GRASS status and future development

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Abstract

GRASS is unanimously recognised as the leading Free Software/Open Source Geographic Information System project. It is part of a vast and correlated set of FOSS projects for the management of geographic information. This paper reports an up to date review of GRASS status and its future development.

1. Introduction

The development of Free Software/Open Source Geographic Information Systems has known a significant acceleration during the last years, acceleration probably more sensible than that of all the rest of FOSS software. While this is certainly due to the growing interest in GIS, a strong reason is the increasing demand of integration and interoperability which is not always met by proprietary GIS. In fact, despite the lack of central development coordination, all the FOSS systems for the management of geographic information offer good interoperability and adherence to open standards.

The new GRASS 6.0 release brings significant enhancements in many aspects of the management and elaboration of geographic information, in particular for the vector data which benefit from the reimplemented vector library.

2. FOSS systems for geographic information management

FOSS system for the management of geographic information cover the whole spectrum of applications of this kind of systems. A comprehensive list is given in table 1: these systems range from data visualisation, simple editing to full management and elaboration and dissemination through the Web. As stated in section 1., one of the strong appealing feature of these FOSS systems is their good interoperability, so that it is possible to combine different systems to obtain an integrated system for the management, elaboration and distribution to the final user of the geographic data. The implementation of this approach is one of the main goals of the new GRASS 6.0 release, which relies on the external GDAL/OGR libraries for data input/output and allows the use of external spatial database

Data viewer	GIS analysis	DBMS	WebGIS	Interop.
QGIS	**GRASS**	PostgreSQL/	MapServer	GDAL/OGR
Thuban	GRASS/R-stats	PostGIS	GeoServer	PROJ
OpenEV	JGRASS	MySQL		
	JUMP			
	uDIG			

Table 1: FOSS projects for the management of geographic information.

management systems (DBMS), notably PostgreSQL/PostGIS, to store all the geographic information (attributes, geometry and topology).

It is therefore possible to use the same database to acquire, organise, process and distribute geographic data. GRASS plays a central role in this process, by acquiring and processing the semantic, geometric and topologic data to be fed into the database.

3. GRASS past and present

GRASS (Geographic Resources Analysis Support System) is a GIS for the management and analysis of geographic data which allows the use of raster and vector data, image processing, map creation, spatial models development and 2D/3D visualisation. The project was started in 1982 by the CERL (Construction Engineering Research Laboratory) of the U.S. Army Corps of Engineers, Champaign, Illinois, which released GRASS as public domain software up to version 4.1 in 1992. From 1992 to 1995 various updates and fixes have been released with the collaboration of various U.S. federal offices (NASA, NOAA, USDA, the National Park Service, the U.S. Census Bureau, USGS), universities and private companies. In 1997 the project coordination has been taken by the GRASS Research Group of the Baylor University, Waco (Texas), U.S.A., which released version 4.2 of GRASS.

From 1997 GRASS development is carried out by the international GRASS Development Team coordinated by Markus Neteler originally at the University of Hannover, Germany, now at the ITC-irst of Trento, Italy. The GRASS Development Team has released all the GRASS versions after 4.2, with a change to the GNU license from version 5.0.

The GRASS Development Team has adopted many of the standards common to big FOSS projects, from the licensing to the version numbering scheme, from the internal organisation to the software development tools. All GRASS development is done though a unified CVS (Concurrent Versioning System) server which automatically synchronises all the code changes made by the developers around the world and makes them available in real time to the users. GRASS "versions" are released as "snapshots" of the CVS content and are conventionally indicated with even number if they are *stable* versions and with odd numbers if they are to be considered development/experimental versions.

Current GRASS versions are:

5.4.0 the last of the 5 series, released on November the 5th, 2004. The 5.5 version from the CVS, provides only bugfixes for users willing to continue to use the old 5 series for back compatibility;

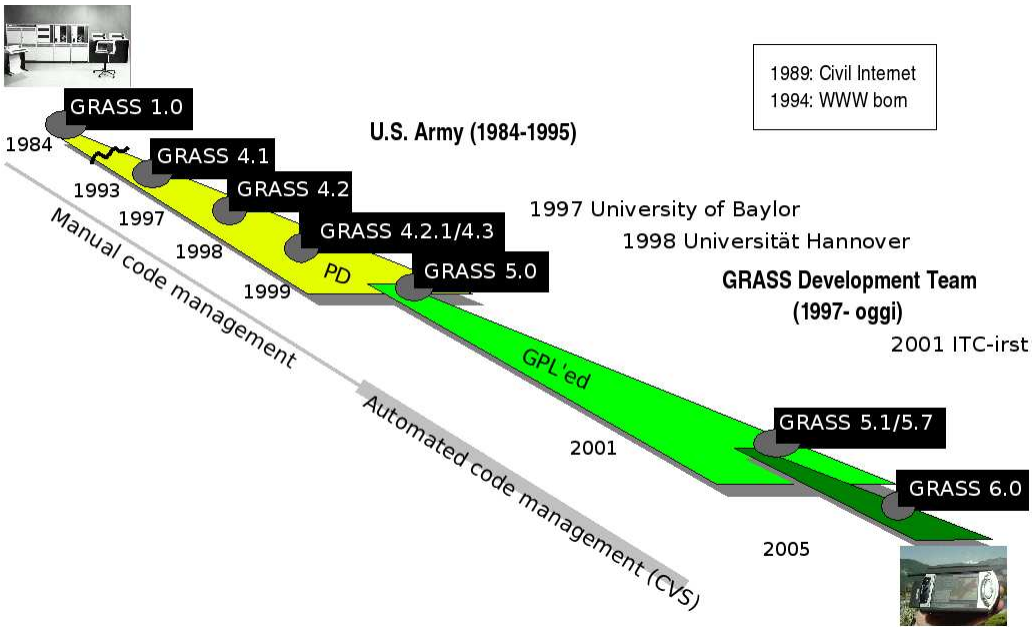

Figure 1: GRASS release history and host agencies.

6.0.1 the current stable release, featuring the new vector architecture.

6.1.0 the development release, containing the last updates and features.

As a FOSS project, all the releases are available as source code, while binaries for some operating systems including packages for some Linux distributions, are provided.

An estimate of GRASS development costs has been made in August 2004 by H. Bowman[1] using the Source Lines of Code (SLOC) analysis and the COCOMO model [2] for GRASS version 5.0, 5.3 and 5.7, with a comparison to the Linux kernel (table 2). An estimate for current releases must be made using the sum of versions 5.3 and 5.7 costs (35+12=47 million U$) as starting point.

4. GRASS current versions

While all the 5.x series versions are available basically for backward compatibility, the current 6.0 and 6.1 versions provide interesting new features with respect to older GRASS versions as well to other GIS softwares.

[1] http://grass.itc.it/pipermail/grass5/2004-August/015127.html

[2] Basic COCOMO model: $person-months = 2.4*(KSLOC^{1.05})$, $months = 2.5*(person-months^{0.38})$, average salary = $56,286/year, overhead = 2.40. Overhead: rate for corporate overhead (to cover facilities, equipment, accounting, and so on)

	GRASS 5.0.3	GRASS 5.3.0	GRASS 5.7.0	Linux Kernel 2.4.27
SLOC	772 kL	919 kL	334 kL	3511 kL
PY (PM)	216 (2,600)	259 (3,100)	89 (1,000)	1,056 (12,700)
Costs	3	35	12	142

Table 2: GRASS development cost estimates, SLOC: Total physical Source Lines of Code (kL: kilo-lines = 1000 lines), PY (PM): Development Effort Estimate, Person-Years (Person-Months), Costs: Total Estimated Cost to Develop in Million USD.

GRASS 6.0 features a new vector architecture, offering a 3D multiattribute, multilayer vector library, a modified NVIZ viewer and new database management tools.

Main new features[3] of the geometry vector engine are:

- support for 2D/3D vectors;
- point data, which used its own *site* format, are now managed as vector points;
- multiformat, virtual map supported from external data sources (SHAPE-file, PostGIS) without the need of data conversion (through OGR library with "v.external");
- Export/Import to PostGIS;
- spatial index build on the fly, topology build significantly accelerated;
- category index to accelerate attribute queries;
- vector network analysis: Shortest path, Travelling salesman (round trip), Allocation of sources (subnetworks), Minimum Steiner trees (starlike connections), and isodistances (from centres), costs may be assigned both to nodes and arcs (and also different in both directions of a vector line);
- Linear reference systems supported (LRS, available but yet to integrate).

The new Database Management Interface provides a new way of managing attributes:

- attribute storage in DBMS, compatible with industry standards (SQL based interface for PostgreSQL, mySQL, ODBC, dBase);
- multiattribute — attribute tables stored in dBase files (default) or saved in external DBMS;
- multilayer — features in one vector may represent one or more layers and may be linked to one or many external tables;
- SQL queries/selects/extractions supported by vector modules;

[3] see GRASS web page `http://grass.itc.it` for a comprehensive list

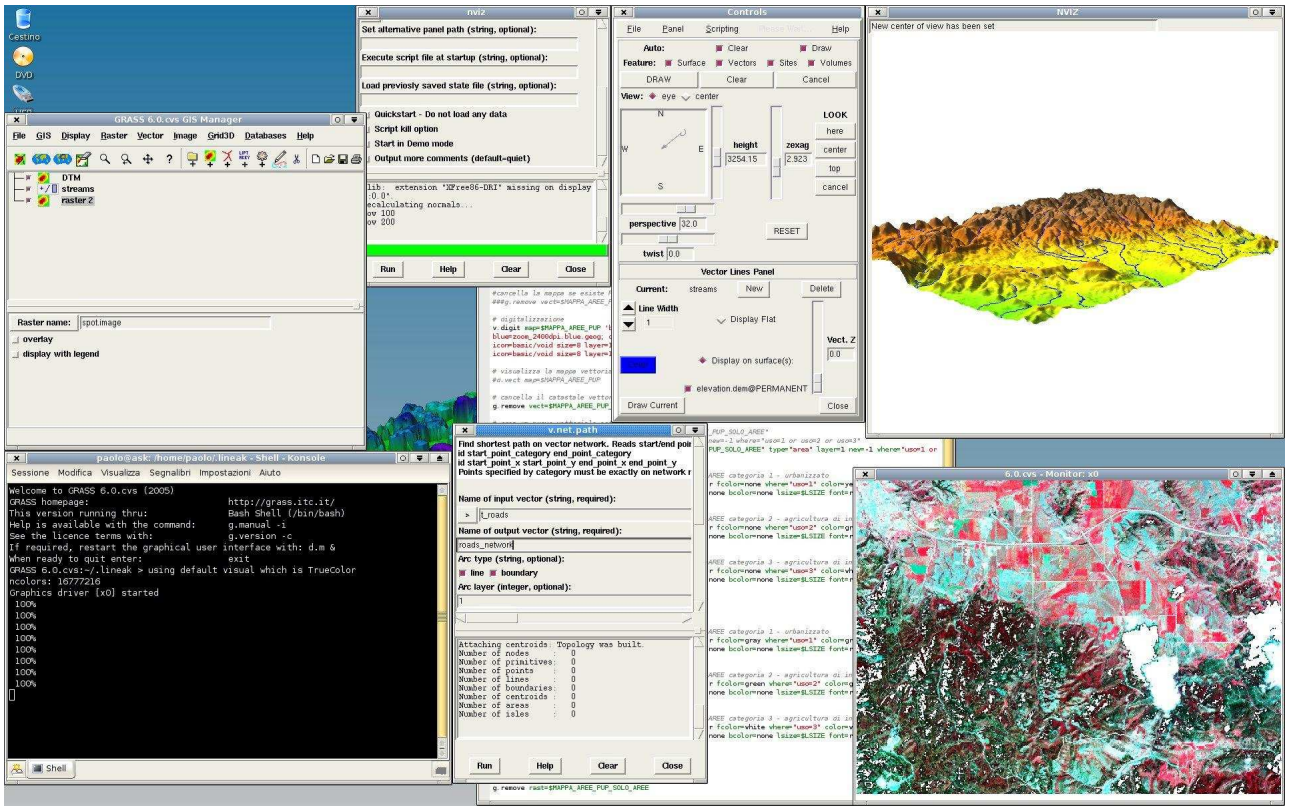

Figure 2: GRASS 6.0 screenshot.

- user friendly query dialogs are implemented using the forms library, allowing the editing of the attributes.

The development 6.1 version will offer several advantages:

- improved display manager;
- integration of NVIZ viewer into a single user interface and new flythrough navigation;
- new 3D raster voxel tools;
- enhancements of the the is undergoing to several for large file support for maps larger than 2GB;
- long map/mapset names support;
- various new modules/scripts added, others extended;
- native winGRASS version under development;

- improved Programmer's Manual (extracted from documented source code now).

GRASS is developed mainly under Linux but it is available for several operating systems:

- UNIX-like (Solaris, IRIX, Linux, BSD) with X-Window interface;
- MS-Windows (NT/2000/XP with Cygwin);
- MacOS X;

The same code can be compiled on different operating systems, the main differences in functionality depend on the availability of the relevant libraries for the operating system.

A set of graphical user interfaces is available now:

- Tcl/TK based GIS manager (d.m, integrated);
- QT based geodata browser (QGIS, separate project);
- JAVA based (JGRASS, separate project).

5. Choice of the GRASS version

Different GRASS versions are available as source code or binary in different formats (Linux Debian-.deb, SuSE/Mandriva-.rpm or generic tarball,MacOSX, MS Windows/Cygwin), when choosing the right GRASS version, the following issues should be taken into account:

version 6.0 is suggested for all users;

version 6.1 is the choice for those who need new features or like to experiment (feedback is welcome);

version 5.4 is still available for those who need to retain back compatibility but which is not developed anymore.

For users of the 5.x series the switch to the 6.x series is smooth, the old datasets can be used without conversion for the raster maps while an automated conversion tools for the sites and vector maps are available. Other differences[4] include a different way of managing and processing vector data, and a generic database management interface independent for all supported DBMS.

The choice between source code and pre compiled binaries depends mostly on the experience of the user (actually, of whom is installing GRASS).

In fact, while the compilation from the source code allows the use of the latest version (which can be grabbed from the CVS server at any time or taken as weekly snapshot) and makes it possible to tailor the compilation parameters, optimising the resulting system for the user's need and for the

[4] see http://grass.gdf-hannover.de/twiki/bin/view/GRASS/ModulePortingList.html for detailed information.

machine in use, it requires some expertise in the configuration of the compilation parameters and in the installation of the required libraries. On the other hand, the installation of the binary packages makes the installation a fully automated process, but the packages are generated periodically and with a generic use and machine as target.

Another way of trying GRASS is the use of *live CD*, that is a bootable CD with GRASS and all the required libraries installed, usually along with other FOSS system for the management of geographic information described in section 2.. Several live CD providing GRASS are available, see Appendix for links. They run completely from CDROM/DVD without the need of hard disk installation. Most of the live CD are based on Linux, but there is also a live CD for MS Windows available, as well as an installation CD for MS Windows.

6. GRASS users and documentation

While the free availability of the source code, the presence of abundant documentation in English and in other languages and the diffusion of Internet make easier the experimentation of GRASS, it is difficult to estimate the actual number of GRASS users. This problem is common to all the FOSS project, where the diffusion of the software is in no way limited by the license. The only tentative estimate can be made, accepting the inevitably poor performance of this method, by counting the software downloads from the web sites and multiplying them for a coefficient taking into account that the software from a download is used for more than one installation. By August 2004, the estimated number of GRASS users in its various versions is of 10000[5].

A wide documentation is available for GRASS, the main source is the GRASS Documentation Project (GDP, `http://grass.itc.it/gdp/index.php`), which provides manuals, tutorials, documents about specific uses of GRASS in several application fields, in English. GDP also acts as an index for the national Users Groups which supply translations of most of the material in their local language as well as supplemental documentation.

The most complete GRASS documentation available is the book by M. Neteler and H. Mitasova [1], while books in German language are available from GDF Hannover [2].

Periodic GRASS Users conferences are organised both at national and at international level, they are all announced at the main GRASS web site[6]. The next international GRASS conference will be held together with other FOSS communities involved in the management of geographic information, FOSS4G 2006, September 12-15th, 2006 in Lausanne, Switzerland.

7. Feedback

GRASS users can cooperate to its development in various ways, depending on their skills, available time and interest:

[5] see `http://grass.itc.it/pipermail/grassuser/2004-August/026263.html`
[6] `http://grass.itc.it`

- writing code which solves known problems or adds new functionality; there exists a *wish list* with the more requested features not already present;
- sharing the code already written for adding a new custom functionality and asking its inclusion in the next GRASS release (this can be done through the developers' mailing list);
- writing/updating/enhancing the documentation;
- translating the documentation or GRASS messages with the i18N system;
- providing information about bugs/problems to the bugtracking system;
- supplying funds to the GRASS project, giving developers more time to work on GRASS code and documentation.

However, the sole use of the system can help the project to attain a critical mass, necessary condition for its future survival and development.

8. Conclusions

GRASS is a mature project, providing a complete and advanced FOSS Geographic Information System. Code development, documentation growing and spread interest testimony the vitality of the project and bode well for its future development. This paper is a first introduction to the project for those willing to try a GIS the FOSS way.

Appendix - Live CDs

Linux

- GIS Knoppix: http://www.gisix.fukengrueven.com/
- GISIX: http://www.gdf-hannover.de/gisix
- Freeduc-cd: http://www.ofset.org/freeduc-cd
- AIT StarCD: http://www.star.ait.ac.th/~yann/starcd/
- GEOLivre Linux: http://www.geolivre.org.br/
- Geomorphix: http://www.geomorphix.org/modules/news/

MS Windows XP

- the XliveGRASS-CD: GRASS 6.0 (data on HD or USB drive) https://www.geographie.uni-freiburg.de/~mlechner/xlivegrass/

- the CygwinGRASS-Install-CD: installs GRASS 6.0 from CD
  https://www.geographie.uni-freiburg.de/~mlechner/CygwinGRASS/

Note that these web addresses are correct at time of writing, they may change or disappear quickly, as it often happens in the Internet.

References

[1] Neteler M. and Mitasova H. Open Source GIS: A GRASS GIS Approach. *Kluwer Acad. Publishers/Springer*, Boston, 420 pp., http://mpa.itc.it/grassbook2/, second edition, 2004.

[2] GDF Hannover. GRASS GIS 6.0 Tutorial. *GDF Hannover bR*, Free Document, GNU FDL, http://www.gdf-hannover.de/literature, 2005.