[PD-02-022] Licensing of GIS Applications

Abstract

GIS applications have gone through the same trends in licensing as the broader software industry. This article focuses on GIS software, but will also address data as it is inextricably linked to GIS software and GIS more broadly. We begin with some key legal concepts applying to intellectual property in general and software specifically. This is followed by sections on historical and current GIS licensing. We then discuss licensing of GIS data. We close with practical considerations for GIS users and developers.

Keywords: FOSS, FOSS4G, free and open source software, license, open source, software

Author & citation

Hachadoorian, L. (2026). Licensing of GIS Applications and Data. The Geographic Information Science & Technology Body of Knowledge (Issue 2, 2026 Edition), John P. Wilson (Ed.). DOI: 10.22224/gistbok/2026.2.2.

Explanation

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3. History of GIS Licensing
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1. Definitions

- **Application Programming Interface (API)**: a set of rules for providing instructions to a program and receiving results
- **closed source:** software which is only distributed in binary form, i.e. without access to the source code
- **End User License Agreement (EULA)**: legal contract between a software supplier and an end user; typical of desktop software
- **FOSS/FOSS4G free and open source software (for geo)**: as there are differences in philosophy and emphasis of free software and open source software, many use FOSS as a compromise and a shorthand
- **free software**: software which is licensed to facilitate sharing, and which grants certain freedoms, such as the freedom to modify and to distribute modified versions
- **license:** authorization to use intellectual property such as software or data
- **open source**: software whose source code is freely available
- **proprietary software**: software which places limits on use, such as copying, redistributing, or creating derivative works; usually closed source, although sometimes proprietary software is “source available”
- **Software as a Service (SaaS)**: the capability to use applications running on the provider’s cloud infrastructure

- **source code:** computer code in a programming language that must be compiled to create a computer program
- **terms of service (ToS)**: legal provisions (“terms”) that set forth the rules that a user of an application or website must follow

2. Key Legal Concepts

A software license is permission granted to a licensee to use software, a specific kind of creative work. Intellectual property in creative works may be protected by copyright, patent, or trade secrets, and software may be protected by any of these.

A copyright gives the exclusive legal right to copy, distribute, adapt, display, or perform a creative work. While usually applied to printed text, music, or video, source code can be copyrighted. Ideas cannot be copyrighted, only expression can. A patent gives the owner the legal right to exclude others from making or using an invention, even if they have the knowledge to do so. Unlike copyrightable material, which is sold with a restriction on copying or reproducing, or patent, which requires a description of the process or invention in a patent application, trade secrets are not made public. Their value lies in not being widely known.

GIS, as with other software, may be distributed with a free and open source (FOSS) license or a proprietary license. Free software is software that comes with certain rights, including access to the source code, the right to modify, and the right to redistribute. “Proprietary license” is not really a legal term, but emerges in the software industry in contrast with free software, and refers to a license in which the software vendor grants the right to use the software, but retains other rights explicitly granted by FOSS licenses.

The reader should keep in mind that this article is intended for educational purposes and does not constitute legal advice.

3. History of GIS Licensing

Although the term would not be coined until much later, most software was essentially FOSS until the late 1960s. Prior to this, software was a companion to the hardware, and distributed with it. It wasn’t until 1969 that IBM began selling some software separately from the hardware that it could run on, with proprietary software becoming the norm by the mid-1970s (Gonzalez-Barahona, 2021).

SYMAP, a proto-GIS project at Harvard, illustrates this history. The software was designed to run on mainframes. A licensing fee was charged, but source code was provided, and often had to be modified in order to run on the specific hardware at a licensing institution (Chrisman, 2006). As the hardware necessary to run this and other software was not readily available, there was little concern for restricting access to the source code.

Esri was founded as a nonprofit environmental consultancy by Jack Dangermond, who had trained at the aforementioned Harvard Laboratory. Its origins arose out of frustration with the pace of commercialization for the GIS software arising in academia (Chrisman, 2006).

Esri transitioned to a software company (while continuing to provide consulting services), releasing proprietary software such as ARC/INFO for minicomputers in 1982, followed by desktop applications in the 1990s.

The rise of proprietary software created the issue, in some ways still unresolved, of the proper paradigm for protecting intellectual property in software. Copyright may be asserted for any creative work, and, as source code, software may be treated as copyrightable. As instructions that lead to an outcome, it may be treated as patentable. There have been arguments that software be protected by both copyright and patent, or instead as a trade secret (González, 2006).

Patents must be shown to be original and approved by a patent office. Algorithms or mathematical formula are not patentable, and consequently the United States Patent and Trademark Office (USPTO) denied many patents for software during the 1960s and 1970s. This changed with *Diamond v. Diehr*, 450 U.S. 175 (1981), a U.S. Supreme Court decision that held that an industrial process (related to curing synthetic rubber) that was controlled by software could nonetheless be patented. This led to a flood of new software patents, which USPTO seemed unable to keep up with. Subsequent Supreme Court cases have restricted the patentability of software for “business methods,” but this is not relevant to a discussion of GIS software. González (2006) discusses arguments for and against the patentability of software from both a European and American perspective.

GRASS, another important early GIS project which remains in current use, began in 1982 as a project of the Army Corps of Engineers. Initially this software was public domain (as is most U.S. government data). With the rise of commercial GIS software, GRASS development languished. Control was transferred to a nonprofit in 1992, and a FOSS license was adopted in 1999 (Mitasova and Neteler, 2004). GRASS grew as an open source project and continues to be used today, both as a standalone application and with many of its tools integrated into the processing toolbox of QGIS, another widely used FOSS4G application.

Licensing and software distribution were further transformed by the rise of the Software as a Service (SaaS) model. In SaaS, the user accesses the software via a thin client, usually a web browser, and either subscribes to use the application for a period of time, or pays for specific uses of the application. If using a web browser, no specific software needs to be installed locally. Access is controlled via network-based authentication. Esri introduced a SaaS product, ArcGIS Online (AGOL), in the mid-2000s. AGOL integrates with ArcGIS Pro (desktop software), but can be used via a web browser as well. Data can be uploaded to AGOL and analysis and visualization can be done entirely in the cloud. Individual transactions, such as geocoding or executing a notebook, are paid from a pool of prepurchased credits.

4. GIS Software Licensing Today

With this historical background, this section will discuss current licensing of a selection of major desktop and SaaS geospatial products. Aspects of free and open source software are covered in linked articles on Openness (Moreno-Sanchez, 2018) and Open Source Software Development (Petras, Mitasova, and Petrasova, 2021). Important calls for openness in GIScience, including open source software, open data, and reproducible research are found in Sui (2014) and Singleton et al. (2016). Licensing of FOSS and proprietary software can

change, and Terms of Service (ToS) of SaaS are constantly updated, so this section will be current as of the date of publication or revision. Pricing models will be discussed, but specific pricing is volatile and will be omitted. GIS users and developers should always refer to current licenses and ToS of specific products.

We begin with the ArcGIS Pro, the desktop application of the market-dominant Esri suite. ArcGIS Pro is tightly integrated with ArcGIS Online, which will be discussed below with other SaaS products. ArcGIS Pro is the core application, with “extensions” that add additional features. Extensions can be purchased individually, but a set of extensions can be licensed at three levels (of increasing cost and capability): Basic, Standard, and Advanced.

Individuals can purchase ArcGIS Single Use licenses. Organizations can use Single Use or Named User licenses. A Single Use license allows the software to be used by one person on up to two computers. Named User licenses require the organization to run ArcGIS Enterprise or to create an organizational account on ArcGIS Online. In either case, the organization creates user accounts, and the desktop software is authenticated over the intranet or internet against the ArcGIS Enterprise server or AGOL. Named Users within the organization can be assigned different license levels or have different extensions licensed. (Concurent User licenses, which used to be common for many applications and which readers may have previously used with ArcGIS, have been deprecated.)

QGIS is the dominant FOSS desktop application. It is often referred to as a GIS “platform” as it allows integration of additional tools and cloud services. The analytical capabilities of independent FOSS projects such as GRASS and Saga GIS are arguably used more often via QGIS Processing Toolbox than as standalone applications. QGIS’ FOSS license has facilitated its rapid growth in capabilities via plugins and integrations of other FOSS software, as well contibuting to rapid growth in users since its launch in 2002. There is no charge for installation and there are no restrictions on commercial use of work product, such as maps or analysis results. As GPL-licensed software, developers should be aware that QGIS plugins, or custom applications that link against QGIS libraries, must be GPL-licensed as well. See the “Practical Considerations” section below for more information on viral licenses.

The Google Maps API/SDK allows web and software developers access to a range of Google geospatial products. A number of APIs are available including Geocoding, Directions, and Places. Simple interactive map embedding requires an API key but is free, while more complex applications, such as using the Directions API to build routing into your own software or website, work on a pay-as-you-go model with a free tier below a certain monthly threshold. There are significant restrictions on use and redistribution in the Terms of Service. For example, many of the API Terms of Service explicitly disallow using Google API results in conjunction with a non-Google map, such as displaying Geocoding API results on an OpenStreetMaps-based interactive map. Using Google map images as a core part of printed matter (such as a printed map or guidebook) is prohibited.

Mapbox, a SaaS product which primarily relies upon OpenStreetMap data, also works on a pay-as-you-go model with a free tier, although it provides a free tier threshold for each product, whereas Google Maps applies one threshold across products. Mapbox free tiers do not apply to certain commercial uses, such as business intelligence and real estate; that is, these uses require specific licensing and payment for any use, with no free usage. Mabox has no equivalent to Google’s restriction on use alongside non-Google products. As a

product designed with use of OSM data in mind, this intentional flexibility allows integration of OSM data and other open or prorietary data sources in Mapbox-based applications.

Mapbox is currently a proprietary product, but began life as an open source product. In December 2020, Mapbox unexpectedly announced that it was switching to a proprietary license. Community reaction was largely hostile, and MapLibre was forked as a FOSS alternative to Mapbox. A prominent open source developer argued that Mapbox was never really a software company, it was a data and services company, and that Mapbox exposed an inherent problem of “single vendor projects” for open source (Ramsey, 2020). Recent download statistics of MapLibre (https://npmtrends.com/mapbox-gl-vs-maplibre-gl) as well as sponsorship by major tech companies such as Microsoft, AWS, and Meta, suggest that MapLibre is a viable competitor to Mapbox.

ArcGIS Online is Esri’s SaaS platform, and is tightly integrated into ArcGIS Pro. Many geospatial capabilities are available, including feature storage, cartography (including interactive web mapping), and geospatial analysis and modelling. ArcGIS Online makes use of the same Named User License structure as ArcGIS Pro. In fact, the Named User License gives a user the right to install ArcGIS Pro and credits for ArcGIS Online services. The credits paradigm is quite different from Google Maps and Mapbox. Whereas users may find a raw count of API requests to Google Maps fairly straightforward to count, Esri’s own knowledge base and community forum suggest that users and managers have a hard time estimating credit usage, and certain iterative algorithms (for example, for spatial optimization) may consume an unpredictable number of credits.

All three SaaS platforms discussed reserve the right to change APIs on relatively short notice (typically 30 or 90 days). There are practical reasons for this. Cloud solutions are often built upon microservices, and these underlying third-party services can change. The platforms need to preserve the flexibility to change their own providers and change their APIs to adapt to changing technology and costs. Further, these integrated systems create a security complexity that self-contained systems never faced, and newly discovered vulnerabilities may need to be addressed rapidly. Additionally, all SaaS systems, including these proprietary systems, rely upon open source components. The proprietary vendors are therefore vulnerable to license change, such as Elasticsearch’s 2021 change from the open source Apache license to a newly created, proprietary, source available license (Xia, 2022) (though the move was later reversed). SaaS therefore creates real complexity that may necessitate rapid and unexpected changes to APIs.

5. Licensing of GIS Data

Because of the tight integration of GIS applications and spatial data in specific file formats (e.g., the shapefile was introduced by ESRI to support its ArcView product) the licensing of GIS data itself must be addressed. Facts and data cannot be copyrighted. For example, it is not copyrightable that the population of New York City was 8,804,190 on April 1, 2020. American and European law take different approaches to intellectual property in data, with very little protection in American law. In the United States, a tort called “misappropriation” was developed during WWI to prevent Western U.S. newspapers from buying wire reports from an East Coast news service that merely transcribed stories published in Eastern newspapers, which had themselves spent considerable resources on reporting in Europe.

However in 1997, in a case brought by the National Basketball Association against Motorola Corporation, federal courts did not extend the concept of misappropriation to sports scores. The European Union in 1996 created a *sui generis* database right to protect substantial investment in the creation of a database (obtaining, verifying, and presenting the data). Attempts to add a similar database protection to U.S. law have been unsuccessful (Vaidhyanathan, 2017, 90).

Thus, facts cannot be copyrighted, and in U.S. law, collecting facts into a database also does not create the grounds for a copyright. Data use and dissemination must therefore be controlled through specific licensing agreements. Esri's ArcGIS Data and Maps (data distributed with ArcGIS software) specifies various levels of use and dissemination. Some data are redistributable, some may be used for static maps distributed publicly, and some can only be used for internal purposes.

What if a government agency wishes to restrict distribution of public domain data in a specifically geospatial format? Nyerges et al. (2011) note that most U.S. federal agencies provide data below the marginal cost of production, while Europe has followed a "cost recovery" model, i.e. using license fees to cover the cost of creating the data rather than distributing the data. In the U.S. the cost recovery model has been followed with Landsat pricing, and also by many state and local governments. He argues that these fees "cannot recover a significant fraction of government data budgets" and that they "act as a drag on private-sector investments."

GIS database licensing fees are exactly what was at issue in the 2013 case of *Sierra Club v. County of Orange*, a California court case regarding public access to cadastral data in Orange County (Frank, 2013). Sierra Club sued Orange County for access to OC Landbase, Orange County's cadastral database in GIS format, under the California Public Records Act. The parcel data itself were clearly public records, but Orange County argued that the database fell under the Public Records Act exemption for computer software, which specifically listed "computer mapping systems" as exempted software. The court sided with Sierra Club that the database was not software, and had to be provided in its entirety at the cost of reproduction.

The Orange County example illustrates Sui's point that state and local governments have tended to follow a cost recovery model. Much federal government data is and has always been public domain, with payment associated with the cost of distribution, but with the data itself freely redistributable. The federal government has pushed heavily into providing widespread low/no-cost access, so that data that used to be sold on physical storage media by third-party vendors under contract with the government was later made available as free downloads through early internet protocols such as Gopher, and later FTP and web downloads.

Many state and local governments have followed or been pushed into making their data freely available as part of a general movement toward transparency as well as the reduced cost of distribution. As with the Orange County case already discussed, local governments seem to have been particularly guarded regarding property data. In 2004, a City University of New York researcher reported New York City's obstructionism with regard to obtaining sales price and sales date information for New York City properties (Kahr, 2004). Shortly thereafter, this information began to be published on city websites under Mayor Bloomberg, a strong proponent of open data. However the full parcel database, including assessed

values, footprints, and other parcel and building data, was still licensed for a fee under terms that prohibited redistribution. Even that fee was removed in 2013. Further, the Department of City Planning formally released licensees of earlier data releases from all restrictions. Without that formal action, users would be able to redistribute current versions of the data, but data paid for under the old license would technically still be subject to the license restrictions under which they were purchased.

The trend toward open data has also led to the creation of open data licenses to control how that data is used. As with software licensing, there is a difference between public domain and open licensing, and public domain may create ambiguity regarding licensing of products which mix public domain and licensed data. As mentioned above, facts and data cannot be copyrighted, and *sui generis* database rights exist only in the European Union and a handful of other countries. Creative Commons provides guidance on applying Creative Commons licenses to databases, including the issue of sharing data between countries that do and do not protect *sui generis* database rights (https://wiki.creativecommons.org/wiki/data). An alternative is the Open Database License (ODbL, https://opendatacommons.org/licenses/odbl/summary/), a copyleft license released in 2009 granting rights to redistribute, produce works from, and modify the original database, and created to specifically protect databases in jurisdictions both that do and do not recognize *sui generis* database rights. Notably for GIS data users, OpenStreetMap switched from CC-BY-SA (a share-alike license) to ODbL (Weait, 2012). An important reason was that ODbL clearly allows the use of OSM data in works that do not modify the original database. This includes creating static and interactive maps, something that would have triggered the share-alike provisions of CC-BY-SA, and combining OSM and non-OSM data in the same static or interactive map, which would have been legally ambiguous under CC-BY-SA.

6. Practical Considerations for Users and Developers

Desktop users face a choice between proprietary and FOSS software. For individuals within larger organizations, using the tools of the organization is expected, and the user should have enough of an understanding of geospatial methods that they can implement a given analysis in multiple applications, or can evaluate each application’s capabilities and limitations in order to decide which to use. Users’ ability to install licensed software on “their” devices may be limited by organizational policy. For organizations with a Bring Your Own Device policy, users may be working on a personally owned computer and be able to install any software they want. For devices owned and managed by the organization, users may be prohibited from installing proprietary software that isn’t licensed by the organization (even if the user has a legally valid personal license). While some organizations have policies allowing FOSS software to be installed on organizationally managed computers, the author is also familiar with organizations that require individual approvals for each software to be installed, including FOSS and freeware. Therefore, do not assume that zero-cost software can be freely installed until you check your organization’s policy.

Managers may be in a position of choosing what software a department or organization will use. A reasonable first pass is to use industry-dominant software, regardless of license. Esri frequently cites a market share of 40-45%, although as a privately held company, these

figures are difficult to independently verify. What is clear is that job announcements for geospatial technicians and analysts overwhelmingly require ArcGIS. Esri is heavily represented in government contracts (as evidenced by searching on “esri” at the Federal government's website for tracking its spending, https://www.usaspending.gov/), and also has a large footprint in engineering and environmental firms. A similarly large footprint in higher education should be understood as educators tailoring their curricula to industry demand.

The calculus changes for certain industries, in particular for nonprofits and for academic researchers. In the nonprofit sector, cost savings may be paramount. Nonprofit users should keep in mind that many proprietary software vendors offer nonprofit pricing, but in general a bias towards reducing costs may favor using FOSS. Nonprofits should also keep in mind that FOSS has a large footprint in certain fields, such as civic tech, and that supportive communities in those fields may ease the path of FOSS adoption. For academic research, some advocates consider open source software to be an integral part of open scientific research, in particular for ensuring reproducibility. Using open source software guarantees that anyone can reproduce your methods without having to pay to license the software. Furthermore, as the source code is available, every part of the analysis can be inspected and critqued by other researchers.

The manager should not assume that FOSS comes without costs, as there may be retraining costs, missing capabilites, etc. Conversely, the manager should not assume that FOSS is less capable than proprietary software or that technical support is lacking. “It is important to keep in mind [. . .] that any licensing model of software is no proof of quality, regardless of whether it is free and open or closed and proprietary” (Christl 2008, 23). Many FOSS projects have vibrant user communities or third-party vendors providing support contracts. When comparing any software for organizational use, a good recommendation is to perform model workflows in candidate software. FOSS and proprietary software should be compared on equal footing, with cost being just one of the competing factors.

Server administrators and systems architects may tend toward FOSS solutions. As mentioned earlier, Esri has a large footprint in industries such as engineering or government administration, and server deployments in these indsutries will rely heavily on Esri solutions. In the technology industry generally and in geospatial technology particularly, FOSS dominates in server deployments. To begin with, the internet was built on the open source LAMP stack (Linux-Apache-MySQL-Perl/PHP). Where these applications have lost market share, it is generally to other FOSS tools (Apache to nginx, MySQL to the MySQL fork MariaDB, Perl/PHP to Python). For database servers specifically, PostGIS dominates the geospatial industry and largely replaces MySQL as the database of choice. Although spatial add-ons exist for the most popular relational databases (in addition to PostgreSQL a mix of proprietary and FOSS software including Oracle, MySQL/MariaDB, and Microsoft SQL Server have comprised the four most popular relational databases for the past decade), among spatial databases their use does not even register (DB-Engines, 2026). While DB-Engines Ranking shows the non-relational database MongoDB as a more popular spatial database than PostGIS, PostGIS hews to the traditional relational model and boasts far more extensive spatial features. MongoDB will be chosen only when the use case calls for a document store or key-value store, with its limited spatial capabilities (primarily proximity and intersection) as a nice extra rather than a deciding factor.

Developers face different questions, namely, whether to license their applications as FOSS

or proprietary, and, if FOSS, which license to choose. The decision to go with a proprietary license or a FOSS license is likely tied to an entire business strategy, and beyond the scope of this article. However, while the idea of selling software may be familiar, those not familiar with FOSS may wonder how a business can make money in FOSS. The interested reader should consult “Free Software and Open Source Business Models” (Christl, 2008). For those already working in FOSS development, and academics wishing to create software for research purposes that may have very little market potential, the more important question is which FOSS license to choose.

Here, the primary dividing line is between FOSS licenses which can be categorized as permissive and those which are or copyleft (restrictive). Permissive licenses have few restrictions. Importantly, software distributed under a permissive open source license can be incorporated into closed source projects. Copyleft licenses are “viral,” meaning they require derivative work to be licensed under no less restrictive open source licenses. The MIT License is a widely used permissive license. Copyleft licenses can be “strong” or “weak.” The GNU General Public License (GPL) is a widely used strong copyleft license. It requires that the source code of derivative works also be distributed under the same license. The GNU Lesser General Public License (LPGL) and Mozilla Public License are weak copyleft licenses. The GNU LPGL allows larger works that link to LGPL components to be distributed under different terms (such as proprietary licenses, or more permissive open source licenses) or without the source code for the larger work. This would allow, for example, an LPGL software library to be used unmodified by a closed source software application. The Mozilla Public License allows larger works to be distributed under different terms and without source code for files added to the larger work.

Users must attend to the license of the data they use. The main constraint to be aware of is restrictions on redistribution of the data. Usually conclusions based on the use of licensed data can be published or shared publicly. Developers must be especially conscious of not creating applications that can expose the underlying data if the license prohibits redistribution. Cartographic products are usually an acceptable use of licensed data. However, as noted earlier, data is sometimes licensed for internal use only. That means that a user must take care to not distribute maps or other visualizations based on that data, even if the underlying data itself is not shared.

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