



HAL
open science

Information Commons between Peer-Production and Commodification: the case of Cloud Computing

Primavera de Filippi, Miguel Said Vieira

► **To cite this version:**

Primavera de Filippi, Miguel Said Vieira. Information Commons between Peer-Production and Commodification: the case of Cloud Computing. 17th Annual Conference of The International Society for New Institutional Economics, Jun 2013, Florence, Italy. hal-01382004

HAL Id: hal-01382004

<https://hal.science/hal-01382004>

Submitted on 15 Oct 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Information Commons between Peer-Production and Commodification: the case of Cloud Computing

Primavera De Filippi¹
Miguel Said Vieira²

Abstract

Internet and digital technologies allowed for the emergence of new modes of production involving cooperation and collaboration amongst peers (peer-production) and oriented towards the maximization of the common good—as opposed to the maximization of profits. To ensure that content will always remain available to the public, the output of production is often released under a specific regime that prevents anyone from subsequently turning it into a commodity (the regime of information commons).

While this might reduce the likelihood of commodification, information commons can nonetheless be exploited by the market economy. Indeed, since they have been made available for use by anyone, large online service providers can indirectly benefit from the commons by capturing the value derived from it. While this is not a problem as such, problems arise when the exploitation of the commons by one agent is likely to preclude others from doing the same—often as a result of commodification. This is especially true in the context of cloud computing, where the content holder has become as powerful, if not more powerful than the copyright owner. Nowadays, regardless of their legal status, information commons are increasingly controlled by large corporations who can precisely define the manner in which they can be used or accessed.

Digital communities need to be aware of these risks. This article proposes a theoretical and normative exploration of these issues, based on the analysis of recent trends in the area of cloud computing. It argues that, in order to reduce the likelihood of commodification, but still benefit from the advantages offered by cloud computing, digital communities should rely on decentralized platforms based on peer-to-peer architectures—thereby escaping from the centralized control of large service providers while nonetheless preserving the autonomy of the commons they produce.

Keywords

information commons, peer-production, cloud computing, commodification

¹ Centre d'Études et de Recherche en Sciences Administratives et Politiques CERSA/CNRS, pdefilippi@gmail.com

² Faculty of Education, University of São Paulo; msaid@usp.br, <http://impropriedades.wordpress.com>; receives a PhD scholarship from Capes.

Introduction³

This article is a reflection on commons, the possibilities of its commodification through cloud computing, and possible alternative approaches to cloud computing that might fare better in terms of autonomy. It is structured as follows: section 1 presents the notion of information commons, and the relation between its recent prominence and peer-production. Section 2 explores cloud computing and its potential benefits to information commons, particularly regarding online collaboration. Section 3 defines commodification—distinguishing it from commercialization and cooptation—, and discusses how it can happen to information commons (particularly through cloud computing). Finally, section 4 examines the governance model of provider-based cloud computing, and proposes that there are alternative governance approaches that could avoid commodification while achieving much of the benefits offered by cloud computing.

While the reasoning is based on historical analysis and empirical examples related to information commons and cloud computing, the approach is more theoretical and exploratory than it is descriptive. The main interest of the paper is to draw attention to the possible contradictions between the practices and values underpinning information commons and provider-based cloud computing, to explore alternative scenarios where commodification can be less likely. To be sure, more empirical research is needed in this area; the alternatives mentioned here should be taken as preliminary pointers.

1. Information commons

People share things, and they have done so since a long time: medieval England’s Charter of the Forest, with the rights to *herbage*, *pannage*, *chiminage* etc.;⁴ France’s *communals*;⁵ Spain’s millenary *huertas*;⁶ Brazil’s *faxinais* and *terras de quilombo*,⁷ and many more. Historical and ethnographic records attest that plenty of commons—continued practices of common property and sharing by communities—have existed successfully over the years. These examples suggest that humans might be better described as the *homo reciprocans* of certain economic theories,⁸ motivated in cooperating in order to improve their environment, than the *homo economicus* of classical economics—a mythical

³ The authors thank Mayo Fuster Morell for her thoughtful comments regarding an earlier version of this paper.

⁴ The Charter of the Forest was a companion to the Magna Carta, and formalized a number of traditional common rights to forests, such as those to pasture and wood (Linebaugh 2008, 42).

⁵ The main cell of peasant communal property in feudal France (Bloch 2008 [1931], t. 1, 194–216).

⁶ Collective arrangements to share and maintain irrigation systems (Ostrom 1990, 69–81).

⁷ *Faxinal* is a modality of shared land usage that exists in Brazil and is believed to have its origins in Portugal; *terras de quilombos* are lands shared by runaway slaves and their descendants in Brazil (Almeida 2008).

⁸ The concept of *homo reciprocans* (as opposed to *homo economicus*) was introduced following the researches of Ostrom & Fehr on “reciprocal fairness” illustrating the natural tendency of individuals to respond in a reciprocal manner to the actions of other individuals in their environment (for more details, see Bowles et al. 1997; Dohmen et al. 2006).

creature that combines rational decision-making with a strictly self-interested human nature.

It is tempting to classify those early examples as belonging exclusively to the realm of “physical commons”. After thorough examination, however, it becomes obvious that they involve much more than a mere set of physical goods. Indeed, most of those examples could not properly subsist without a complex mesh of practices, rights and agreements—whether formalized or not. In addition, there is in those examples significant amount of information being shared, such as the fundamental pieces of knowledge regarding how to properly use and care for those common resources (*i.e.* when to sow, where to let cattle graze, how much should one fish, etc) and how the community rules affecting them are determined.

Drawing a binary distinction between physical commons and information commons can, as those examples show, be difficult, and at times even undesirable.⁹ Indeed, the majority of information commons also rely, to some extent, on material resources: the Internet, as the backbone for modern information commons, requires, for instance, a significant amount of physical infrastructure and energy to work; ignoring this and pretending that certain commons can be exclusively information-based is an analytical mistake that could lead to a careless assessment of the serious socio-environmental problems we are currently challenged with.

Today, however, one cannot deny that the role assumed by information in everyday life has become so important as to affect both our methods of socialization and our practices of sharing. It is not a coincidence that the commons initiatives with the largest scale of collaboration today—such as FLOSS (Free / Libre Open Source Software) and Wikipedia—are information commons. Why has this come to be?

a. The rise of Information Commons

One of the possible explanations for the prevalence of information commons in the digital realm is linked to both an opportunity and a threat which had to be faced by emergent communities.

The opportunity arose as a side effect of mass consumerism and media culture. Today, a significant slice of the world’s population has access to tools that—in the words of Walter Benjamin (1986)—enable or facilitate “technical reproducibility”. While industries are always looking for cheaper ways to mass produce things or products, the personal computer can be regarded as one of the major steps in this direction: it is, among other things, a machine for reproducing information quickly and at virtually no cost—thereby strongly enhancing its characteristics of non-rivalry, since the consumption by one person does not affect the consumption by others. The advent of Internet and of digital technologies has helped people to produce information content on their own and distribute it worldwide with less reliance on intermediaries.

The threat, on the other hand, arose from the fact that, over the past century, information and culture have become the next frontiers for commodification. Neoliberal economic theory posits that many areas

⁹ We do believe, however, that this distinction can be useful to provide a simplified account of reality for analytical purposes. In the context of this paper, the term “information commons” will thus be used to refer to those commons which are not exclusively based on information, but rather predominantly based on information (and only on a lesser degree based in physical goods).

of life are more efficiently managed when modelled as markets. Hence, the argument goes that society as a whole would greatly benefit if ideas and information were to be treated as commodities in a free market.¹⁰

But in order to treat something as a commodity, it must be possible to claim private property rights over it. This is where the so-called intellectual property rights (IPRs)¹¹ came into play. Although limited in time and subject to many more exceptions and limitations than standard property rights,¹² both the scope and duration of IPRs have been progressively extended so that, nowadays, the differences between IPRs and private property are in practice reduced to a minimum: for practical matters, IPRs can turn information into a private good, thus enabling it to be treated as a commodity. This change has been brought about by a series of diplomatic shifts started in the second half of the 20th century. The starting point of this movement can be traced to the creation of the World Intellectual Property Organization, in 1970 (subsequently turned into a United Nations specialized agency, in 1974), and its latest apex has been the Agreement on Trade-Related Aspects of Intellectual Property Rights (the section of the World Trade Organization treaty dealing with IPRs). Also known as TRIPS, it raised and “harmonized” the possibilities of commodifying information and culture across the world. It was not a coincidence that this was such an important focus of lobbying during the WTO rounds of discussions (see *e.g.* Drahos 2003): the economic weight of IPRs-intensive industries (such as media and entertainment, pharmaceutical, agrochemical and biotechnology companies) has risen tremendously over the past few years;¹³ national laws limiting the breadth of intellectual property rights could pose serious obstacles to the expansion of those industries.

The flipside of the story is that, the greater the amount of information that is turned into commodities safeguarded by intellectual property rights,¹⁴ the more limited becomes the public domain and the lesser is the amount of information that can be freely accessed and reused by society.

It is as a response to this threat that digital information commons emerged—as clearly illustrated by

¹⁰ The actual benefits this kind of policy brings to poorer countries are, at best, debatable; empirical evidence, however, shows that this market for information and cultural goods is deeply unbalanced: IMF data shows that the USA had, in 1999, a net surplus of intellectual property exports that amounted to US\$ 23 billion, while no other country in the world even reached US\$ 1 billion in surplus (Story 2002, 131). What is certain, thus, is that the strengthening of intellectual property rights (IPRs) laws is in the direct interest of the conglomerates that trade with information commodities.

¹¹ Expression commonly used to refer collectively to copyrights, patents, trademarks, and *sui generis* systems such as geographical indications (regarding controlled designations of origin for products), plant varieties etc. Although usually lumped under this heading, those systems are significantly varied in terms of principles and functioning. This, along with the fact that they are not property rights strictly speaking, has led to criticism of the term as ideologically loaded (see, for instance, Stallman 2012).

¹² Property rights are not absolute as well and are subject to exceptions and limits—a common example being compensated expropriation by the State; even though usually subject to very strict conditions, it is a common fixture in national laws and would not be possible if property were regarded as fully absolute. IPRs, however, are in general markedly more restricted by exceptions and limitations.

¹³ Between 1977 and 1999, the contribution of USA’s core copyright industries to its GDP grew 360% according to data from the International Intellectual Property Alliance (Story 2002, 129–30).

¹⁴ Eventually also by technological restriction measures, that can go even further than the law in guaranteeing the privatized nature of information (see *e.g.* Gillespie 2007).

Richard Stallman's (2002, 159) account of an experience that strongly influenced him with regard to the concept of free software: Stallman, a programmer at the Massachusetts Institute of Technology, was trying to fix bugs in the driver of a printer, which, unlike previous printers in that lab, ran with a proprietary driver. Given that the company refused to disclose the source code to the driver—and also made anyone who had access to the source code sign nondisclosure agreements—Stallman was ultimately unable to overcome the many problems of that driver.

While free software already existed by then (in fact, many accounts suggest that most software was at that time effectively treated as such), it did not have a more formal movement around it, nor ways to avoid its private appropriation. To avoid a similar situation to repeat itself, Stallman devised a technique that came to be paradigmatic: Stallman used copyright turned on its head in order to guarantee (and enforce) the possibility of sharing. He did this by developing a licence (the GNU General Public Licence, or GPL) which used the author's rights vested in a work to ensure that such work is and will always remain freely accessible to the public, without many of the restrictions imposed by default under the regime of copyright law. Intended to promote and preserve the commons, this licence is geared to facilitate sharing amongst individuals, subject to only specific conditions—the most important of which are the requirement to share the source code along with the software itself, and the so called “copyleft clause” which asserts that all works derived from GPL-licensed works should also be distributed under the GPL licence. A short manifesto in itself, the GPL can be seen as a landmark in the free software movement initiated under the leadership of Richard Stallman.

Many other licenses developed later on were admittedly inspired by the GPL license, using copyright to build and to preserve the information commons. Most prevalent nowadays are the Creative Commons licenses: a set of licenses establishing a regime of “some rights reserved” (as opposed to the “all rights reserved” proposed by default under the law). The common characteristic of these licences is that they all assert the right to share and to copy, provided that proper attribution is given. Additional conditions can also be incorporated into the licence in the way that better suits the preferences of each author: the copyleft clause, the non-commercial clause (only allowing for non-commercial uses of the work), and the non-derivatives clause (precluding the production of derivatives works—and thus incompatible with the copyleft clause). Today, Creative Commons licenses are the most used licenses in some of the largest information commons initiatives outside the FLOSS movement, such as Wikipedia and the open access scholarly publishing movement.

b. Commons-based peer production

Most initiatives concerned with the production and dissemination of information commons have explored the opportunities provided by Internet and digital technologies in ways that go far beyond the near-costless reproduction and distribution of digital content. Indeed, with the advent of Internet and digital technologies, new ways of production have progressively emerged, often involving online cooperation and collaboration amongst peers.

Thanks to digital technologies, many users have become producers of information.¹⁵ A variety of

¹⁵ While there are controversies about the actual extent of this change, it is clear that, in comparison to the situation with earlier mass media, digital technologies provide more opportunities for people to produce (and not only

affordable digital devices can be used to record, process, combine or edit digital content. Given that the costs of production are low, a greater number of people can produce information content without any significant investment beforehand. This is one of the reasons why most user generated content is distributed for free—often under an expectation of fame, popularity, or deferred reciprocity (see Geach 2008).

The worldwide scope of the Internet also provides the means for users to socialize and to contribute together to common projects regardless of their individual location. This encourages collaboration rather than competition and facilitates *peer production*—a process whereby interactions amongst peers are not performed on the basis of economic transactions, but rather on the basis of solidarity and social relationships.

In the context of peer production, the traditional model of production based on a hierarchical subdivision of tasks gives way to a more dynamic system of production based on more symmetrical relations between peers and a self-governed subdivision of labour. According to Bauwens (2005), the system of peer production is characterized by the following attributes: distributed architectures; self-organized task-forces (*i.e.* individual contributions are not determined *a priori*, but rather based on voluntary self-identification of interests with *a posteriori* reputation and validation systems); and a great deal of transparency (regarding individual collaborations, metrics, documentation of the project etc.). Online communities often rely on this new model of production to promote collaboration and to coordinate a large variety of actors using each other's contributions to create something that is often greater than the sum of its parts.

There exists a positive interaction between peer production (as a particular mechanism of production) and information commons (as the potential output of such production). While one does not always imply the other, in practice, the majority of initiatives relying on peer production are generally concerned with the production of information commons. This combination has been described by Benkler as *commons-based peer production*,¹⁶ a new way of production that combines the contributions of a widely distributed network of individuals collaborating together towards the creation of information commons.

2. Cloud computing

Cloud computing is a term whose definition is difficult to establish: it is often used to describe a new business model rather than a new technology (Foster et al. 2008); and it has also been argued that its meaning can be stretched enough to refer to practically any use of the Internet (Stallman 2010, 212). In this paper, we refer to cloud computing platforms as any online infrastructure with huge computational power that is able to store and process a very large amount of data. As the amount of data keeps growing at an exponential rate (whether it is publicly available on the Internet, or privately held in personal files and databases), it becomes increasingly difficult to store everything locally, either for

consume) information.

¹⁶ Commons-based peer production is a term coined by Yochai Benkler (2002; 2006) to describe a particular mode of socio-economic production that has emerged on the Internet.

individuals or organizations. Data is thus increasingly stored on remote servers (or data centres) which constitute the infrastructure of a cloud. This is generally done through highly distributed architectures made up of several data centres located in various parts of the world, but nonetheless subject to centralized governance by one or more identifiable entities—such as Google, Amazon, Facebook, and so on.

Cloud computing can be subdivided into three distinct categories that distinguish themselves according to the type of resources involved: Infrastructure as a Service [IaaS], Platform as a Service [PaaS], and Software as a Service [SaaS]. For the purpose of this paper, we will focus mainly on the latter—as the one most likely to affect information commons. In the context of cloud computing, SaaS refers to a new way of delivering software functionalities by providing a variety of online applications that can be accessed directly from a web-browser, without the need for users to download any application onto their own devices. The key idea is to separate the ownership and possession of software from its actual use (Turner, Budgen, and Brereton 2003). In spite of the increasing complexity of underlying software, users only interact with the application through the user-interface provided by the cloud provider, without any knowledge as regards the technical implementation of the applications they are running; most or all of the back-end processing and storage is made in the cloud infrastructure, and not in the user's own devices. Cloud providers can thus modify their software at any time, or diversify the operators that contribute to providing the underlying services without the need for any kind of intervention from users, who are often unaware of any changes made in the back-end infrastructure of the cloud.

a. Value of cloud computing

Cloud computing offers a series of advantages and opportunities to a large number of Internet users and operators. Most of these advantages are related to the concept of *elasticity* (i.e. the automatic reconfiguration of computing resources according to actual needs) and *utility computing* (i.e. the provision of hardware and/or software resources on a pay-as-you-go basis rather than as a lump sum).

Online operators and intermediaries can benefit from being able to use an indefinite amount of computing resources without having to plan ahead. Since they only have to pay for the actual amount of resources they use, online operators can provide a service to users with no considerable investment in time and money for acquiring the hardware and setting up the software necessary for the initial bootstrapping. Cloud computing allows them to start small and only acquire additional computing resources at a later stage, when the need actually arises. Cloud computing also protects online operators from the risk of wasting unused computing resources—which will be automatically released and redistributed as needed. Indeed, in order to minimize the waste deriving from excess capacity, cloud computing redistribute resources amongst different operators according to their individual needs to make sure that resources are always assigned to the most efficient use (for more details, see Armbrust et al. 2010).

Users, on the other hand, can benefit from cloud computing through facilitated access to data: as it is exported into the cloud, data is no longer trapped in any personal computer or user device. Software

applications and user’s documents can thus be accessed from anywhere, at any moment,¹⁷ and regardless of the device used to connect into the cloud (as long as there are no compatibility or interoperability issues with the cloud computing interface).¹⁸ Cloud computing can also facilitate users’ collaboration, since documents stored in the Cloud can be accessed simultaneously by a variety of users—who can enjoy the benefits of sophisticated applications without having to install them on their computer.

b. Cloud Computing and Information Commons

Cloud computing can provide significant benefits to the development and sharing of information commons. Most of these benefits—which are mainly related to the storage and access to data via the cloud interface, as well as the collaborative production or editing of such data—can be roughly classified in the following way:

	Storage / Access	Development / Editing
Centralized platform	single point of reference; up-to-date content	aggregation of multiple contributions; versioning
Online ubiquity	accessible from everywhere and at any time	distributed and asynchronous collaboration
Elasticity	scalability of resources (pay-as-you-go); reduce the risks of overcapacity or unpredicted resource shortage	automatic management of software applications (invisible to end users); evolving user interface

Let us consider, for instance, a scenario in which a few hundred people collaborate in compiling and updating a complex database containing information about scientific experiments. The initiative in this example is intended to be an information commons: the results are to be shared—even if subject to certain rules concerning access and provisioning.

As the database grows over time, local storage by each individual can become increasingly difficult to achieve due to the sheer size of accumulated data. Such local and independent storage appears as an even less practical alternative when considering the fact that the records in the database are constantly

¹⁷ To the extent that it does not belong to any given computer or device, data becomes ubiquitously available to anyone with an Internet connection. Yet, even if one cannot pinpoint the data to a specific machine in the cloud infrastructure, the data still “belongs” to a specific technical device: the cloud as a whole—as opposed to users’ personal devices. This means, for instance, that if the cloud infrastructure is down users will be unable to access the data.

¹⁸ As an example, Adobe Flash—used in a variety of cloud interfaces—is not currently supported in quite a few operative systems and architectures: it was not supported for a long time in Apple’s iOS, and will not be supported in the latest Android version; there's also no fully working free software replacement for it.

being edited. Cloud computing could facilitate the task by providing a centralized platform to aggregate all individual contributions in an automated way. Not only would that ensure a single point of reference to access the most up-to-date instances of all database's records, but this would also enable people to keep track of all previous versions of the records, so as to refer back to them whenever this is necessary (Miller 2008). While the online and ubiquitous character of the cloud infrastructure (as being time-, location- and device-independent)¹⁹ could simplify global collaboration and make the database available to a larger public, the scalability of the cloud architecture could significantly reduce downtime, as well as the costs involved in maintenance and the over-provisioning of hardware resources. Finally, cloud computing could provide users with a sophisticated interface to access or query the database (an interface that could implement some, though not all,²⁰ of the access and provisioning rules pertaining to this database), by deploying specialized web applications for online collaboration that would be immediately accessible to users, without any kind of intervention on their part; this management of the cloud's back-end software is invisible to final users.

As this example illustrates, cloud computing is an useful mean to facilitate the storage and access to data, as well as to encourage collaboration around it. By automating the aggregation of data or information into a scalable and ubiquitously available platform, cloud computing constitutes an important step in developing information commons through digital technology. This is particularly true in the field of scientific collaboration, where the ability to aggregate large amounts of data from different sources is an essential requirement for the global-scale collaboration and extensive data analysis that characterizes many current research projects (Dudley and Butte 2010).

More and more information commons are being produced through a mechanism whereby users are invited to contribute individually to a large project that is ultimately made up of a very large number of separate contributions. Although each individual contribution carries very little value by itself, the large-scale aggregation of all contributions can produce something which, taken as a whole, is much greater than the sum of each individual parts. Cloud computing can, as we have argued, facilitate this process by simplifying the procedure of collaboration and cooperation amongst users. This encourages the establishment of new models of production based on the management of voluntary-based human resources, sometimes referred to as crowdsourcing (La Vecchia and Cisternino 2010) or—somewhat ironically—Human as a Service [HaaS]. (For a more detailed overview of this new trend in cloud computing, see Sabetzadeh and Tsui [2011, 14–20].)

This can be the most clearly observed in the context of the FLOSS movement, which has been the pioneer in this field. Many FLOSS applications are produced not by any given individual or company, but by a distributed community of users—often passionate and enthusiastic volunteers—relying upon a shared online platform to collaborate asynchronously in the development of the code. Given the inherently distributed character of this type of production, it is very helpful if the source code resides in one place that is always and unconditionally available to everyone. Several platforms have thus been created to facilitate peer collaboration and software development—many of which rely on cloud computing technologies; for instance, GNU Savannah, a central point for development, distribution and

¹⁹ But cf. footnotes 17 and 18 above, regarding the relative aspect of this ubiquity.

²⁰ As an example, this platform could track and display the licenses that each database record is distributed under, but it certainly would not be able to enforce such licenses.

maintenance of Free Software (<https://savannah.gnu.org/>), and SourceForge, a web-based source code repository that acts as a centralized location for software developers to control and manage FLOSS development (<http://sourceforge.net>).

Although initiated by the FLOSS movement, the same model can be applied, by analogy, in the realms of scientific, literary, musical or audiovisual works. There are, to date, a significant number of initiatives providing tools for the production and dissemination of information commons on cloud computing platforms—a number that is likely to grow in the coming years. Wikipedia is probably the most renowned example, but it is not the only one. Kune, for instance, is a newly developed web application based on Cloud Computing technologies, intended to encourage collaboration amongst peers so as to promote the creation and facilitate the sharing of free culture. It allows users to create an online group space for the creation of collaborative documents, build community websites, hold and plan meetings in real time, interact or share contents with other users of the same group or with others people within the social network (<http://kune.ourproject.org>). The Kopfschlag project has applied this model in the domain of the arts, by creating an online canvas that anyone can edit, draw or erase, contributing thereby to a continuously evolving collaborative work of art (<http://kopfschlag.com/>). In the domain of academic research, there are several platforms—such as CiteULike, Zotero and Connotea—aimed at allowing users to store, manage and share bibliographical information (including comments and folksonomical tagging). In the field of computer graphics, BlendSwap is a repository of models (files detailing objects and characters) for Blender, a FLOSS for 3D animation; models can be shared under certain Creative Commons licenses (CC-0, CC-BY, CC-BY-SA), and users can favourite, comment and download them (<http://blendswap.com>).

In addition, cloud computing platforms can be particularly useful to promote access to and dissemination of information commons, even if the tools they provide are not focused on facilitating collaborative production as such. Wikimedia Commons, for instance, is a database of over 13 millions freely usable media files to which anyone can contribute. It makes available public domain and freely-licensed educational media content (images, sound and video clips) to everyone, and is mostly maintained and populated by volunteers (<http://commons.wikimedia.org>). Similarly, the Internet Archive is a non-profit digital library offering free access to books, movies and music that ultimately belong to information commons, either because they are part of the public domain or which have been released under a free / open license (<http://archive.org>). In the field of music, a number of platforms have been set up to facilitate access and dissemination. A popular example is ccMixer, a searchable repository of samples (uploaded and categorized by users) which are licensed under free/open licences and which can be either downloaded or directly streamed onto the website. The platform also comes along with a series of tools to promote interaction between users (such as user's profiles and forums), while allowing them to bring value to the repository by writing reviews or adding “trackbacks” indicating that certain samples have been used in a derived work (<http://ccmixter.org>).

Oftentimes, the flexibility and dynamicity of digital communities based on the logic of collaboration and incremental innovation can produce results which are as good—if not better—than those of large corporations. It is not uncommon for FLOSS to be considered more reliable than its commercial counterparts²¹—and the same can be said for many products released under free / open licences.

²¹ Internet web servers are a strong case in point; according to a long-running survey by an independent Internet

Given the perceived value of information commons, large online service providers are often tempted to capitalize on them. Indeed, although they cannot directly appropriate the commons' resource pool, market actors can nonetheless benefit indirectly by capturing value derived from the information commons. An increasing number of commercial platforms—such as Flickr, Vimeo or SoundCloud—have identified the economic potential of information commons, and are nowadays providing the means for users to upload content produced by them or by others into their platforms, provided that it has been released under a free/open licence. While this might not be a problem as such, this situation could result into a series of unintended consequences that were hard to foresee before the advent of cloud computing. Among the most pernicious of those consequences is the fact that, in certain cases, cloud computing technologies can be used by commercial actors to extract value from the information commons in ways that might hamper their development or restrict their availability to the rest of society.

3. Commodification of the commons

a. Definition

Commodification is the process through which something becomes a commodity. Commodity, in turn, is a concept that can be defined in many (often complex) ways. For the purpose of this paper, we have adopted an operational definition of commodity, similar to that of Karl Polanyi (1957 [1944], 72): a private good, produced through a process which is mostly driven by market needs or considerations (as opposed to a process driven by direct needs or considerations of a community).

Before further exploring this definition, let us consider an argument in favour of commodification which is frequently raised in mainstream economics: the market demand for commodities is the most efficient way to gauge the needs of communities. We argue that the problem with this approach is that markets can only offer, at most, an indirect signalling of community's needs; one which is prone to serious distortions. This distortions can be clearly exemplified by the “neglected diseases” issue, which refers to diseases that receive very little attention from the pharmaceutical industry (in terms of research investments, and sometimes even production and distribution of existing medicines), even though they affect more than a billion people around the world (DNDi 2012).²² This same industry, in turn, makes huge investments in

services company, FLOSS has always accounted for the largest percentage of web servers, and as of July 2012 at least 72.5% of the servers run FLOSS (with the top proprietary software option accounting for 11.46%); see the survey by Netcraft (2012), covering 665 million websites. Another survey by a different company, covering only the Internet's top 10k websites showed a very similar distribution (Royal Pingdom 2012).

²² Neglected diseases include Sleeping Sickness, Chagas disease, Kala Azar and paediatric HIV, all of which tend to be fatal when untreated. The crucial difference between neglected and non-neglected diseases is that market production can be much less profitable (or even unprofitable) when it is aimed at satisfying certain needs (those of poorer, marginalized patients), even if those are life-threatening needs that affect a large portion of the world.

research for drugs that cater to the needs of a wealthy minority, often wasting valuable resources in developing similar medicines for already treatable conditions (as in the case of erectile dysfunction drugs), only in order to have a share in the most lucrative markets (Latrive 2005, 27). This illustrates how markets might frequently be better in signalling the profitability of an endeavour than the needs of communities.

Coming back to the definition of commodity, its application to information commons (namely, when information commons are the subjects of a commodification process) involves a peculiarity. To turn a commons into a commodity, it must firstly be turned from a common good (*i.e.* a good that is owned by a community) into a private good through the process of *enclosure*. This is due to two main reasons. First, in order to legitimately offer a commodity in a market, one must be able to exert exclusive rights (such as those connected to private property) over it.²³ Second, if a commodity can be shared amongst several individuals, it will be less scarce (and thus less valuable as a commodity) than if it was exclusively controlled by one person.

To better understand the concept of commodification as applied to information commons, it might be useful to distinguish it from similar but distinct phenomena that can occur within or around the commons.

One of these is the process of *commercialization*, *i.e.* the act of offering something for sale. While commodification presupposes commercialization, the reverse is not always true. For instance, although FLOSS can sometimes be sold commercially, such a sale does not involve the commodification of the software (which remains shareable and free—in the strong sense of this word—despite the sale), nor does it imply that the production thereof was necessarily driven by market needs. In this example, commercialization occurs *inside* the commons, to the extent that it is directly affecting its resource pool; however, commercialization can also occur *around* the commons, by indirectly leveraging the contents of the resource pool. This is the case of many “indirect sale-value” (Raymond 2001, 134–140; Eric Raymond is a leading figure in the open source software movement) and “freemium” (Anderson 2009) business models, in which profit comes not from the sale of the commons resource pool, but rather from the sale of products or services related to it. In the context of FLOSS, this type of commercialization is generally achieved through the sale of proprietary versions with additional features, specialized hardware that is compatible with the software, support or customization services. In the context of literary works, this is achieved through the sale of abridged audio versions, deluxe editions; and so on. Finally, commercialization *around* the commons can also be achieved by means of advertising. Providing information commons for free in order to attract a substantial users base and subsequently selling users’ data for the purpose of behavioural advertising is nowadays a frequent business model which, although definitely involving some degree of commodification, does not necessarily imply commodification of the commons’ resource pool itself.

Many of these cases are based upon the provision of previously unavailable services or products; ones that can satisfy communities’ needs, without posing threats to the commons they’re structured around. Additionally, the benefits derived from advertising and previous examples could potentially be used to

²³ It is also possible that the whole community jointly agrees to dispose of all or part of the things they share in a commons; in this case, the good can be commodified while it is still common property. While this “voluntary” case of commodification of a commons is worthy of analysis, we will not examine it in this paper for reasons of simplicity.

provide resources for the development of more information commons.

A second phenomenon that must be distinguished from the commodification of information commons is the one of *cooptation*: *i.e.* transforming the structure of an information commons in such a way as to no longer reflect the aims and needs of its community. Cooptation can be a consequence of commercialization happening *around* the commons (as in the cases outlined above), but it is a more subtle and nuanced phenomenon. Let us consider two possible examples of cooptation.

One is the case of FLOSS becoming the object of interest of a few companies whose businesses are based on providing services or selling hardware somehow related to that FLOSS. Those companies are likely to contribute to the development of that software, mainly to ensure it is being developed in ways which are compatible with the businesses they run around it. In this case, cooptation would take place whenever the influence these companies exert over the development of the software is so large (*e.g.* because of the amount of community members that the company can employ for paid work, or because of their interference in the governance structure of the commons) that it eventually supersedes the influence of other actors, thus effectively making the needs of those companies a priority over the community's needs.²⁴ Since the commons' resource pool remains free, it is in theory always possible for the community to fork²⁵ in order to follow a different direction; yet, apart from the fact that forking is generally rare (it is undertaken only as a last resort, as communities acknowledge that otherwise it wastes too much effort [Weber 2005, 64]), the fact that the company employs many members of the community introduces an additional imbalance favouring the primacy of the company's interests.²⁶ The second example is that of many blogs licensed under free/open content licenses. Most of those blogs resort to advertisements (either in the form of banners and text ads, or through sponsored posts and paid product placement) in order to earn money. In this case, cooptation would occur if the content and general editorial direction of those blogs were transformed in such a way as to make them more attractive to advertisers (for instance, by focusing on content that is seen as more advertising-friendly, that promotes more click-throughs, or that is geared to increasing search engine hits).

As mentioned above, cooptation is ultimately a nuanced process: in both examples, there is a continuum of gray areas (rather than a binary measure) of cooptation. It is—unlike commercialization *inside* or *around* the commons, which could potentially help in funding the maintenance of the commons—a process strictly detrimental to commons, although it does not necessarily involve commodification *per se*.

²⁴ For instance, if some of those companies sell servers with heavily multithreaded processors, in the circumstance that a choice had to be made between alternative development paths enhancing either multi-threaded or single-threaded performance, that company could use its influence over the project to guarantee that the multi-threaded path be the chosen one (even if the community's needs are closer to the opposite choice).

²⁵ In the context of software development, “forking” is the act of splitting a project, by taking the code which has been implemented until now, to further develop it in a different direction than the original project, in such a way that it becomes difficult to share future code between the two projects. Forking usually implies a similar schism in that project's community.

²⁶ As an example, Android is a FLOSS operating system in which such imbalance is evident in its governance structure; see *e.g.* Vieira (2011, 9–10).

b. Traditional means of commodification

Commons are generally driven by the needs of their communities; and with information commons, communities can be remarkably large and porous to new members.²⁷ Information commons create value for society by allowing anyone to use them, but also to build upon them, to subsequently produce new works that will become themselves part of the commons (either immediately, whenever the derivative works have been released under a free/open license, or at a later time, after the copyright has expired).

²⁸ All works derived from the information commons will either become immediately available to the public under an identical (in the case of copyleft licenses) or similar regime, or they will be subject to the copyright regime and thus only benefit society at a later time, after the exclusive rights have expired.

While any work released under a free/open licence will contribute to increasing the pool of information commons, licenses precluding the making of derived works or imposing restrictions over commercial uses of the commons could reduce potential benefits that can emerge from those works (in particular, the possibility that certain derived works are produced and added to the commons). Those are, however, the most widely used types of licences: according to an estimate by Creative Commons in 2010, almost half the works using their licenses used those with clauses precluding commercial usage—including the making of derived works.²⁹

This can be detrimental to the extent that using the commons—either commercially or not—is likely to result in previously unavailable products or services that could ultimately benefit society. The use of these licences is therefore discouraged by many online communities concerned with the preservation and the promotion of information commons,³⁰ on the grounds that information commons cannot be, in themselves, directly harmed by commercial usages, since they will, at least in principle, also remain accessible to others in a non-commercial way.

What is true in principle is, however, not necessarily true in practice. Indeed, many mechanisms can be employed to turn information commons into a commodity.

One of such mechanisms—albeit somewhat controversial—is to acquire the copyright in a work and

²⁷ Access to technology, internet infrastructure and technical knowledge, and even language and gender issues can still be barriers to participate (particularly in a more active way). However, the situation is considerably better than with most physical commons, where the scarcity and more rival character of resources limits membership in a much stronger way. Because of that, membership requirements in physical commons can be more “arbitrary”, restricting the community to those born in a certain area, for instance; while in information commons, the requirements to join as user can be as low as agreeing to follow copyleft rules (which only apply when the user wants to redistribute the good).

²⁸ While it is not unusual to refer to a single “information commons” as one wide pool that includes all content in the public domain, under free/open licenses, or that qualifies as fair use, we refer here instead to *many* instances of information commons (which can sometimes be superposed or linked, as when there are compatible licenses). In this sense, the public domain is one of those many instances of commons.

²⁹ Additionally, 2.63% of the works used the “Attribution-NoDerivs” license, which forbids all derivative works but allows other commercial uses (Cheliotis 2012).

³⁰ This can be exemplified by the Open Knowledge Foundation’s Open Definition (OKF). Among the conditions it requires for a work to be considered open is that it “may not restrict the work from being used in a business”, or in any other endeavour.

subsequently revoke the licence. This issue was raised in the *CyberPatrol*³¹ case, where the copyright in software released under the GPL licence was transferred to a third party which purported to revoke the licence. Although the judge ultimately did not rule on the issue, the general opinion is that even though the copyright owner may decide that a work be no longer released under a particular license, this decision cannot impinge upon the rights of any previous licensee who has legitimately obtained a license: any formerly issued license will continue to be valid provided that no breach has occurred.³²

When the law does not allow for the commons to be turned into a commodity, contracts and technology can be used instead, as a mechanism to dictate the extent to which a particular piece of content can be used. This can be done, for instance, by incorporating protected material into an information commons (e.g. adding a preface to a book that has entered the public domain) and subsequently relying on contractual provisions and/or technological measures to introduce an additional layer of protection to the work as a whole. While this practice has been precluded by several free / open licences,³³ it can nonetheless be employed to acquire control over information that is not subject to copyright protection, such as facts, ideas, or any work whose copyright has expired.

Moreover, some people claim that the mere act of digitization gives rise to a new right over the resulting digital copy. Although this claim has thus far not been acknowledged by the jurisprudence, several corporations, such as Google, implement something similar by incorporating contractual provisions into the digitized copies of public domain works in order to prevent users from exploiting them commercially.³⁴ Contracts and technology can thus potentially supersede the law, turning public domain information into a commodity whose exploitation can be regulated as if it qualified for copyright protection (for more

³¹ See *Mattel v. Jansson, Skala et al.* (District Court of Massachusetts, 2000, Civil Action no. 00-10488-EFH): the defendants developed a software capable of decrypting the database of Mattel's web-filtering software and Mattel sued for copyright infringement, as a result of which the defendants assigned the copyright in their software to Mattel. On the belief that the software had been released under the GPL, the case generated strong controversies in the FLOSS community. While many claimed that revocation of the GPL license was impossible, the Free Software Foundation nonetheless admitted that revocation is potentially a problem, as the GPL specifically states that "the recipient automatically receives a license from the *original licensor*" (emphasis added).

³² This view has been formalized by the Creative Commons licenses, according to which the "licensor reserves the right to release the Work under different license terms or to stop distributing the Work at any time, provided, however that any such election will not serve to withdraw this License (or any other license that has been, or is required to be, granted under the terms of this License), and this License will continue in full force and effect unless terminated [by a breach]." Accordingly, as long as the license has not expired and that none of its provisions have been breached, the license is deemed to be valid and legally effective with regard to every work it has been applied to, and any change in the terms and conditions of the license will not have any effect on the copies that have already been released but will only affect the license for the new copies of the work (see Välimäki and Hietanen 2004).

³³ Certain licenses are incompatible with the application of technological measures of protections to the extent that they prevent or restrict the access to and/or the legitimate exploitation of a work (see e.g. the Creative Commons licenses), whereas others are incompatible with the application of any technological measures of protection, whether or not they have been designed to prevent or restrict the legitimate exploitation of a work (see e.g. the Anti-DRM license and the GNU Free Documentation License).

³⁴ Google Books allows users to download the digitized copies of public domain books. However, Google also imposes a series of restrictions on the use of those copies. According to Google Books' Terms of Service, users can only use them "for personal, non-commercial purposes" and are under the obligation to maintain "attribution" by preserving the Google watermark.

details on the use of contracts for the commodification of information, see *e.g.* Radin 2004).

c. Commodification through Cloud Computing

Cloud computing provides the underlying infrastructure for the establishment of a whole new layer of commodification, which applies not only to public domain information but also to copyrighted content released under free/open licences.

Given that information stored into the cloud is made available to the public through a specific, provider-controlled user interface (be it a graphical user interface, or an application programming interface), cloud providers can unilaterally determine the extent to which and the manner in which information commons can be accessed, used or reused. If—as clearly expressed by Lawrence Lessig (2006)—code is the law of the internet, in the context of cloud computing the user interface can become *de facto* law. As the main content holders, cloud providers have become as powerful, and sometimes more powerful than copyright owners. Indeed, the provisions of copyright law have become irrelevant in a context where everything the user can or cannot do is determined by the technical specifications of the cloud computing platform. By exporting content into the cloud, the copyright owner no longer enjoys direct access to such content and is thus left with little practical means of control over it. The cloud provider, on the other hand, has the power to specify the terms and conditions regulating the access to and the usage of any piece of content stored on its servers, potentially ignoring the provisions of the licence under which it has been released (De Filippi and McCarthy 2012).

By limiting the extent to which users control their content, cloud computing itself, as a service sold to communities, is commodified; its characteristics have less to do with communities' needs than with the provider's profit motivation. But commodification can also happen here in a second and less obvious direction: when commons are turned into commodities, and are used to “pay” for cloud computing services.

One of techniques used to reach that goal is the practice of crowdsourcing.³⁵ Nowadays, the production of content or information frequently is done not by online operators, but rather by a large community of users participating in online platforms. Encouraging digital communities to produce and share information is a means for online service providers to maximize their profits by exploiting the output of peer production as a means to reduce their own costs of production. Online operators can subsequently reap off the benefit thereof by offering a service whose value is for the most part derived from the commercial exploitation of this content.

In the last few years, a large number of such platforms have been deployed to facilitate social interactions through the dissemination of user-generated-content. This is the case of Facebook, whose business model relies—in addition to selling user's data to advertisers—mainly on the content produced by its user-base; but also Flickr, Twitter or any other company that does not actually produce any content itself, but merely exploits the content generated by others for its own profit.

³⁵ Crowdsourcing is a process based on the outsourcing of small tasks or problems to a distributed and decentralized group of individuals. As opposed to many forms of outsourcing directed towards specific entities or individuals (*e.g.* contractors), crowdsourcing is directed towards an undefined public which voluntarily and autonomously decides to take on one or more of these tasks.

Most of those platforms are nowadays controlled by large corporations that are able to precisely define the manner in which content can be produced or communicated through them. Although they cannot claim any right over such content, they can nonetheless dictate the way users can access or interact with it (Lametti 2012). Oftentimes, terms of use also require users to automatically transfer the copyright in any content produced onto the platform, or *a minima* to grant the service operator a universal, perpetual and unconditional license for exploiting such content.³⁶ In spite of its legal status, content can thus be freely exploited by cloud operators.³⁷ Conversely, to the extent that they cannot fully control the content they have produced (as it is now hosted in the infrastructure owned by the provider), users cannot freely dispose of it—regardless of whether or not it has been released into the commons.

Finally, this leads to another fundamental concern raised by cloud computing with regards to the freedom to use and reuse information commons. To the extent that content is only available through the interface provided by the cloud provider, users can no longer access the *source file* of such content. In the case of FLOSS, access to the source code is a prerequisite for users to exercise their freedom to understand, edit and modify the code. Similarly, in the context of information commons, access to the source file is often necessary—or to the least instrumental—to the creation of derivative works. By not providing the means for users to download the source files of content stored into the cloud, cloud providers can negatively affect some of the freedoms granted to users under the licence.

4. Governance and architecture design

a. Decentralized peer-production

As mentioned in previous sections, commons production models are mostly geared towards the satisfaction of a community's direct needs; as a result, the output of production cannot be regarded as a commodity (in Polanyi's terms). Even if certain communities do actually sell some of their common resources, most frequently this form of commercialization is not aimed at the accumulation of surplus, but rather at guaranteeing the sustained existence of the common resources, or, eventually, at financing the production of other resources to fulfil further needs of the community.

Relatedly, Ostrom's extensive research found that the most successful and enduring commons displayed a significant level of self-organization and democratic community participation.³⁸ While Ostrom's

³⁶ See *e.g.* Facebook's terms of use: "you grant us a non-exclusive, transferable, sub-licensable, royalty-free, worldwide license to use any IP content that you post on or in connection with Facebook (IP License). This IP License ends when you delete your IP content or your account unless your content has been shared with others, and they have not deleted it."

³⁷ Flickr, for instance, hosts pictures released under a variety of licenses, including Creative Commons licences. A large number of pictures are released under a licence that does not allow for commercial use (CC-BY-NC). Yet, to the extent that Flickr constitutes the infrastructure on which the pictures are hosted, they can essentially bypass the terms of the licence and exploit these pictures commercially (*e.g.* as a result of advertisements).

³⁸ Three of the eight design principles identified by Ostrom (1990, 90–102) as characteristic of enduring commons are related to self-organization and community participation: collective choice arrangements ("3. Most individuals affected by the operational rules can participate in modifying the operational rules"), monitoring ("4. Monitors, who actively audit CPR [common-pool resource] conditions and appropriator behaviour, are accountable to the

research was then restricted to physical, small-scale commons, there are already studies suggesting that self-organization and democratic participation are also features of ongoing and arguably successful information commons projects (Fuster Morell 2010, 233–55).

Highly centralized, hierarchical models of production are often unwelcoming to input from the members of the community, so that the needs of many users could simply be ignored and go unattended. In those models, the risk of the community breaking down is therefore considerable, unless there is a strong leader or a significant level of cohesion.

While Ostrom’s research focused material commons, those traits can easily be observed in the context of intellectual commons. Wikipedia and the Debian project³⁹ are good examples of this. Even though they do implement some limited form of hierarchy, their structure and organization is ultimately based on democratic principles that dictate most of the wide ranging decision-making processes. These projects are also permeable to new members and their contributions: anyone can edit Wikipedia (in most articles, even without being a registered member) or contribute to Debian, and can do so voluntarily, self-selecting their preferred tasks—as is typical of peer production initiatives. In the case of the Debian project, even if some of the most substantive ways to contribute (package maintenance, for instance) require specialized technical knowledge, many others do not (translations, legal issues, communications, advocacy etc.); and since 2010, non-technical contributors can also attain the official status of Debian Developers, and thus vote in the most important decisions concerning the project (Debian Project 2010).

b. Centralized cloud environment

Commodities, according to Polanyi’s definition, are mainly produced to satisfy market needs and considerations. Oftentimes, commodities are directly *pushed* into the market, and profit is taken as an indirect measure of people’s needs. Rather than being determined by those communities’ needs, production is gauged according to the overall profits: if one commodity sells well, more of it will be produced, until market demand is satisfied—that is, not because they reflect effective societal needs, but merely because some can buy it at a profitable price for the producer. Matters are further complicated through advanced and ubiquitous advertising and branding practices, which have the effect of blurring people’s effective needs.

In the context of cloud computing, where most online operators are profit oriented, information commons are not produced by the community for the community; they are produced—by the community—to ultimately satisfy the interests of cloud operators. While this usually involves furthering the interests of the community—a precondition to maintain a satisfied, productive user-base—answering

appropriators or are the appropriators”) and minimal recognition of rights to organize (“7. The rights of appropriators to devise their own institutions are not challenged by external governmental authorities”).

³⁹ Debian is an operating system (a GNU/Linux distribution), and probably the largest existing free software project, including more than 29000 packages (pieces of software). Many popular GNU/Linux distributions, such as Ubuntu and Linux Mint, are Debian-based.

to the community is only a means to reach another end, which is mostly oriented towards the maximization of profits.

To do so, the majority of cloud computing platforms rely on centralized architectures combined with a hierarchical system of governance. Given that all hardware and software is controlled by the cloud operators, users can only interact with the platform according to the rules established by the service provider. Risks of cooptation increase, as service providers are likely to encourage the production of information commons according to the amount of profits that they might derive from it, rather than according to the actual interests of the community itself.

Besides, unless data portability or interoperability has been provided by the cloud operator, users willing to leave one platform might only do so at the costs of losing all data stored in the cloud. Insofar as users are locked into the platform (*i.e.* the costs of switching to another platform are higher than the benefits they might derive from it), the correlation between users' needs and cloud operators' interests is weakened, as profits are not necessarily linked to the satisfaction of actual users' needs (De Filippi and Belli 2012).

c. Decentralized alternatives for peer-production

Previous sections have illustrated the existence of a clear and serious mismatch between information commons produced according to a community-centred and democratic approach, and those produced in the context of cloud providers' market-driven, centralized and asymmetrical approach. This mismatch is one of the main culprits for the various possibilities of commodification that we have described so far. However, this does not necessarily mean that all forms of cloud computing are equally inadequate to the production or the dissemination of intellectual commons; it is in fact theoretically possible to design a series of decentralized cloud computing platforms based on a peer-to-peer architecture.⁴⁰ Such platforms might allow communities to escape from the centralized control of large service providers, thereby increasing their autonomy as regards their own data, and reducing the risks of commodification.

Implementing decentralized infrastructures for cloud computing is not necessarily a trivial task (on the contrary), nor necessarily the most efficient option: centralized, large-scale providers often benefit from economies of scale in terms of costs, performance and maintenance. However, the intensive use of file-sharing peer-to-peer technologies⁴¹ as an alternative to centralized file-serving suggests that the peer-to-peer approach to cloud computing is not only feasible, but also promising. Apart from a clearly more adequate fit with the commons' model of governance, another reason for this is that personal computers connected to the Internet are often below their maximum usage capacity (in terms of processor cycles, memory usage and bandwidth). Peer-to-peer approaches to cloud computing allow communities to tap and pool these "spare resources" (which would otherwise go unused) instead of purchasing them from cloud providers. Exclusive reliance on user's personal computers might introduce

⁴⁰ Or, at least, platforms that are less centralized than provider-based cloud computing.

⁴¹ The BitTorrent protocol, for instance, has been widely adopted in the FLOSS community—where releases of popular GNU/Linux distributions can attract thousands of simultaneous users, each of them usually downloading a 700Mb file. Since 2012, the Internet Archive has also begun sharing part of its collection through the BitTorrent protocol; nowadays, the files offered this way amount to almost a petabyte of data (1 billion megabytes).

a series of concerns in terms of infrastructure reliability and resources' availability (personal computers are more likely to fail, or to be turned off, than cloud providers' servers located on dedicated data centres); but most of these drawbacks can be lessened by means of planned redundancy, for instance.

There are already many initiatives experimenting with a communitarian approach to cloud-related services. One interesting example tackling the issue of online storage is Tahoe-LAFS, a distributed, secure, fault-tolerant FLOSS file system, which can be used for the storage of personal files (<https://tahoe-lafs.org>). Data is stored across a variety of nodes in a redundant way (where the level of redundancy is configurable), so that even if some nodes are not online (or even if they have been completely lost due to hardware failure), files can still be accessed.⁴² All data stored on Tahoe-LAFS is encrypted, so that—unlike what happens by default in most commercial cloud computing platforms—no one but the file owner can access its contents (not even those who actually control the nodes where that file sits). In practice, this means that a small group of individuals with only moderate technical knowledge and standard personal computers can provide *each other*, for free, online backup services that can be more secure (in terms of privacy, at least) than those offered by commercial providers. Another example with a wide range of applications is FreedomBox: a community project to develop, design and promote personal servers running free software for distributed social networking, email and audio/video communications. The project was initiated by Eben Moglen on February 2010 and is now being carried out by the FreedomBox Foundation. Intended to assemble a “collection of social communication tools, distributed services, and intelligent routing in a package anyone can use” (FreedomBox Foundation), the basic idea is to allow anyone to easily set-up their own personal servers, using FLOSS software to replace many provider-based web services. The list of applications a FreedomBox should be able to run include feed aggregators, photo sharing, webmail, blog (and microblog) publishing, link shortening / sharing, text chat, calendar and time-management systems, telephony systems, activity stream (as in current social networks), and online backup (“Leaving the (proprietary) cloud” 2012). While much of the software already exists, it is being packaged and adapted in a way that it can run from cheap, low-power devices (from older personal computers to modern “plug-sized” computers),⁴³ and take advantage from cryptography and peer-to-peer technologies (such as mesh networking) to guarantee privacy, avoid censorship and overcome localized connectivity problems.

Those are just a few of the various initiatives that have been taken so far,⁴⁴ yet, it is important to note that those efforts, albeit extremely valuable, are not sufficient (as such) to counteract the trend towards the commodification of information commons. Issues related to Internet governance and access to technology, which can undermine these efforts, must also be worked on. For these alternatives to actually have an impact upon society, they also must be widely available and easy to use, and—most importantly—the dangers of commodification must be clearly communicated to the public. Awareness

⁴² With the default settings, all data can be accessed even when 70% of the nodes have failed (and the storage used in each node is only 3.3 times higher than a single copy of the data).

⁴³ As of December 2012, a FreedomBox-related web page lists 12 existing plug-sized computers; 8 of them are priced below USD 100 (“Target Hardware” 2012).

⁴⁴ Other similar initiatives include, *inter alia*, Freenet (a distributed, anonymous file sharing and web publishing network), GlusterFS (another distributed file system); and several federated social network and microblogging tools, such as Diaspora, Friendica and StatusNet.

of the risks resulting from the growing centralization of cloud computing platforms is the first step towards the provision of decentralized alternatives which are likely to be adopted by a sufficiently large number of users. Only then will it be possible to offer a community-oriented service capable of being an alternative to the services provided by commercial cloud operators.

LITERATURE CITED⁴⁵

- Almeida, Alfredo Wagner Berno de. 2008. *Terras De Quilombos, Terras Indígenas, “Babaçuais Livres”, “Castanhais Do Povo”, Faxinais e Fundos De Pastos: Terras Tradicionalmente Ocupadas*. 2nd ed. Tradição e Ordenamento Jurídico 2. Manaus: PGSCA-UFAM.
http://www.novacartografiasocial.com/arquivos/publicacoes/livro_terrasOcupadas.pdf.
- Anderson, Chris. 2009. *Free: The Future of a Radical Price*. New York: Hyperion.
- Armbrust, M., A. Fox, R. Griffith, A. D. Joseph, R. Katz, A. Konwinski, G. Lee, et al. 2010. “A View of Cloud Computing.” *Communications of the ACM* 53 (4): 50–58.
<http://dx.doi.org/10.1145/1721654.1721672>
- Bauwens, Michel. 2005. “The Political Economy of Peer Production.” *CTHEORY* (td026) (January 12). <http://www.ctheory.net/articles.aspx?id=499>.
- Benjamin, Walter. 1986. “The Work of Art in the Age of Mechanical Reproduction.” In *Illuminations*. New York: Schocken Books.
- Benkler, Y. 2002. “Coase’s Penguin, or, Linux and ‘The Nature of the Firm’.” *Yale Law Journal*: 369–446. <http://www.yalelawjournal.org/images/pdfs/354.pdf>
- Benkler, Yochai. 2006. *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. New Haven [Conn.]: Yale University Press.
http://cyber.law.harvard.edu/wealth_of_networks/Main_Page.
- Bloch, Marc Léopold Benjamin. 2008 [1931]. *Les Caractères Originaux De L’histoire Rurale Française*. Saguenay: UQAC.
http://classiques.uqac.ca/classiques/bloch_marc/histoire_rurale_fr_t1/histoire_rurale_fr_t1.html.
- Bowles, S., R. Boyd, E. Fehr, and H. Gintis. 1997. “Homo Reciprocans: a Research Initiative on the Origins, Dimensions, and Policy Implications of Reciprocal Fairness.” *Advances in Complex Systems* 4 (2/3): 1–30. <http://www.umass.edu/preferen/gintis/homo.pdf>
- Cheliotis, Giorgos. 2012. “World - CC Monitor.” <http://monitor.creativecommons.org/World>.
- De Filippi, Primavera, and Luca Belli. 2012. “The Law of the Cloud V. the Law of the Land: Challenges and Opportunities for Innovation.” *European Journal of Law and Technology* 3 (2). <http://ejlt.org//article/view/156>.
- De Filippi, Primavera, and Smari McCarthy. 2012. “Cloud Computing and Data Sovereignty.” *European Journal of Law and Technology* 3 (2). <http://ejlt.org//article/view/101>.
- Debian Project. 2010. “General Resolution: Debian Project Members.”
http://www.debian.org/vote/2010/vote_002.
- DNDi (Drugs for Neglected Diseases initiative). 2012. “Developing and Delivering New Treatments to

⁴⁵ All URLs were last visited on December 2012.

- Combat Poverty-Related Neglected Diseases.”
http://dndi.org/images/stories/DNDi_Brochure_web.pdf.
- Drahos, Peter. 2003. *Information Feudalism: Who Owns the Knowledge Economy?* New York: New Press. <http://www.anu.edu.au/fellows/pdrahos/books/Information%20Feudalism.pdf>.
- Dudley, J. T., and A. J. Butte. 2010. “In Silico Research in the Era of Cloud Computing.” *Nature Biotechnology* 28 (11): 1181–1185.
- Falk, A., T. Dohmen, D. Huffman, and U. Sunde. 2006. “Homo Reciprocans: Survey Evidence on Prevalence, Behavior and Success.”
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=920647.
- Foster, I., Y. Zhao, I. Raicu, and S. Lu. 2008. “Cloud Computing and Grid Computing 360-degree Compared.” In *Grid Computing Environments Workshop, 2008. GCE'08*, 1–10.
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4738445.
- FreedomBox Foundation. “Flyer.” <https://www.freedomboxfoundation.org/doc/flyer.pdf>.
- Fuster Morell, Mayo. 2010. Governance of online creation communities: Provision of infrastructure for the building of digital commons. Doctoral thesis, Department of Political and Social Sciences, European University Institute. http://www.onlinecreation.info/?page_id=5.
- Geach, N. 2009. “The Future of Copyright in the Age of Convergence: Is a New Approach Needed for the New Media World?” *International Review of Law, Computers & Technology* 23 (1–2): 131–142. <http://dx.doi.org/10.1080/13600860902742588>
- Gillespie, Tarleton. 2007. *Wired Shut: Copyright and the Shape of Digital Culture*. Cambridge, Mass: MIT Press.
- Lametti, David. 2013. “The Cloud: Boundless Digital Potential or Enclosure 3.0?” In *Virginia Journal of Law & Technology*, Vol. 17. No. 3.
http://www.vjolt.net/vol17/issue3/v17i3_190_Lametti.pdf
- Latrive, Florence. 2005. “Le Médicament Comme Bien Commun, Une Réflexion En Développement.” In *Pouvoir Savoir : Le Développement Face Aux Biens Communs De L'information Et à La Propriété Intellectuelle / Coordonné Par Valérie Peugeot*, ed. Valérie Peugeot. Caen: C&F. <http://vecam.org/rubrique97.html>.
- “Leaving the (proprietary) Cloud.” 2012. <http://wiki.debian.org/FreedomBox/LeavingTheCloud>.
- Lessig, Lawrence. 2006. *Code: Version 2.0*. 2nd ed. New York: Basic Books.
<http://codev2.cc/download+remix/Lessig-Codev2.pdf>.
- Linebaugh, Peter. 2008. *The Magna Carta Manifesto: Liberties and Commons for All*. Berkeley: University of California Press.
- Miller, Michael. 2008. *Cloud Computing: Web-based Applications That Change the Way You Work and Collaborate Online*. Indianapolis, Ind: Que.
- Netcraft. 2012. “July 2012 Web Server Survey.”

- <http://news.netcraft.com/archives/2012/07/03/july-2012-web-server-survey.html>.
- OKF (Open Knowledge Foundation). “Open Definition.” <http://opendefinition.org/okd/>.
- Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. The Political Economy of Institutions and Decisions. Cambridge: Cambridge University Press.
- Polanyi, Karl. 1957 [1944]. *The Great Transformation*. Boston: Beacon Press.
- Radin, Margaret Jane. 2004. “Regulation by Contract, Regulation by Machine.” *Journal of Institutional and Theoretical Economics (JITE)* 160 (1).
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=534042.
- Raymond, Eric S. 2001. *The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*. Rev. ed. Beijing; Cambridge, Mass: O’Reilly.
- Royal Pingdom. 2012. “75% of Top 10k Websites Served by Open Source Software.”
<http://royal.pingdom.com/2012/05/22/75-percent-top-10k-websites-served-by-open-source-software/>.
- Sabetzadeh, Farzad, and Eric Tsui. 2011. “Delivering Knowledge Services in the Cloud.” *International Journal of Knowledge and Systems Science* 2 (4): 14–20.
doi:10.4018/jkss.2011100102.
- Stallman, Richard. 2002. *Free Software, Free Society: Selected Essays of Richard M. Stallman*. First Printing, First ed. Free Software Foundation.
<http://www.gnu.org/philosophy/fsfs/rms-essays.pdf>.
- . 2010. *Free Software, Free Society: Selected Essays of Richard M. Stallman*. 2nd ed. Free Software Foundation. <http://www.gnu.org/doc/fsfs-ii-2.pdf>
- . 2012. “Did You Say ‘Intellectual Property’? It’s a Seductive Mirage.”
<https://www.gnu.org/philosophy/not-ipr.html>.
- Story, Alan. 2002. “Copyright: TRIPS and International Educational Agenda.” In *Global Intellectual Property Rights Knowledge, Access and Development*. Basingstoke: Palgrave Macmillan.
- “Target Hardware.” 2012. <http://wiki.debian.org/FreedomBox/TargetedHardware>.
- Turner, M., D. Budgen, and P. Brereton. 2003. “Turning Software into a Service.” *Computer* 36 (10): 38–44. <http://dx.doi.org/10.1109/MC.2003.1236470>
- Välimäki, Mikko, and Herkko Hietanen. 2004. “The challenges of creative commons licensing: What are the legal implications when the principles of open source software licensing are applied to other copyrighted works on the Internet?” *Computer law review international* (6): 173–178.
http://www.valimaki.com/org/oc_cri.pdf
- La Vecchia, G., and A. Cisternino. 2010. “Collaborative Workforce, Business Process Crowdsourcing as an Alternative of BPO.” *Current Trends in Web Engineering*: 425–430.
- Vieira, Miguel S. 2011. “What Kind of a Commons Is Free Software?” In *Proceedings of the 6th*

Open Knowledge Conference. Berlin: CEUR. http://ceur-ws.org/Vol-739/paper_10.pdf.
Weber, Steven. 2004. *The Success of Open Source*. Cambridge, MA: Harvard University Press.