Chapter 6 – GIS Software

§ 1 Introduction

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§ 5 Types of GIS software systems

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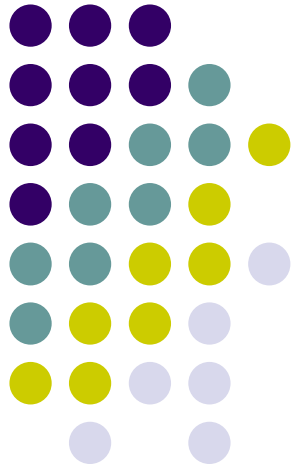
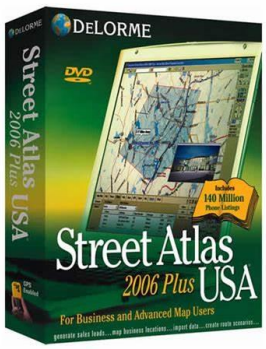
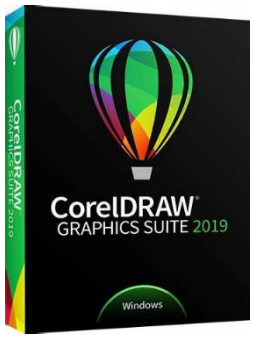
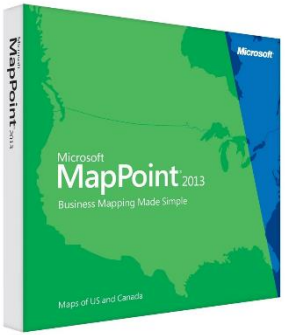


§ 1 Introduction

- The different ways in which GIS capabilities are realized in software products and implemented in operational system
- Takes a fairly narrow view of GIS software, concentrating on systems with a range of generic capabilities to collect, store, manage, query, analyze, and present geographic information
- It excludes atlases, simple graphics and mapping systems, route finding software, simple location-based services, image processing systems, and spatial extensions to database management systems





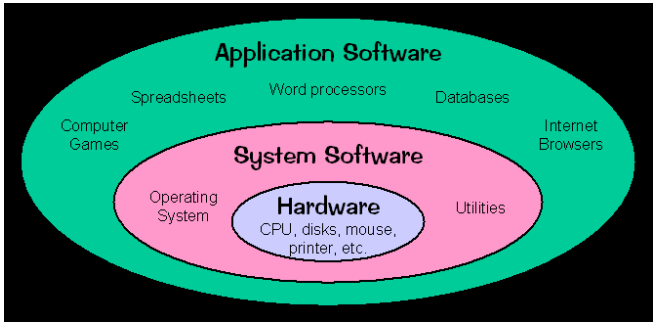


Some GIS-related software

§ 1 Introduction(cont.)

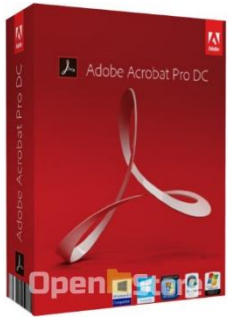
- Programs are collections of instructions that are used to manipulate digital data in a computer
  - System software programs, such as a computer operating system, are used to support applicationsoftware – the programs with which end users interact
  - Integrated collections of application programs are referred to as software packages or systems

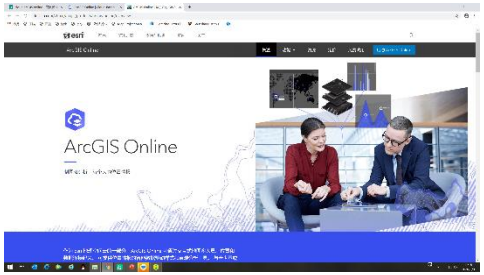
Application Software vs. Operating System



§ 1 Introduction(cont.)

- Software distributed to market in several different ways
  - Sale of commercial-off-the-shelf (COTS) software products on hard copy media
  - Alternative distributionmodels that are becoming increasingly prevalent include *shareware,liteware ,freeware, public domain software, and open source software*
- Internet is becoming the main medium for software distribution
- GIS software vendors – the companies that design,develop, and sell GIS software – build on top of basic computer OS capabilities
- GIS software packages provide a unified approach to working with geographic information

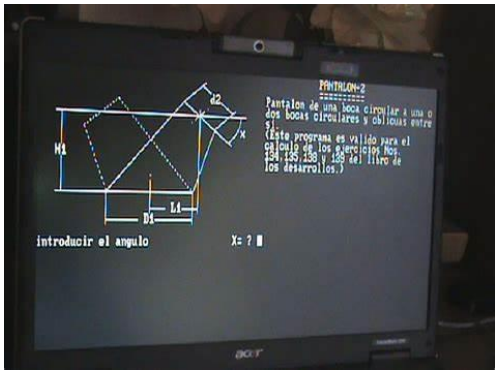




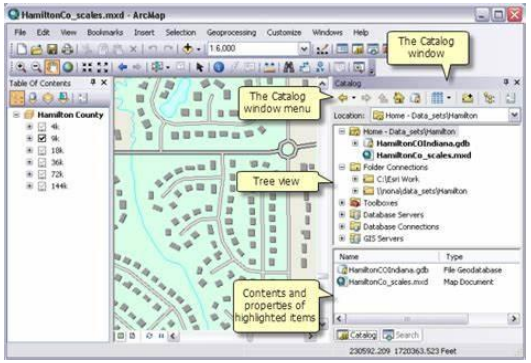
Distribution of software

§ 2 The evolution of GIS software

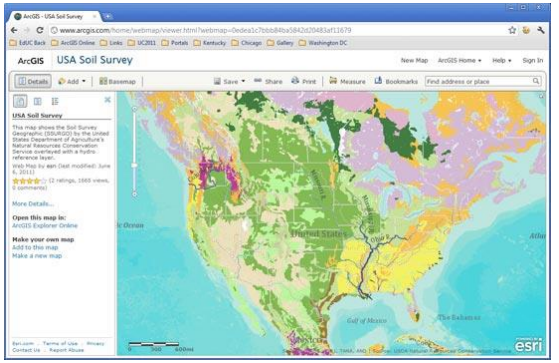
- In the late 1970s and early 1980s the standard means of communicating with a GIS was to type in command lines -- *DOS*
  - a GIS softwarepackage was a toolbox of geoprocessing operators or commands that could be applied to datasets to create new datasets
  - Programming Language: Asembler, Basic, FORTRAN, PASCAL, C, LISP, PROLOG
- two key developments in the late 1980
  - interfaces were replaced by graphical user interfaces(GUIs) – *Windows, Unix*
  - a customization capability was added to allow specific-purpose applications to be created from the generic toolboxes
  - Programming Language: C++, JAVA (Script), Python
- In the last few years a new method allows software systems to communicate over the Web using a Web Services paradigm



Ms-Dos based Graphics

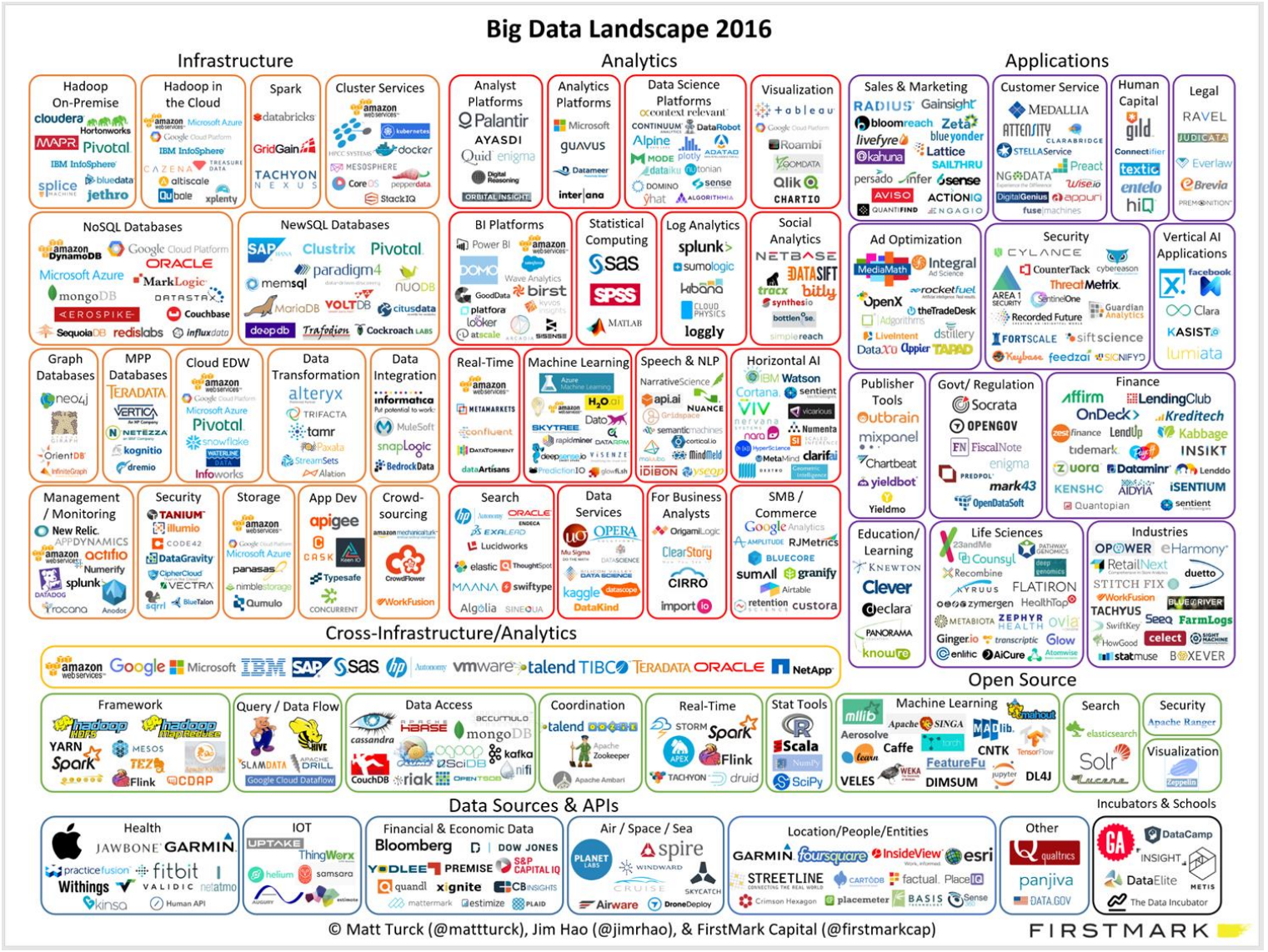


Windows-based GIS



Web-based GIS

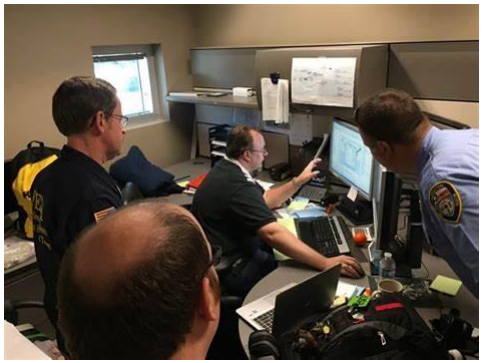
Spectrum of software



§ 3 Architecture of GIS software

§ 3.1 Project, departmental, and enterprise GIS

- GIS is first introduced into organizations in the context of a single, fixed-term project
- As interest in GIS grows, to save money and encourage sharing and resource reuse, several projects in the same department may be amalgamated. This often leads to the creation of common standards, development of a focused GIS team, and procurement of new GIS capabilities
- Through a process of natural growth, and possibly further major procurement (e.g., purchase of upgraded hardware, software, and data), GIS gradually becomes accepted as an important enterprise-wide information system



Project- Level

Department - Level

Enterprise - Level

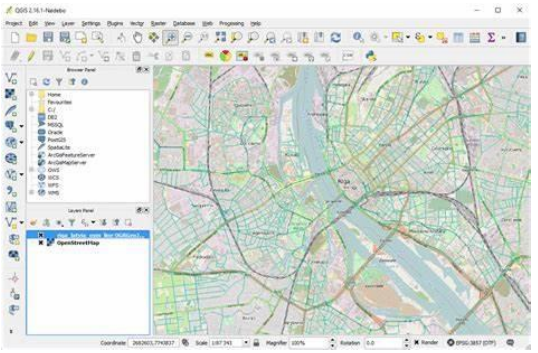
§ 3 Architecture of GIS software(cont.)

§ 3.1 Project, departmental, and enterprise GIS(cont.)

- A type of societal implementation has additionally been identified in which hundreds or thousands of users become engaged in GIS and connected by a network
- *OpenStreetMap* is a map of the world, created by people like you and free to use under an open license. Hosting is supported by UCL, Bytemark Hosting, and other partners

Baidu Map

Map World



Openstreet Map

§ 3 Architecture of GIS software(cont.)

§ 3.2 The three-tier architecture

- GIS software systems deal with user interfaces, tools, and data management
- The presentation tier must be adept at rendering (displaying) and interacting with graphic objects
- The business logic tier is responsible for performing compute-intensive operations such as data overlay processing and raster analysis. It is here also that the GIS data model logic is implemented
- The data server tier must import and export data and service requests for subsets of data from a database or file system

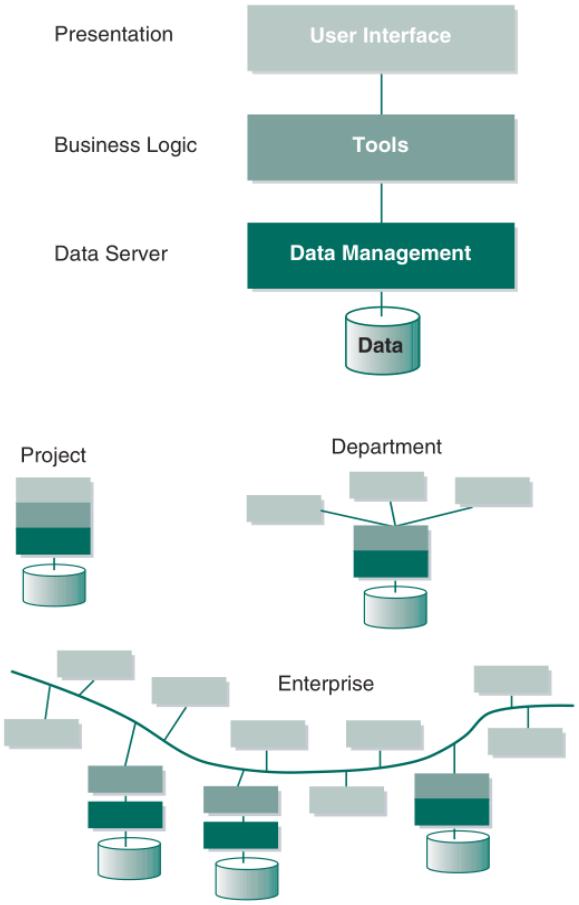
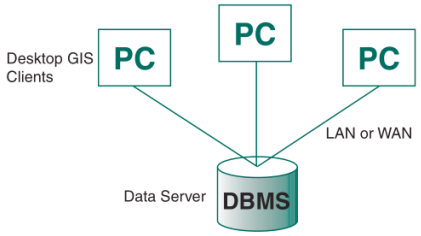


Figure 7.2 Classical three-tier architecture of a GIS software system

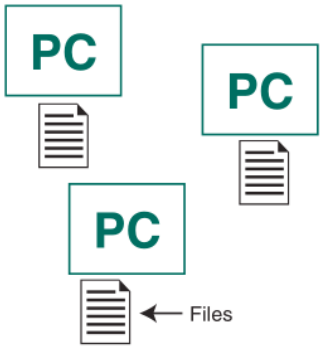
§ 3 Architecture of GIS software(cont.)

§ 3.2 The three-tier architecture(cont.)

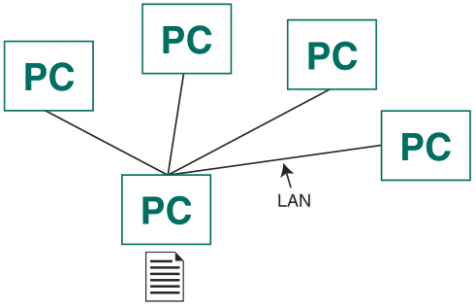
- Four types of computer system architecture configurations are used to build operational GIS implementations:
- Desktop/Client-server/Centralized desktop/Centralized Data server
- In a client-server GIS, clients request data or processing services from servers that perform work to satisfy client requests
- Client/Server vs Browser/Server Architecture



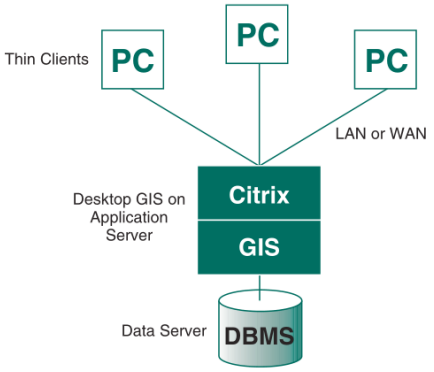
Client-server



Desktop



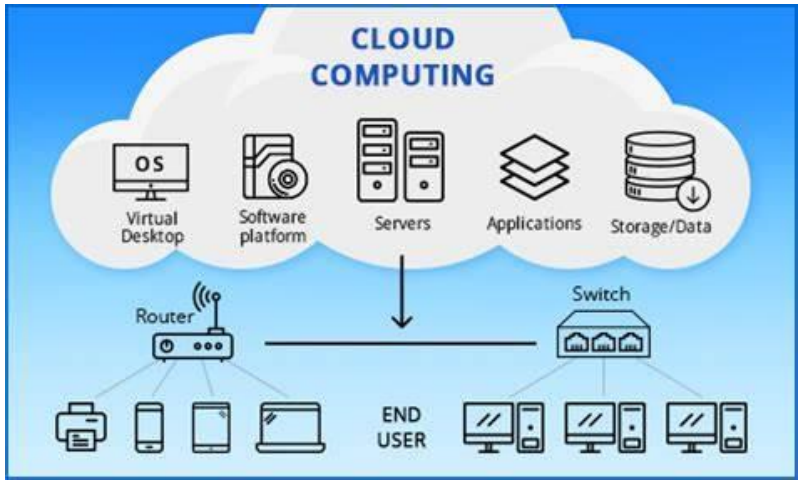
Centralized desktop



Centralized Data server

Cloud Computing

- Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user
- The term is generally used to describe data centers available to many users over the Internet.
- Large clouds, predominant today, often have functions distributed over multiple locations from central servers
- If the connection to the user is relatively close, it may be designated an edge server



Cloud computing

Cloud Providers

§ 3 Architecture of GIS software(cont.)

§ 3.3 Software data models and customization

- A *data model* defines how the real world is represented in a GIS. It will also affect the type of software tools (functions or operators) that are available
  - Data model is very important to software developers that are interested in customizing or extending software
- *Customization* (二次开发)is the process of modifying GIS software to, for example, add new functionality to applications, embed GIS functions in other applications, or create specific-purpose applications
  - a number of industry standard programming languages (such as Visual Basic, Java, and Python) are available for customizing GIS software systems
  - Integrated Development Environments (IDEs) with an editor; a debugger, and a profiler
  - Programming language, such as C, C#, Visual Basic and Java, support the development of Windows-based GUIs containing forms, dialogs, buttons, and other controls

§ 3 Architecture of GIS software(cont.)

§ 3.3 Software data models and customization（cont.）

- To support customization using open, industry-standard IDEs, a GIS vendor must expose details of the software package's functionality.
- This can be done by creating and documenting a set of application programming interfaces(APIs)
- These are interfaces that allow GIS functionality to be called by the programming tools in an IDE

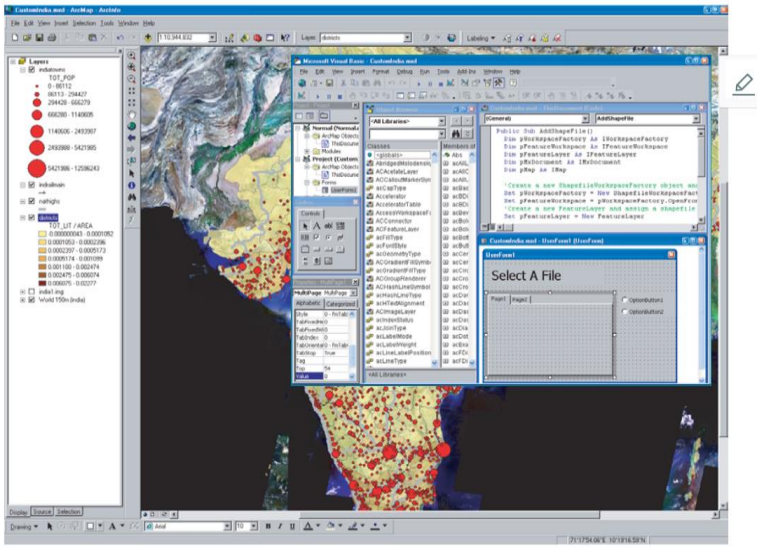
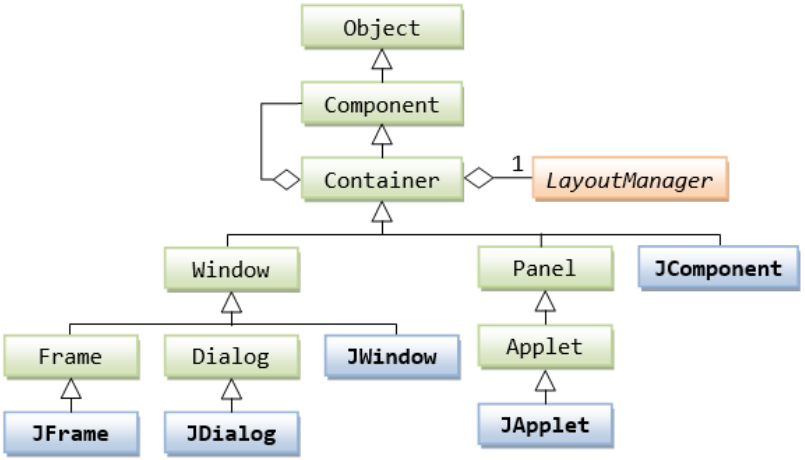


Figure 7.7 The customization capabilities of ESRI's ArcGIS 9. ESRI chose to embed Microsoft's Visual Basic for Applications as the scripting and GUI integrated development environment. The window at the front is the Visual Basic Integrated Development Environment (IDE). The window at the back is ArcMap, the main map-centric application of ArcInfo (see also Box 7.3)



Java Framework

§ 3 Architecture of GIS software(cont.)

§ 3.4 GIS on the desktop andon the Web

- high-end GIS users work primarily with software that runs either on the desktop or over the web
- Desktop uses PC and Windows, with C/S, .net and many other Microsoft local products
  - The Windows-based client-server system architecture is a good platform for hosting interactive, high-performance GIS applications
  - Usually for internal management purpose
- Network GIS can use the cross-platform Web browser to host the viewer user-interface
  - Clients are very thin, often with simple display and query capabilities
  - Server-side functionality may be encapsulated on a single server, or two servers containing the business logic (a middleware application server) and the data manager (data server)
- Combination of desktop with network GIS

§ 5 Types of GIS software systems

- Over 100 commercial software systems claim to have mapping and GIS capabilities
- Esri. Inc., Hexagon AB, The US Geological Survey, and MacDonald, Dettwiler and Associates Ltd are the key vendors in the GIS market
- The other vendors who potentially take part in GIS market growth are Astrium, Autodesk, AvisMap GIS Technologies, Bentley Systems, Digital Globe, GE Energy, Geo Eye etc

GIS Vendors

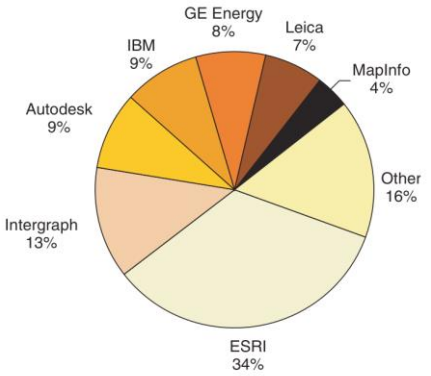


Figure 7.10 GIS 2003 software vendor market share (Courtesy Daratech)

§ 5 Types of GIS software systems

§ 5.1 Desktop GIS software

- Desktop GIS are the mainstream workhorses of GIS today
- In the late 1990s, a number of free GIS viewers that can display and query popular file formats
- GIS viewer has developed into a significant product subcategory
- With their focus on data use, rather than data creation, and their excellent tools for making maps, reports, and charts, desktop mapping and GIS software packages represent most people's experience of mainstream GIS today
- Professional GIS are high-end, fully functional systems
- The distinctive features of professional GIS include data collection and editing, database administration, advanced geoprocessing and analysis, and other specialist tools

§ 5 Types of GIS software systems

§ 5.2 Server GIS

- A server GIS is a GIS that runs on a computer server that can handle concurrent processing requests from a range of networked clients
- Stimulated by advances in server hardware and networks, the widespread availability of the Internet and market demand for greater access to geographic information, GIS software vendors have been quick to release server-based products,such as ESRI ArcGIS Server
- Internet GIS have the highest number of users, although typically Internet users focus on simple display and query tasks
- Today, it is routinely possible to perform standard operations like making maps, routing ,publishing census and suitability analysis
- The second generation server GIS products were strong on architecture and exploited the unique characteristics of the Web by developing GIS technology that integrates with Web browsers and servers

§ 5 Types of GIS software systems

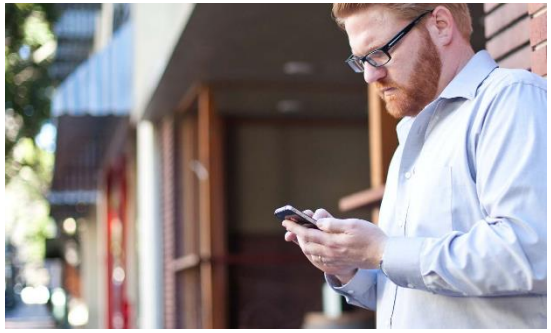
§ 5.3 Developer GIS

- Developer GIS products are collections of components used by developers to create focused applications
- Collections of GIS software components oriented toward the needs of developers, which a reasonably knowledgeable programmer can use to build a specific purpose GIS application
- Examples of component GIS products include Blue Marble Geographics GeoObjects, ESRI ArcGIS Engine, and MapInfo MapX
- Most are built on top of Microsoft's *.Net* technology standards
- There are several cross platform choices (e.g., ESRI ArcGIS Engine) and several *Java-based toolkits* (e.g., ObjectFX SpatialFX and Engenuity JLOOX)

§ 5 Types of GIS software systems

§ 5.4 Mobile GIS

- Mobile GIS are lightweight systems designed for mobile and field use
- Extends GIS beyond the office, allows organizations to make accurate, real-time business decisions and collaborate in both field and office environments, and decrease task redundancy and keep data more current
- 60% app is related locations, potentially GIS application to some extent
- Benefits of Mobile GIS
  - Improves efficiency and accuracy of field operations with GPS
  - Provides rapid data collection and seamless data integration
  - Replaces paper-based workflows
  - Helps you make timely and informed decisions



Mobile GIS

§ 6 Conclusion

- GIS software is fundamental and critical part of any operational GIS
- The software employed in a GIS project has a controlling impact on the type of studies that can be undertaken and the results that can be obtained
- There are far reaching implications for user productivity and project costs
- There are many types of GIS software products to choose from and a number of ways to configure implementations
- One of the exciting characteristics of GIS is its very rapid development
- This is a trend that seems set to continue as the software industry pushes ahead with significant research and development efforts