing, and sharing multiuser geodatabases. In a collaborative GIS environment, ArcView acts as a client for viewing and analyzing geographic data.

Figure 5
Collaborative GIS With ArcSDE
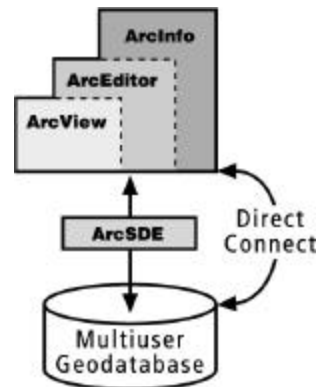
ArcSDE 8.x uses a compressed binary format for storing geographic data. This binary format was developed to work with multiple DBMS platforms. In addition, ArcSDE can use the extended spatial types of a spatially enabled DBMS to store and manage feature geometry. In this manner, ArcSDE supports the major functions and capabilities of Oracle Spatial, IBM's DB2 Spatial Extender, and Informix's Spatial DataBlade. In these cases, the geometry is also directly accessible via the SQL implementation of the specific DBMS (an Oracle -specific SQL implementation for Oracle Spatial and SQL 3 Multimedia for IBM DB2 and Informix).

It is important to note that a multiuser geodatabase is not stored in a proprietary structure but is stored in standard tables managed by the DBMS. As a result, users can access a multiuser geodatabase through the ArcSDE gateway or through any standard DBMS access methodology.

With ArcSDE 8.x, all of ESRI's core clients feature a read-only direct connection to Oracle Spatial or an existing binary format spatial database in Oracle or Microsoft SQL Server. There is no additional cost to use this read-only direct connection with ArcView 8.x, ArcEditor, ArcInfo, or ArcIMS. However, a read-only connection license

is required if the read-only direct connection is used with ArcView 3.x, MapObjects®, ArcSDE CAD Client, or a third party application.

There are also two ways that ArcSDE 8.x can be configured at installation. The first configuration option is a read-write direct connection. The other configuration option is to install a classic three-tier client/server system (i.e., the client application layer, the ArcSDE application server layer, and the DBMS). An ArcSDE 8.x license is required for either configuration option.

Regardless of whether the system is configured with the application server, direct connect drivers, or a mixture of the two, the client applications have the same functionality. The direct connect option adds a new level of flexibility for system design and configuration. On one hand, it is easier to administer since an ArcSDE server process does not have to be established and administered. Conversely, the direct connect option increases network traffic and moves server functionality to the desktop.

ArcIMS

ArcIMS is a powerful Internet mapping system that provides a framework for centrally building and deploying GIS services and data. Using ArcIMS, you can deliver focused, lightweight GIS applications and data to many concurrent users, both within your organization and externally on the World Wide Web. ArcIMS works with data files or a multiuser geodatabase managed with ArcSDE.

ArcIMS includes a suite of spatial services and Web clients. The spatial services include the following: map services, feature services, geocoding, database queries, and data extraction or clipping. The Web clients complement the ArcGIS Desktop software and include browser-based viewers (HTML and Java™) and stand-alone ArcExplorer™ viewers (Windows and Java). In addition, ArcPad software, ESRI's mobile mapping solution, can retrieve maps from ArcIMS using wireless technology.

With GIS on the Internet, I feel like we have just invented the printing press for maps.

–Jack Dangermond President, ESRI

ArcIMS map services and feature services are distinguished by what is transmitted to the client. Map services create and send cartographic map images in a raster format. Feature services stream vector features as shapefiles and attributes to the client. An important new capability at 8.x is that ArcGIS Desktop software can connect to map and feature services. These new layer types behave as if they are local data and can be symbolized, mapped, queried, edited, and analyzed. In addition, streamed vectors and attributes can be saved locally for later use.

Figure 6
Distributed GIS With ArcIMS
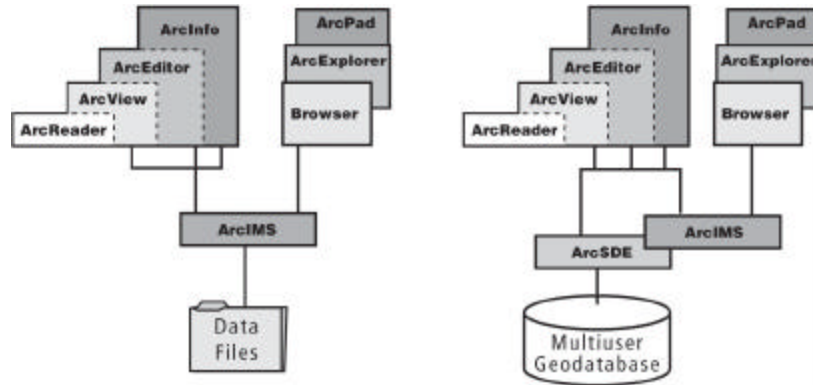
ArcIMS allows a new and dramatic architecture supporting dynamic integration of loosely coupled (Intranet/Internet) GIS clients and servers. This architecture allows clients to integrate local GIS data with ArcIMS layers served from multiple Web sites. This "data fusion" is revolutionizing the use, scope, and impact of GIS. Geographic data providers using ArcIMS to publish live maps, downloadable data, and Web services can register their sites on the Geography Network[SM]. For more information, visit www.geographynetwork.com

ArcPad　　ArcPad software is mobile geographic information system technology. It makes data collection in the field easy and efficient. Users can create a copy of their GIS data using ArcGIS Desktop, and it is ready to use on a handheld mobile device. Data can also be provided from the Internet using ArcIMS via wireless technology. Global positioning system (GPS) receivers can optionally be added, facilitating direct data capture. Data is now immediately available and validated in the context of an actual map.

Summary　　The 8.1, 8.2, and 8.3 releases of ArcGIS meet the ESRI plan for a single, scalable software architecture. As a result, ArcView and ArcInfo have merged into a single, integrated platform with a new deployment option known as ArcEditor positioned between them. This release contains a common architecture, common code base, common extension model, and single development environment for ArcView and ArcInfo. This is something that ESRI and its users have wanted for many years.

Scalability—How well a solution to some problem will work when the size of the problem increases　　Furthermore, the ArcGIS system is designed to interoperate with existing enterprise technology, applications, and databases. Through the use of standards such as COM, XML, and SQL, ArcGIS can integrate with enterprise databases, Web servers, and complementary applications for enterprise resource management, customer relationship management, and land management.

In summary, the 8.1, 8.2, and 8.3 releases comprise a major breakthrough in the GIS field. ArcGIS is a comprehensive, integrated scalable system designed to meet the needs of a wide range of GIS users. Organizations deploy multiple ArcReader, ArcView, ArcEditor, ArcInfo, ArcSDE/ArcIMS application servers, and ArcPad in a configuration appropriate for their GIS needs. For more information, visit the ESRI Web site at www.esri.com/arcgis .
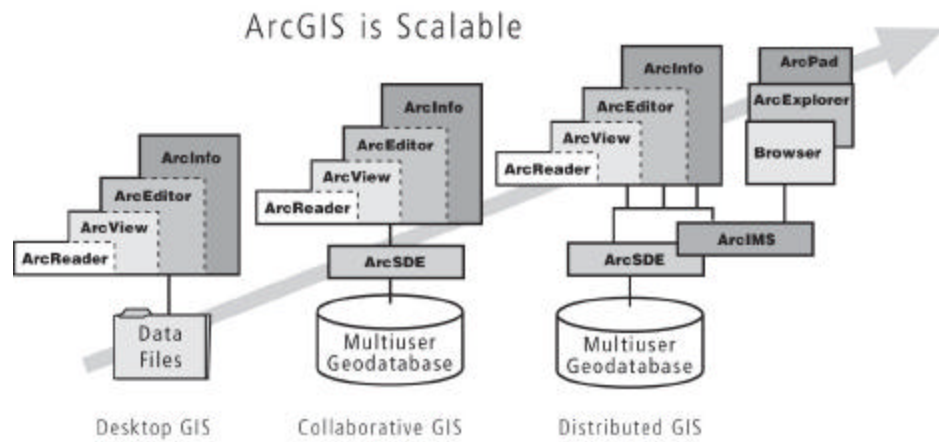
Appendix A: Glossary

ArcEditor includes all the functionality of ArcView and adds the power to edit features in a multiuser geodatabase.

ArcGIS is a scalable system of software for geographic data creation, management, integration, analysis, and dissemination for every organization, from an individual to a globally distributed network of people.

ArcGIS Data Models provide a ready-to-use framework for modeling and capturing the behavior of real-world objects in a geodatabase.

ArcGIS Desktop refers to ArcReader, ArcView, ArcEditor, ArcInfo, and ArcGIS extensions.

ArcGIS extensions add functionality to the core capability of ArcView, ArcEditor, and ArcInfo.

ArcIMS provides the foundation for disseminating high-end GIS and mapping services via the Internet.

ArcInfo includes all the functionality of ArcView and ArcEditor and adds the advanced geoprocessing capabilities that make it the most comprehensive GIS available.

ArcObjects is a collection of software components with GIS functionality and programmable interfaces.

ArcReader is a free, easy-to-use product that allows anyone to view, explore, and print published map files.

ArcSDE is an application server that facilitates storing and managing spatial data (raster, vector, and survey) in a database management system.

ArcView provides high-quality visualization, query, analysis, integration, and basic geographic data automation.

Behavior describes how an object can be edited and displayed. Behavior includes, but is not limited to, relationships, topology rules, subtypes, and default values.

Concurrent Use License (also known as floating license) is controlled by a license manager operating on an organization's network and can be checked out by any computer on the network.

Coverage is a file-based vector data storage format for storing the location, shape, and attributes of geographic features with topology.

Custom features are intelligent and may have behavior, editing rules, and relationships.

Floating License (See Concurrent Use License.)

Geodatabase (short for geographic database) is composed of two major concepts. First, a geodatabase is a physical store of geographic information inside a DBMS. Second, a geodatabase has a data model that supports transactional views of the database (versioning) and also supports objects with attributes and behavior (intelligent features). Behavior describes how an object can be edited and displayed. Behavior includes, but is not limited to, relationships, validation rules, subtypes, and default values.

The **Geography Network** is a global community of data providers who are committed to providing immediate access to the latest maps, data, and related services.

A **shapefile** is a file-based vector data storage format for storing the location, shape, and attributes of geographic features without topology.

Single Use License (previously known as fixed license) permits software operation on one computer.

Versioning allows simultaneous editing by multiple editors and transactional views of the geodatabase.

Appendix B: What's New at 8.1

This appendix lists an overview of the major new features included in the 8.1 release.

ArcView 8.1   The following are major new features of ArcView 8.1:

- Internet-enabled, operates as a client to ArcIMS
- On-the-fly, layer-level projection and datum transformation (vector and raster)
- Enhanced editing tools

    ? Ability to edit in either map space or layout view, edit multiple layers simultaneously, and undo and redo edit operations
    ? Advanced feature construction including bearing and distance, parallel to segment, intersection, parametric curves, and polygon autocomplete
    ? Improved feature editing including extend, flip, divide, and scale and improved vertex editing

- Support three-dimensional coordinates and linear measures (e.g., dynamic segmentation)
- Support for the creation and management of static annotation
- Improved map interaction

    ? Spatial bookmarks, map tips, magnification window, overview window, and identification of works across data layers

- Exceptional map production

    ? Map templates, map rotation, transparent layers, multifield labeling, and splined labels on the fly

- Metadata creation and reporting
- New image tools including rectification, rotation, and flip
- Ability to produce MrSID images from input images of up to 50 MB
- New export graphic formats including PDF, EMF, TIF, and EPS
- COM-based customization
- OLE container (insert OLE objects within ArcMap)
- Intuitive Windows interface
- Import ArcView 3.x APR and AVL files

ArcEditor 8.1   ArcEditor is a new software release positioned between ArcView and ArcInfo. Including all the functionality of ArcView, ArcEditor adds the power to edit features in a multiuser geodatabase.

ArcInfo 8.1   The following are major new features of ArcInfo 8.1:

- Internet-enabled, operates as a client to ArcIMS
- Single address or batch address geocoding
- Clean and build coverages within ArcMap
- Three-dimensional coordinates and linear measures (e.g., dynamic segmentation)
- Dimensions as a new multiuser geodatabase feature class
- Storage of raster data in a multiuser geodatabase
- Improved tabular data management

  ? On-the-fly dynamic joins between different databases, many-to-one and one-to-many joins or links, and view joined data tables
  ? Charts and reports for tables, statistics on tables, and ability to save results as a table/file and export tables respecting the selection
  ? Ability to show selected records, edit tables, add a table to the layout, and create charts and reports for tables

- New image tools including rectification, rotation, and flip
- Ability to produce MrSID images from input images of up to 50 MB
- Charts dynamically linked to table and map selections
- Includes Crystal Decisions Crystal Reports
- OLE container (insert OLE objects within ArcMap)
- Import ArcView 3.x APR and AVL files

ArcGIS Extensions   The 8.1 release introduces a new set of extensions built on the same architecture. ArcGIS extensions add functionality to the core capability of ArcView, ArcEditor, and ArcInfo. The extensions available at the 8.1 release are

- ArcGIS Spatial Analyst
- ArcGIS 3D Analyst
- ArcGIS Geostatistical Analyst
- ArcGIS StreetMap
- ArcPress for ArcGIS
- MrSID Encoder for ArcGIS
- TIFF/LZW comp ression for ArcGIS

ArcSDE 8.1   The following are major new features of ArcSDE 8.1:

- Support for IBM DB2 and Informix added to the previous support of Oracle and Microsoft SQL Server
- Ability to support a direct connection configuration option allowing ArcGIS Desktop clients to connect directly to the geographic information stored in the DBMS
- Three-dimensional coordinates and linear measures (e.g., dynamic segmentation)
- Dimensions as new geodatabase feature class
- Integrated with ArcEditor and ArcInfo for the storage of raster data in a multiuser geodatabase
- Serverside geocoding services (U.S. nationwide geocoding included at no additional charge.)

Appendix C: What's New at 8.2

This appendix lists an overview of the major new features included in the 8.2 release.

ArcView 8.2, ArcEditor 8.2, and ArcInfo 8.2

The following are major new features of ArcView 8.2, ArcEditor 8.2, and ArcInfo 8.2:

- Spatial Adjustment toolbar—This toolbar adds new functionality for editing. A new Spatial Adjustment toolbar within ArcGIS Desktop allows rubber sheeting, transformation, edgematching, and attribute transfer. Users can complement their existing editing functionality with these new tools.
- Improved labeling and annotation management—Users can rotate labels by angle from an attribute field and manage annotation group properties such as name, specify layer associations, or specify reference scales. In addition, new text formatting tags for dynamic labels and map annotation allow you to dynamically modify the formatting for a portion of text.
- Enhancements to metadata—Metadata enhancements include support for the International Organization for Standardization metadata standard and the ability to publish metadata to the ArcIMS 4 Metadata Server. The ArcIMS 4 Metadata Server creates a central, online metadata repository from metadata created using ArcGIS 8.2 Desktop.
- Improved ArcIMS Integration—The ArcIMS 4 release coincides with ArcGIS 8.2. ArcIMS is ESRI's solution for distributing mapping and GIS data and services on the Web. Within ArcIMS 4 is the ability to create a central repository for publishing and browsing metadata over the Internet using ArcIMS in conjunction with ArcSDE and ArcGIS Desktop (ArcView, ArcEditor, and ArcInfo). Metadata can be authored using the ArcGIS ArcCatalog application, published to a metadata server, then easily searched by others.
- ArcIMS ArcMap Server—The new ArcIMS ArcMap Server ties ArcGIS Desktop and ArcIMS more closely together. ArcIMS ArcMap Server is an optional ArcIMS extension that allows files created in the ArcGIS ArcMap application or ArcGIS Publisher to be shared over the Internet. With ArcIMS ArcMap Server, users can leverage all the data access and cartographic capabilities of ArcGIS Desktop.
- Support for Military Grid Reference System—Military Grid Reference System (MGRS) grids render the grid zones and 100,000 meter boundaries necessary to refer to a location using the MGRS. ArcGIS Desktop software's MGRS grids follow format guidelines established by the National Imagery and Mapping Agency (NIMA) and conform to the newly adopted U.S. National Grid.
- Updated ESRI Data & Maps 2002 CDs—ArcGIS 8.2 Desktop includes the ESRI Data & Maps 2002 CDs with eight CDs of data. All the United States census-derived layers and attributes are current with Census 2000. All the county, city, place, tract, block group, and block locations are also updated with the most current TIGER or Geographic Data Technology boundary files. World data has been updated to reflect recent changes in international boundaries and time zones.

ArcGIS Extensions
ArcGIS extensions add functionality to the core capability of ArcView, ArcEditor, and ArcInfo. The extensions available at the 8.2 release are

- ArcGIS Publisher
- ArcGIS StreetMap Europe

The following enhancements were made to these existing ArcGIS extensions:

- ArcGIS Spatial Analyst—Includes a number of new groundwater and multivariate functions.
- ArcGIS 3D Analyst—The new Animation toolbar in ArcGIS 3D Analyst includes tools that enable users to easily create flybys, give layers motion, smoothly transition sun position and background color, fade in and out layer visibility, and create AVI files.

ArcSDE 8.2
The following are major new features of ArcSDE 8.2:

- Support for Oracle9*i*—ArcSDE 8.2 for Oracle extends standards-based spatial data storage and functions to the latest generation of the Oracle database.
- Support for 9*i* Locator—ArcSDE 8.2 for Oracle fully supports 9*i* Locator and 9*i* Spatial in addition to ESRI's own compressed binary format. The support of 9*i* Locator is the most recent advancement in the close integration of ArcSDE with the Oracle database. 9*i* Locator is a nonpriced feature that provides spatial services to both the 9*i* Standard and Enterprise databases.
- Support for Linux Servers—ArcSDE 8.2 for Oracle is the first ArcSDE release that supports Linux servers. Support of Red Hat Linux on Intel-based servers is a continuation of ESRI's commitment to open solutions.
- Improved Raster Data Management—ArcSDE provides support for storing and managing all raster data formats supported by the ArcGIS Desktop applications with options for storing raster data with no compression or with data compression (recommended) using lossless (LZ77 compression) or lossy (JPEG compression), "pyramids" (a series of reduced resolution representations of each raster data set) for improved display performance, and caching for fast redisplay.

Appendix D: What's New at 8.3

This appendix lists an overview of the major new features included in the 8.3 release.

ArcView 8.3

The following are major new features of ArcView 8.3:

- Extend and trim tools
- Improved annotation tools
- Map topology (shared editing) tools
- Snap indicator and snap tips
- Sticky move tolerance
- Tool palette: midpoint, end point arc, direction–distance, and tangent curve tools
- Check in/Check out data (personal geodatabase) for use with ArcPad
- Linear referencing: display and query only
- Updated ESRI Data & Maps 2003
- Support for Visual Studio .NET
- Tablet PC Support for ArcGIS

ArcEditor 8.3

In addition to the key ArcView 8.3 enhancements, the following are major new features of ArcEditor 8.3:

- Full topology support
- Advanced editing environment to support topological relationships
- Plan entry tools: traverse, fillet, inverse, and proportion
- Disconnected editing tools
- Check in/Check out data (multiuser geodatabase) for use with ArcPad
- Complete linear referencing tools to create, edit, display, and analyze linear referencing data (routes and events)
- New ArcEditor single use license

ArcInfo 8.3

In addition to the key ArcView 8.3 and ArcEditor 8.3 enhancements, the following are major new features of ArcInfo 8.3:

- Route Event Geoprocessing wizard to overlay, dissolve, concatenate, and transform events

ArcGIS Extensions

ArcGIS extensions add functionality to the core capability of ArcView, ArcEditor, and ArcInfo. The extensions available at the 8.3 release are

- ArcGIS Survey Analyst
- ArcGIS Tracking Analyst
- ArcScan for ArcGIS

ArcSDE 8.3   In addition to providing better performance and scalability for large enterprise deployments, ArcSDE 8.3 provides

- Additional platform support including support for HP Tru64 UNIX, IBM RS/6000 AIX, and Sun Solaris 64-bit with 64-bit Oracle9*i*
- Support for Oracle9*i* release 2 for all server platforms except SGI IRIX
- Support for disconnected editing for mobile field-workers with ArcEditor 8.3 single use

Appendix E: The Geodatabase

ArcGIS is fundamentally based on a data model called the geodatabase (short for geographic database). The geodatabase has two major concepts. First, a geodatabase is a physical store of geographic information inside a DBMS. Second, a geodatabase has a data model that supports transactional views of the database (versioning) and also supports objects with attributes and behavior (intelligent features). Behavior describes how an object can be edited and displayed. Behavior includes, but is not limited to, relationships, topology rules, subtypes, and default values.

Three key features of a geodatabase are

1. Centralized management of a wide variety of geographic information in a DBMS
2. Versioning that allows simultaneous editing by multiple editors and transactional views of the geodatabase
3. Custom (or intelligent) features that have properties, behavior, and relationships

Centralized GIS Data Management

The first key feature of the geodatabase is the centralized storage of a wide variety of geographic information in a DBMS. This is the natural solution for handling the growing amount of digital spatial data and also meets the need to leverage this data among the growing numbers of GIS users. The geodatabase supports multiple formats of spatial data including

■ Simple features such as shapefiles
■ Custom features with business logic and editing rules
■ Attribute data
■ Metadata
■ Images
■ Raster data (images and grids)
■ Computer-aided design (CAD) data

Versioning

The second key feature of the geodatabase is *versioning*. Versioning allows simultaneous editing by multiple users and also allows transacted views of the geographic database. This framework lets you create versions of a geodatabase for the states of a project, reconcile diffe rences between versions, and update the master version of a geodatabase with the design as-built. Versioning is not supported by the personal geodatabase. For more information on versioning, download the white paper titled *Managing Workflow with Versions* from support.esri.com.

Intelligent Features

The third key feature of the geodatabase is that you can add intelligence to features in the form of behavior, editing rules, and relationships. In addition to modeling generic features such as points, lines, and areas, you can create features that more closely resemble real-world objects such as parcels, buildings, and transformers. Features with

relationships and rules are known as custom features. Custom features can be created without any programming using ArcEditor or ArcInfo. Optionally, you can use computer-aided software engineering tools to create custom features and a geodatabase schema from a Unified Modeling Language diagram. The essential idea is that an intelligent database contains business rules and business objects. As a result, GIS applications require less customization and programming.

Personal Versus Multiuser

Geodatabases can be implemented as personal or multiuser. The first key difference between the two is the data format. A personal geodatabase uses the Microsoft Jet format and is stored in a Microsoft Access file. Multiuser geodatabases are stored in a DBMS managed by ArcSDE. The second key difference is that versioning is not supported in the personal geodatabase. The third key difference is that the personal geodatabase cannot store images.

Of special note is that ArcView cannot create custom features or establish behavior in a personal geodatabase, while ArcEditor and ArcInfo contain that functionality. Table E-1 summarizes the differences among a personal geodatabase created with ArcView, a personal geodatabase created with ArcEditor or ArcInfo, and a multiuser geodatabase.

Table E-1
Personal Geodatabase and Multiuser Geodatabase Comparison

	Personal Geodatabase With ArcView	Personal Geodatabase With ArcEditor or ArcInfo	Multiuser Geodatabase
Number of concurrent editors	One	One	Many
Create and edit simple features (points, lines, areas, static annotation)	✓	✓	✓
Define and use attribute domains	✓	✓	✓
Set database schema	✓[1]	✓	✓
Versioning (long transactions)			✓
Store raster data			✓
Create and edit features with subtypes or dimension features		✓	✓
Establish behavior (topology, relationships, geometric networks, feature-linked annotation, etc.)		✓	✓
Create and edit custom features		✓	✓
Database size	$\leq 250K$ features[2]	$\leq 250K$ features[2]	Unlimited
Requires ArcSDE			✓
Supported databases	Microsoft Jet	Microsoft Jet	Oracle Microsoft SQL Server IBM DB2 IBM Informix

[1] Limited to simple features in a personal geodatabase.

[2] This is an approximate limit affected by two factors—file size and computer memory. Microsoft Jet 4.0 used by the personal geodatabase has a 2 GB file size limit. In addition, a personal geodatabase is a single file that is loaded into computer memory. Therefore, performance can become unacceptable even for file sizes less than 2 GB. The recommended 250,000 feature limit is based on ESRI's experience with typical GIS data sets stored in a personal geodatabase.

Geodatabase Topology

Topology is implemented as a set of integrity rules that define the behavior of spatially related geographic features and feature classes. Topology rules, when applied to geographic features or feature classes in a geodatabase, enable GIS users to model spatial relationships such as connectivity (e.g., are all of my road lines connected?) and adjacency (e.g., are there gaps between my parcel polygons?). Topology is also used to manage the integrity of coincident geometry between different feature classes (e.g., are the coastlines and country boundaries coincident?).

ArcEditor and ArcInfo also include a collection of spatial operators (editing tools) to edit the shared geometry and to help discover errors in the spatial relationships based on the rules the user has applied.

ArcGIS geodatabase topology provides a powerful, flexible way for you to specify the rules for establishing and maintaining the quality and integrity of your data as well as a suite of tools specifically designed to support topological geodatabase editing and maintenance. The benefits of defining a topology in the geodatabase model include

- Better data management—You select which feature classes participate in a topology.
- More flexibility—Multiple polygon, point, and line feature classes can participate in a topology.
- Improved data integrity—You specify the appropriate topological rules for your data.
- More opportunities for data modeling—A much greater number of possible spatial constraints can be applied to your data.
- ArcSDE multiuser environment—Take advantage of ArcSDE and the multiuser editing environment.
- Large map layers—Extremely large continuous map layers are stored in a single database.

Topology in the geodatabase model offers a flexible environment along with the ability to define and apply a wider set of integrity rules and constraints. As a result, almost any work flow can be employed in which topological integrity is analyzed only at designated times specified by the user. The user is no longer forced to rerun a clean command to rebuild topology. The user can choose to validate the geodatabase topology at any time, perform queries and analyses using the geodatabase data, and continue to produce high-quality maps.
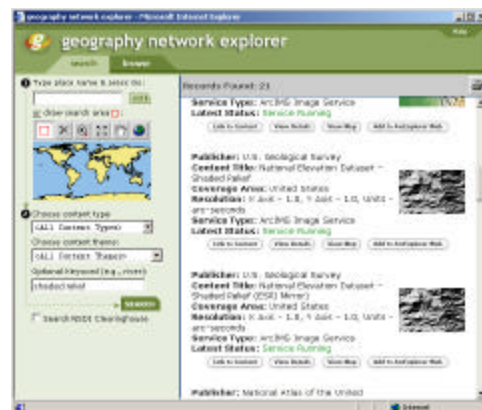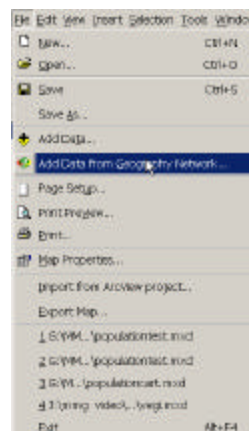
Appendix F: ArcGIS Desktop and ArcIMS

ArcView 8.x, ArcEditor 8.x, and ArcInfo 8.x operate as clients to ArcIMS services allowing you to work with data served over the Internet like any other data source. All ArcIMS services fall into two broad categories: MapServices and GIS services.

An ArcIMS MapService delivers a map to the client as either an image or as streamed features. An Image MapService delivers a snapshot of the map to the client as a compressed JPEG, PNG, or GIF file. A new map image is created each time the client requests new information. A Feature MapService streams compressed vector features to the client. This enables tasks such as feature labeling, feature symbolization, map tip creation, and spatial selection of features. ArcIMS GIS services include geocoding, database queries, and data extraction or clipping.

The standard toolbar allows you to easily add Internet servers and browse the available MapServices. In addition, many data providers register their ArcIMS services on the Geography Network. The Geography Network (www.geographynetwork.com) is a portal for immediate access to maps, data, and related geographic services over the Internet.

ArcGIS Desktop easily accesses data from the Geography Network with a few simple commands. The **Add Data from Geography Network** command opens the Geography Network Explorer and lets you browse and access MapServices offered by various data publishers.

In this case we accessed an Image MapService provided by the U.S. Geological Survey. A snapshot of the map is displayed within ArcView, ArcEditor, or ArcInfo.

Integrate GIS data stored locally with data from the Geography Network and other ArcIMS servers as illustrated below.

Appendix G: Frequently Asked Questions

General Questions

Q.   Is ArcGIS comparable to Microsoft Office?

A.   Yes and no. Like Microsoft Office, ArcGIS is a tightly integrated family of software. Unlike Microsoft Office, the various software of ArcGIS are sold and licensed separately.

Q.   What operating systems are required for ArcView 8.3, ArcEditor 8.3, and ArcInfo 8.3?

A.   ArcView, ArcEditor, and ArcInfo Desktop operate on Windows NT, Windows 2000, and Windows XP (Home Edition and Professional). ArcInfo Workstation operates on Windows NT, Windows 2000, Windows XP (Home Edition and Professional), and several UNIX platforms.

Q.   What are the recommended hardware requirements for ArcView 8.x, ArcEditor 8.x, and ArcInfo 8.x?

A.   Use an appropriately configured PC for best performance.

- A fast Pentium processor (400+ MHz)
- A minimum of 128 MB RAM (256 MB RAM recommended)
- Fast disks (SCSI as opposed to IDE)
- True color monitor with a minimum of 16 MB video card

Q.   Can I evaluate the ArcGIS extensions?

A.   Users can evaluate the following ArcGIS extensions at no charge: ArcGIS Spatial Analyst, ArcGIS 3D Analyst, ArcGIS Geostatistical Analyst, ArcGIS Publisher, ArcGIS Survey Analyst, ArcGIS Tracking Analyst, ArcScan for ArcGIS, and ArcPress for ArcGIS. Installing the evaluation unlocks the complete functionality of these extensions for a fixed number of days. The ArcGIS Desktop software (ArcView, ArcEditor, and ArcInfo) includes the media for the ArcGIS extensions and instructions for evaluation and purchase.

Q.   I want to develop an application with ArcObjects using a COM-based language such as Visual Basic or C++. How do I acquire the Software Development Kit? How do I deploy my applications?

A.   There is not a separate ArcObjects SDK. ArcView, ArcEditor, and ArcInfo users and developers can access the underlying ArcObjects components. Extensive instructions with samples are provided in the documentation, help, and Web-based help. Of

special note is a new book titled *Exploring ArcObjects* that is a comprehensive guide to programming and customizing ArcGIS. *Exploring ArcObjects* is provided with ArcGIS as an Adobe® Acrobat® PDF file and is also orderable in printed format.

Deploying custom tools and extensions that operate with licensed ArcGIS software as a host does not require a unique deployment license. If you want to deploy stand-alone ArcGIS applications, run-time licenses of ArcView, ArcEditor, and ArcInfo are available to ESRI business partners.

Q. Do I need ArcIMS installed at my organization to access data over the Internet?

A. No. ArcView, ArcEditor, and ArcInfo are Internet-enabled out of the box and can operate as a client to ArcIMS services available on the Internet.

Q. Does ArcEditor include the ArcEdit subsystem from ArcInfo?

A. No. ArcEdit remains part of ArcInfo Workstation.

Licensing Questions

Q. What are the licensing options for ArcGIS Desktop software (ArcView, ArcEditor, and ArcInfo)?

A. Software licenses are either single use (previously known as fixed) or concurrent use (sometimes known as floating). Single use licenses permit software operation on one computer. Concurrent use licenses are controlled by a license manager operating on an organization's network and can be shared by any computer on the network. A license manager can administer all the different concurrent use software. Multiple license managers can be installed in an organization.

ArcView and ArcEditor are available as either single use or concurrent use licenses. Either way, the functionality of ArcView or ArcEditor is identical. ArcInfo is only available as a concurrent use license.

The ArcGIS extensions are available as single use or concurrent use. Single use extensions only operate with the single use version of ArcView or ArcEditor. Concurrent use extensions operate with concurrent use licenses of ArcView, ArcEditor, and ArcInfo.

Separate from licensing, all the ArcGIS Desktop software can be installed on a single computer—ArcView single use; ArcEditor single use; and concurrent use licenses of ArcView, ArcEditor, and ArcInfo. ESRI provides a Desktop Administrator tool for controlling which software is operational on that machine and listing additional floating licenses available on the network. Users can easily switch between software depending on their role or daily tasks.

J-8583

Q. Can I operate concurrent use ArcGIS extensions with ArcView single use? For example I have three ArcView single use licenses in my organization and want to share one ArcGIS Spatial Analyst among them. Is this technically possible?

A. No. The licensing for the extensions must match the licensing of the core software. Otherwise, the core software cannot recognize the extension. For example, ArcView single use does not recognize concurrent use extension licenses. If you want to operate concurrent use extensions, you need to install concurrent use core software (ArcView concurrent use, ArcEditor concurrent use, or ArcInfo).

Q. How would I configure a laptop computer to operate ArcGIS Desktop software (ArcView, ArcEditor, and ArcInfo)?

A. Installing ArcView or ArcEditor single use is the most apparent choice. This permits operation of ArcView or ArcEditor whether or not connected to the network.

If you require ArcInfo functionality only while connected to the network and not when mobile, install ArcView or ArcEditor single use and ArcInfo on your laptop computer. Use the Desktop Administrator tool to switch among ArcView single use, ArcEditor single use, or ArcInfo depending on the task at hand and whether mobile or not. When mobile, operate ArcView or ArcEditor single use. When connected to the network, you may choose between ArcView or ArcEditor single use and ArcView, ArcEditor, or ArcInfo concurrent use depending on your task and available concurrent use licenses.

If you require ArcInfo functionality when mobile, install a license manager with hardware key on your laptop computer. This allows you to operate ArcInfo when mobile. While connected to the network, the ArcInfo license installed on the laptop computer would be available for use by others on the network when not utilized by the laptop user.

These are typical examples. The licensing options allow flexibility for installing and operating ArcView, ArcEditor, ArcInfo, and the ArcGIS extensions.

Migration Questions for Existing Users

Q. ArcGIS introduces many new concepts. Is training available?

A. Yes. Instructor-led training, Web-based training, and new self-study workbooks are available. Of special interest is a free Web-based course for migrating to ArcView 8.x. Since the interface and operating concepts are identical between the ArcGIS Desktop software, this course is also relevant for ArcEditor and ArcInfo users. For more information about training, go to www.esri.com/training.

Q. How is ArcGIS software packaged?

A. In addition to the full ArcGIS package, there are separate boxes for ArcView single use, ArcView concurrent use, ArcEditor single use, the ArcGIS extensions (single use and concurrent use), ArcSDE, ArcIMS, and ArcPad.

Q.   Will ArcView 3.x extensions work with ArcGIS?

A. No. ArcView 3.x extensions operate with the ArcView 3.x architecture.

Q.   I use ArcView3.3 and have additional questions about migrating to ArcView8.3, where can I find more information?

A. For complete ArcView migration information, go to www.esri.com/arcview.

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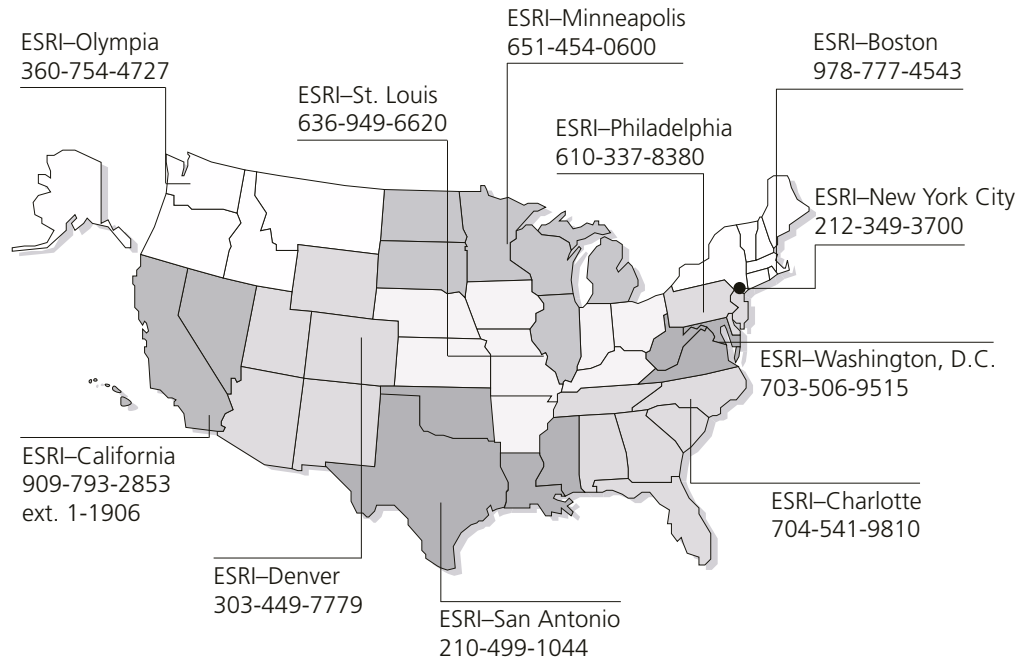or contact an ESRI reseller near you.

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