STANDARD SOFTWARE FOR GIS

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STANDARD SOFTWARE FOR GIS

Software that is used to create, manage, analyze and visualize geographic data is usually incorporated under the umbrella term 'GIS software' (Steiniger & Weibel, 2009). Typical applications for GIS software include the evaluation of places for the location of new stores, the management of power and gas lines, the creation of maps, the analysis of past crimes for crime prevention, route calculations for transport tasks, the management of forests, parks and infrastructure, such as roads and water ways, as well as applications in risk analysis of natural hazards, and emergency planning and response. For this multitude of applications different types of GIS functions are required and different categories of GIS software exist, which provide a particular set of functions needed to fulfil certain data management tasks. Different functional categories of GIS software can be identified with respect to the tool sets that GIS software offers, and with respect to the tasks that can be accomplished. Such tasks involve basic activities that are common to daily computer usage such as (1) data visualization and exploration, (2) data creation, (3) data editing and (4) data storage. Other common GIS tasks include (5) data conflation, i.e., integration of data from different sources (Blasby, Davis, & Kim, 2002), (6) data queries to select a subset of the data, (7) data analysis, which we consider to be the creation of new information (output) from existing data (input), (8) data transformation, as some analysis tasks require the user to transform, or manipulate, the data beforehand (e.g. transform the data into a different coordinate system, or convert them from raster to vector format), and lastly, (9) the creation of maps - the most common method used to visualize analysis and query results. (Hunter & Steiniger, 2012).

GIS software is the processing engine and a vital component of an operational GIS. It is made up of integrated collections of computer programs that implement geographic processing functions. The three key parts of any GIS software system are the user interface, the tools (functions), and the data manager. All three parts may be located on a single computer or they may be spread over multiple machines in a departmental or enterprise configuration. (Longley, 2005).

Steiniger and Weibel (2009) identified seven major types of GIS software: (i) Desktop GIS, (ii) Spatial Data Base Management Systems (SDBMS), (iii) Web Map Server, (iv) Server GIS, (v) Web GIS clients, (vi) Mobile GIS, and (vii) Libraries and Extensions. For the purpose of this survey we did split the last category "Libraries and Extensions" into the two categories: "Libraries" and "GIS Extensions, Plug-ins and APIs". Web Map Server and Web GIS clients have been subsumed under the category "Software for Internet Mapping Applications".

Furthermore, we extend the set to include two additional categories (viii) Remote Sensing Software, which could be considered a special form of desktop GIS, and (ix) Exploratory Spatial Data Analysis (ESDA) software. Fig. 1 characterizes the different software types with respect to GIS functionality as defined above.

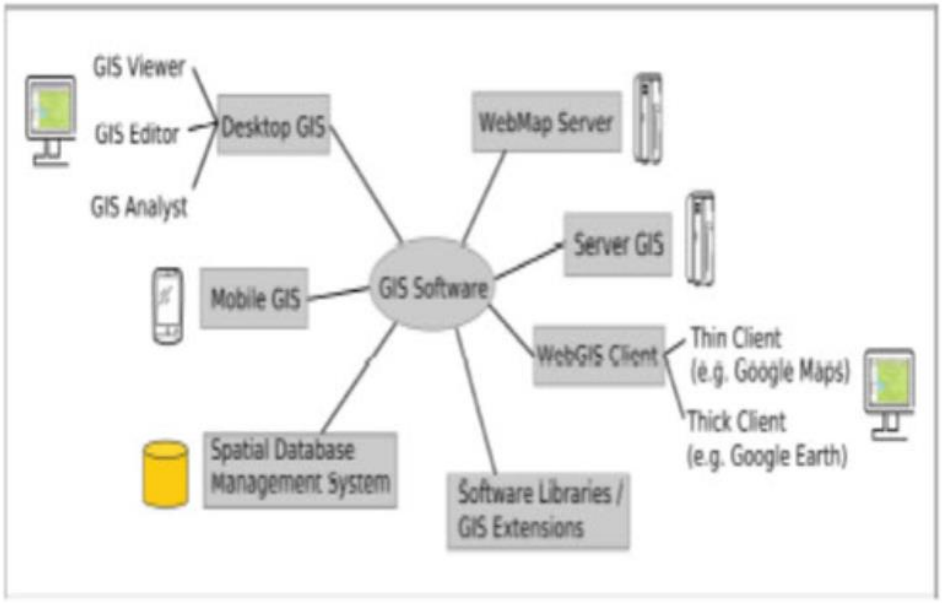

Fig. 1. Different types of GIS software.

1.1 Popular GIS packages

A large number of GIS software options are available as open-source or commercial products. Following is a brief summary of some of the more popular GIS packages. A large listing of GIS software can be found at http://en.wikipedia.org/wiki/GIS_software.

1.1.1 Proprietary GIS

- **ArcGIS:** ArcGIS is the name of a suite of GIS software product lines produced by ESRI (http://www.esri.com/). At the desktop GIS level, ArcGIS can include: ArcReader, which allows one to view and query maps created with the other Arc products; ArcView, which allows one to view spatial data, create maps, and perform basic spatial analysis; ArcEditor, which includes all the functionality of ArcView as well as more-advanced tools for manipulation of shape files and geodatabases; or ArcInfo, the most advanced version of ArcGIS, which includes added capabilities for data manipulation, editing, and analysis. There are also server-based ArcGIS products

as well as ArcGIS products for personal digital assistants (PDAs). Extensions can be purchased separately to increase the functionality of ArcGIS.

- **AutoCAD:** AutoCAD is popular engineering CAD software produced by Autodesk (http://usa.autodesk.com/). AutoCAD Map 3D software is a leading engineering platform that bridges the gap between CAD and GIS. When combined with Autodesk Map Guide technology, AutoCAD Map 3D provides a way to publish data to the Web or an intranet.
- **Cadcorp:** Cadcorp (http://www.cadcorp.com/) is the developer of GIS software and Open GIS standard (e.g., Read/Write Open-Source Post GIS database). Products include a Spatial Information System (SIS), which runs on Microsoft Windows and encompasses desktop GIS modules, ActiveX- and COM-based developer kits, Web-based GIS software (GeognoSIS), and a mobile data-capture solution (mSIS).
- **ERDAS IMAGINE:** ERDAS IMAGINE is a raster graphics editor and remote-sensing application designed by ERDAS, Inc. (http://www.erdas.com/). It is aimed primarily at geospatial raster data processing that allows the user to display and enhance digital images. It is a toolbox allowing the user to perform numerous operations on an image and generate an answer to specific geographical questions.
- **IDRISI:** GIS developed by Clark Labs (http://www.clarklabs.org/products/) at Clark University, Massachusetts. IDRISI Andes is an integrated GIS and image-processing software providing over 250 modules for spatial analysis and display. Originally developed under United Nations sponsorship, the IDRISI is widely used worldwide.
- **Intergraph:** Intergraph (http://www.intergraph.com/) provides software and services for infrastructure management for the electric, gas, water, pipeline, utility, and communications industries. Products include GeoMedia, GeoMedia Professional, GeoMedia WebMap, and add-on products for industry sectors, as well as photogrammetry.
- **MapInfo:** MapInfo (http://www.mapinfo.com/) GIS software products include the desktop GIS software, MapInfo Professional, MapXtreme 2005, and MapXtreme Java for Webbased and desktop client mapping, as well as developer tools such as MapBasic.
- **Micro Station:** Micro Station is a suite of CAD/GIS software products for 2-D and 3-D design and drafting, developed and sold by Bentley Systems

(http://www.bentley.com/). It is used by engineering designers for transportation and for water and wastewater utilities. Bentley also offers GIS-based water resources modeling software for water, sewer, and storm water systems (Sewer CAD, Water CAD, and Storm CAD). (Johnson, 2009)

1.1.2 Open-Source GIS

- **GRASS**: GRASS (Geographic Resource Analysis Support System) is a public-domain open-source raster GIS developed as a general-purpose spatial modeling and analysis package (Neteler and Mitasova 2008). GRASS is a raster/vector GIS, image processing system, and graphics production system. GRASS contains over 350 programs and tools to render maps and images on monitor and paper; manipulate raster, vector, and sites data; process multispectral image data; and create, manage, and store spatial data. GRASS uses both an intuitive Windows interface as well as command-line syntax for ease of operation. (Johnson, 2009).

1.2 Desktop GIS Software:

Desktop GIS software is probably the most common GIS software in use. The company ESRI (2012) defines desktop GIS as mapping software that is installed onto and runs on a personal computer and allows users to display, query, update, and analyze data about geographic locations and the information linked to those locations. All traditional GIS tasks, i.e., not tasks related to web and remote processing applications, can be accomplished with a desktop GIS. Sometimes, proprietary GIS software vendors distinguish in software pricing between two or three categories of desktop GIS with respect to the functionality that the software offers. In the case of 3 desktop GIS categories so-called viewer applications offer functionality for viewing and exploring data, while editor applications provide, in addition to viewer capabilities, the ability to create and update spatial data. Analysis GIS software, also termed “Professional edition”, Typically offers the highest level of functionality by adding functions for data analysis, map creation, data conflation, etc., to editor applications. (DeMers, 2009).

1.3 Open Source GIS Software

Due to the lack of money for buying licenses one of the biggest considerations is the use of Open Source software. There are many analyzed software packages with a certified OSI Open Source License **10**. The software is divided into different categories according to what it is used for. (DeMers, 2009).

1.3.1 OGC Spatial servers

There is a set of available software that helps to create OGC services. This software is normally installed in a web server and is configured to publish your data trough OGC standards. More specifically for our purpose we consider the following standards necessary: **WMS, WFS, CSW, and WCTS**.

Degree 11: free software initiative founded by the GIS and Remote Sensing unit of the Department of Geography, University of Bonn, and lat/long. It is the reference implementation for the WMS standard. With more than one single software package, degree is a set of building blocks to construct OGC services. The software is right now under a big rebuild and a new version 2.0mis expected to be released before the end of the year.

- ✓ **OGC Standards supported:** WMS, WFS, WCS, WCAS, WFS-G, WTS, WCTS, and CSW.
- ✓ **Read & Write interfaces:** ORACLE Spatial, PostGres/PostGIS, MySQL, other JDBC-enabled databases, ESRI Shapefiles, several raster data formats (JPEG, GIF, PNG, (Geo) TIFF, PNM und BMP).
- ✓ **Architecture:** Java-servlet

1.3.2 Geoserver 12: again, a free software initiative. It has a good community support behind and some projects funding its further development. It is the reference implementation for the WFS standard. The installation is easy and the documentation complete. Right now, it only supports one feature per table and the mapping of complex schemas is not complete. There are people working on solving those limitations though.

- **OGC Standards supported:** WMS, WFS.
- **Read & Write interfaces:** PostGIS, ESRI Shapefile, ArcSDE and Oracle, VPF, MySQL, MapInfo, KML…
- **Architecture:** Java-servlet (Javier de la Torre)

1.3.3 Mapserver 13: Originally developed at the University of Minnesota (UMN) through the NASA-sponsored ForNet project, a cooperative effort with the Minnesota Department of Natural Resources. The software has grown and is maintained by an increasing number of developers (nearing 20) from around the world and is supported by a diverse group of organisations funding enhancements.

The project started before the creation of these OGC standards and was later adapted to support them up to a certain degree. Right now the WFS service is read only and transactions are not supported. A bigger limitation is the lack of support of filters in feature attributes and POST operations.

- ✓ OGC Standards supported: WMS, non-transactional WFS, and WCS.
- ✓ Read & Write interfaces: ESRI shapefiles, PostGIS, ESRI ArcSDE, TIFF/GeoTIFF, EPPL7
- ✓ Architecture: CGI implemented in C, scripts in different scripting languages. (Javier de la Torre)

1.4 Software Manufacturers and Projects

GIS software is not only provided by companies but increasingly also by free and open source software projects. While commercial vendors usually offer products for all of software categories, open software projects often concentrate on a single category, e.g. desktop GIS or WebMap server. The key players in the GIS software market today are Autodesk, Bentley, ESRI Inc., GE (Smallworld), Pitney Bowes (MapInfo), and Intergraph. GIS software companies tend to target specific application domains. For instance, ESRI's ArcGIS product tends to be mainly used for business analysis, planning, and environmental applications, while Autodesk, GE and Bentley products are rather used in utility and facility management. Competitive GIS software that is developed by free software projects exists as well - especially with respect to server applications (MapServer, GeoServer) and spatial DBMS (PostGIS). Free desktop GIS projects, such as Quantum GIS and gvSIG, currently experience growing user communities. Such free GIS software rather complements the set of proprietary software instead of competing with it. (Steiniger and Weibel, 2009).

Table 1.1. Sites of proprietary software suites and to those providing programs which are shareware, or low cost, or entirely free of license.

Software	Link
Autodesk	www.usa.autodesk.com
ERDAS	www.erdas.com
ER Mapper	www.ermapper.com
ESRI	www.esri.com
FME Safe Software	www.safe.com
Geo tools	www.geotools.codehaus.org
Global Mapper	www.globalmapper.com
GRASS	www.grass.itc.it
Idrisi	www.clarklabs.org
ILWISS	www.itc.nl/ilwis
ITTVis ENVI	www.ittvis.com/envi
JUMP GIS	www.jump-project.org
Landserf	www.landserf.org
Map Window	www.mapwindow.org
MapInfo	www.mapinfo.com
PCI Geomatics	www.pcigeomatics.com
Quantum GIS opensource	www.qgis.org
SAGA GIS	www.saga-gis.org
Various independent	www.rockware.com
Variowin	www.sst.unil.ch/research/variowin
Virtuozo	www.supresoft.com.

Table 1.2. Data sources including online satellite imagery from major suppliers, Dem data plus GIS maps and data of all kinds.

ALOS data search	www.cross.restec.or.jp
Asia Pacific Natural Hazards Network	www.pdc.org/mde/explorer.jsp
Digital Globe (Quickbird & WorldView)	www.browse.digitalglobe.com
Earth Explorer	www.earthexplorer.usgs.gov

Table 1.3. Online resources for information, software and data.

ALOS data search	www.cross.restec.or.jp
EOS Data Gateway edcims	www.cr.usgs.gov/pub/imswelcome/plain.html
ESA EOLI catalogues	www.catalogues.eoportal.org
Geo Community GIS free data depot	www.data.geocomm.com
GeoEye (GeoFUSE)	www.geofuse.geoeye.com/landing
GIS data depot	www.gisdepot.com
GIS Lounge	www.gislounge.com
GLCF	wwwlcf.umiacs.umd.edu
Glovis	www.glovis.usgs.gov
SPOT catalogue	www.sirius.spotimage.fr
SRTM Public Data	www2.jpl.nasa.gov/srtm/cbanddataproducts.html

GIS software is a 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 also far reaching implications for user productivity and project costs. Today, there are many types of GIS software product to choose from and a number of ways to configure implementations. One of the exciting and at time sun nerving characteristics of GIS software is its very rapid rate of development. This is a trend that seems set to continue as the software industry pushes ahead with significant research and development efforts

References

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- ✓ Hunter, A.J.S and Steiniger, S. (2012), The 2012 Free and Open source GIS Software Map – A Guide to facilitate Research, Development and Adoption, Computers, Environment and Urban Systems.
- ✓ Javier de la Torre, Report of existing GIS standards and software – Deliverable 3.6.1, Synthesys NA- D 3.6.