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**Open Source Software:  
A Survey from 10,000 Feet**

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# Open Source Software: A Survey from 10,000 Feet

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**Stephanos Androutsellis-Theotokis**

*Athens University of Economics and Business  
Greece  
stheotok@aueb.gr*

**Diomidis Spinellis**

*Athens University of Economics and Business  
Greece  
dds@aueb.gr*

**Maria Kechagia**

*Athens University of Economics and Business  
Greece  
mkehagia@dmst.aueb.gr*

**Georgios Gousios**

*Athens University of Economics and Business  
Greece  
gousiosg@aueb.gr*

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## Open Source Software: A Survey from 10,000 Feet

Stephanos Androutsellis-Theotokis<sup>1</sup>,  
Diomidis Spinellis<sup>2</sup>, Maria Kechagia<sup>3</sup>  
and Georgios Gousios<sup>4</sup>

<sup>1</sup> *Department of Management Science and Technology, Athens University of Economics and Business, Patision 76, Athens, GR-104 34, Greece, stheotok@aueb.gr*

<sup>2</sup> *Department of Management Science and Technology, Athens University of Economics and Business, Patision 76, Athens, GR-104 34, Greece, dds@aueb.gr*

<sup>3</sup> *Department of Management Science and Technology, Athens University of Economics and Business, Patision 76, Athens, GR-104 34, Greece, mkehagia@dmst.aueb.gr*

<sup>4</sup> *Department of Management Science and Technology, Athens University of Economics and Business, Patision 76, Athens, GR-104 34, Greece, gousiosg@aueb.gr*

### Abstract

Open source software (OSS), the origins of which can be traced back to the 1950s, is software distributed with a license that allows access to its source code, free redistribution, the creation of derived works, and unrestricted use. OSS applications cover most areas of consumer and business software and their study touches many disciplines, including computer science, information systems, economics, psychology, and law. Behind

a successful OSS project lies a community of actors, ranging from core developers to passive users, held together by a flexible governance structure and membership, leadership and contribution policies that align their interests. The motivation behind individuals participating in OSS projects can be, among others, social, ideological, hedonistic, or signaling, while companies gain from their access to high-quality, innovative projects and an increase in their reputation and visibility. Nowadays many business models rely on OSS as a product through the provision of associated services, or in coexistence with proprietary software, hardware, services, or licensing. The numerous OSS licenses mainly differ on how they treat derived software: some contain provisions that maintain its availability in open source form while others allow more flexibility. Through its widespread adoption, OSS is affecting the software industry, science, engineering, research, teaching, the developing countries, and the society at large through its ability to democratize technology and innovation.

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# 1

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## Introduction

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Open Source Software (OSS) is software distributed with a license allowing access to its source code, free redistribution, the creation of derived works, and unrestricted use. The history of open source software can be traced back to the 1950s SHARE user group, the academic distribution of Unix, and the GNU project.

Open source applications cover most areas of consumer and business software. Prominent application areas include systems infrastructures like operating systems and databases, software development, personal productivity, desktop, entertainment, graphics, publishing, education, scientific, engineering, content management, and business software.

The organization of open source development projects often differs from proprietary ones in terms of their organizational structure, membership, leadership, contribution policies and quality control. Lean, distributed, and often informal operations make it easy to start or participate in an OSS project, but also isolate projects from market pressures allowing many to languish or fizzle.

Behind a successful OSS project lies its community. Its actors range from core developers to passive users. Although a community's governance structure is typically flexible, many processes and mechanisms

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align the interests of the community's members. Initiative, teamwork, communication, and cooperation are generally more important than in business software development.

The key defining element of OSS is its license, which must satisfy a list of important requirements. There are numerous open source licenses, and they mainly differ in how they treat derived software: some contain provisions that maintain its availability in open source form, while others allow more flexibility. Selecting an appropriate license for a new open source project is important, as is studying an open source project's license before incorporating it into a proprietary system.

Nowadays many business models rely on OSS, either as a product or through the provision of associated services. Revenue can be obtained from the complementarity of a proprietary product with an open source one, support and training, subscriptions, and advertising. The strategic dimensions behind a move to OSS include not only opportunities related to marketing and innovation, but also risks associated with a loss of profits and the lowering of competition barriers. On a tactical level an open source-based business model can lower development costs, enable end-user customization, but will also demand new organizational structures, a higher short-term investment, and the continuous nurturing of an open source ecosystem.

OSS can be reused as a (low cost) product, as an adaptable component, or as code and other elements that are morphed into another system. Increasingly, open source systems form complete stacks used as infrastructure for other applications. In specific categories, such as web applications, the adoption level of OSS is near or even higher than that of proprietary offerings. The impacts and effects from open source adoption affect an organization's bottom line, its management, the software's quality, and the software development process.

An often asked question regards the motivation behind individual and organizational participation in open source projects. The incentives for individuals can be social, political, ideological, hedonistic, as well as the allure of a flexible, stress-free, and bleeding edge technological environment. Companies seem to gain from their participation as well, through privileged access to a high-quality product and its development process, as well as exposure to user-driven innovation, higher

reputation and visibility, human capital improvement, and improved employee morale.

The emergence of OSS is fueling the economy as a whole through its widespread adoption as a cheap alternative to pricey proprietary products and as a driver behind many successful e-business ventures. Open source is also directly affecting specific sectors: the software development industry through competition and new business opportunities; hardware development through lower cost and barriers of entry, consumer-led innovation and policy enforcement difficulties; academia through valuable opportunities for research and student involvement in real-world applications, as well as the availability of software tools and the provision of pioneering new courses.

The future of OSS appears to be as exciting as its past. It can lead to new design, production, marketing, and business models, as well as ways to develop large complex software systems in an organic manner. Challenges lie ahead, and problems still need to be overcome, so the potential for future research on OSS is large. For instance, the comparison between open source and proprietary products and processes is still an area lacking solid empirical evidence. More important however is the ability of open source development models to democratize technology and innovation.

## **1.1 Open Source Software and Other Types of Software Distribution**

Up to the late 1980s most packaged software was almost exclusively sold and distributed as a complete and finished product (a so called “precompiled binary”), which was installed on a user’s computer and then ran [24].

With the evolution of software development, computers and the internet, new models and types of software distribution appeared. These differed in aspects such as the degree of openness of the software product (i.e., how much information about the inner workings of it is exposed to the user), the possibility for the end user to modify it or use parts of it in other, derivative software works, and the cost and licensing model.

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According to the classification put forward by the Free Software Foundation (FSF) [76] and elaborated by Perens in reference [181], the main types of packaged software distributions used are the following:

**Proprietary or commercial software** is typically distributed in binary form only, with the source code closed, i.e., not available to the public. Payment is required and the terms of use are very restrictive, not allowing modification or redistribution.

**Public domain software** lies at the other end of the spectrum. The authors of this type of software give up all copyright, the source code is freely available for modification or redistribution, and no fees are required. In fact it is even allowed to obtain public domain software and re-distribute it under other, non-open licensing schemes, or even remove the author's name and treat it as one's own work.

**Freeware and shareware** products do not require upfront payment and can generally also be duplicated, as is the case with public domain software, however modifications are typically not allowed as the source code is not distributed with the product.

The difference between Freeware and Shareware is that with Shareware only limited usage of the product is allowed without payment, either for a fixed evaluation period, or with reduced functionality. Shareware is generally regarded as more of a marketing concept than a licensing option.

**Open source software** is the distribution and licensing approach that is the topic of this survey. The main characteristics of OSS are outlined within the Open Source Definition<sup>1</sup> and can be summarized as follows:

- Free distribution: No licensing fees are charged for this type of software.

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<sup>1</sup><http://www.opensource.org/docs/osd>. Note: All internet URLs in this survey, including in the references section, were last accessed in March '10.

- Source code availability: The source code is distributed together with the product.
- Modifications and derivative works: The users of the software can modify the source code to create derivative software products, or reuse (parts of) the source code in other products. However, this may be subject to specific restrictions dictated by the OSS license used.
- No discrimination: Either against persons, groups or fields of endeavor.
- Licensing: OSS products are copyrighted, and distributed with a particular license that outlines the terms of their use. There are various OSS licensing options, which differ in their degree of permissiveness and other aspects.

One of the most important aspects of an OSS license is whether any derivative work that is based on the source code of this particular software product can be distributed under different licensing schemes (either OSS or proprietary), or whether it is only allowed to be distributed under the same license as the original product.

The OSS licenses enforcing the latter condition are known as restrictive, or “copyleft” licenses, and their goal is to ensure that the source code will remain available to the public. The different types of OSS licenses are discussed in more detail in Section 6 and summarized in Table 6.1.

OSS development is based on the formation of large, open and distributed communities of developers who are guided by a common belief in the freedom of software and information, and who follow collaborative practices such as sharing information, helping others, and studying and peer-reviewing each other’s work. Such developers are motivated by their own interest in the project and the urge to learn from it, and they are rewarded by the acknowledgement of their contributions, the resulting reputation they gain, and the success of the project itself.

## **1.2 Research, Related Disciplines, and Publications**

The study of OSS is inherently multidisciplinary, encompassing various research and scientific disciplines [78]. In the following list, as well as in

## 6 Introduction

Table 1.1, we provide indicative examples of research efforts spanning two or more research fields, including OSS:

- Computer and information system sciences study the technical aspects of OSS development [163, 200, 201].
- Management and organizational sciences deal with the management, organizational and governance aspects of OSS project [127, 164].
- Social science addresses areas related to the communities formed around OSS efforts, their motivation, behavior, and evolution [48, 176, 229].
- Psychology delves into issues relevant to the individual participants in OSS projects, what drives and motivates them, and how they are rewarded [16, 69, 138, 254].
- Economics studies the business models that OSS projects are based on, the involvement of corporations in OSS efforts, as well as the ecosystems and collaborations built around them [19, 146, 110].
- Law focuses on the various legal, licensing and copyright issues around OSS distribution [148, 149, 203].
- A multitude of other scientific fields (such as medicine, biology, and engineering) benefit by using OSS products, and by applying OSS ideas and methods in their domain [10, 28].

Interest in OSS spans many professional areas and domains, including software development, business, research, and government. In Section 10, we discuss in more detail the impact of OSS in all these domains of our society and global economy. We feel that this survey provides not only an overview of the field, but also considerable practical information for those wishing to get involved in OSS as developers or project members, by adopting OSS in their products, or by gaining insight from the OSS practices, ideas, and experience.

Within this survey there are numerous references to works from many different scientific domains and disciplines. We highlight some in Table 1.1, which itemizes some of the most informative relevant works, grouped by subject. We separate empirical studies, surveys and



Table 1.1. A collection of informative publications on different aspects of Open Source Software.

	Empirical studies	Surveys/Overviews	Specific topics
Project communities	[46, 53, 109, 127, 128, 133, 170, 229]		[21, 70, 205]
Motivations	[22, 75, 101, 102, 137, 138, 238]		[11, 21, 190, 257]
Success factors			[21, 36]
Software development	[163, 179, 200, 218]	[67, 68, 201]	
Innovation and future	[71, 75, 238]		[232, 235, 240]
Adoption and reuse	[98]	[222]	[216]
Business models	[204]	[247]	[21, 72, 205]
Licenses			[140, 146, 148]
Generic	[56]	[51, 54, 83, 94, 129, 187, 245]	

overviews, and articles focusing on specific subjects. We also recommend:

- the collected works in [54, 68],
- the 2004 theme issue of *IEEE Software* [216], the 2004 issue of *Research Policy* [239], the 2006 issue of *Management Science* [240], the 2010 special issue of the *Journal of the Association for Information Systems* [42], and
- the proceedings of the International Conference on OSS, and the FLOSS ICSE Workshop.

### 1.3 Organization of this Paper

In this survey we aim to cover most aspects of OSS, including technical, social, organizational, economic, and legal, as well as provide an outlook to the future of OSS by identifying current shortcomings and research directions.

In particular, Section 2 overviews the history and evolution of OSS, from the first free software development efforts to the latest OSS business and financial models.

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Section 3 deals with the organization of OSS efforts into projects, their comparison with proprietary software development efforts, and particular characteristics and potential indicators for project success.

In Section 4, we examine in more detail the characteristics of the communities that are formed around OSS projects, the different actors and participants, the leadership and governance mechanisms that are employed, and their evolution.

Section 5 focuses on the more technical aspects of OSS, and in particular the software development practices and processes. It presents the main characteristics of OSS software development and how it differs from other domains.

Section 6 on the other hand analyses the legal and licensing perspective, which is crucial as it characterizes the permissiveness and often the impact of each OSS effort. We briefly outline the main OSS movements, the different licensing options and we provide some guidance into selecting the most appropriate licensing scheme depending on an OSS project's characteristics.

In Section 7, we focus on the economic and financial nature of OSS projects, and what business models can be adopted to extract business value from an OSS effort. We discuss the business ecosystems that are formed around successful OSS efforts, and the various roles that companies and organizations can play within them.

Section 8 then focuses on the important issue of adoption and reuse of OSS software into other products and domains. It examines the criteria for an OSS product to be a good candidate for reuse, the process of adopting and reusing OSS code, and benefits but also the potential risks and concerns that accompany this practice.

In Section 9, we discuss the motivational aspects for engaging in an OSS effort, both for individuals and for businesses and organizations.

We conclude in Section 10 with an overview of the impact that the OSS process and ideology has had on the software business and our society, closing with a discussion of the current research directions, and where they may lead the future of OSS.

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