Peer-production online communities infrastructures

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Abstract—**This article analyses peer-production online communities according to their technical and governance architectures level of centralization and decentralization. Peer-production online communities can be defined as projects or platforms distributing or producing digital information based on users' voluntary contributions. The resources technical characteristics, the rules organizing provision of the service, production, access and appropriation of the resources, as well as the platforms design will have an influence on the excludability of the users. The level of decentralization or distribution of the architecture of these platforms will have an impact on governance, exclusion, ownership and reuse of the resources and services developed by communities.**

Index Terms—**peer production; commons; governance; distributed architectures, access.**

I. INTRODUCTION

This article[1] proposes an analytical framework to analyze the provision, production and appropriation (as understood in [1]) characteristics of peer-production online communities understood as forms of collective action. The typology presented in the paper is based on the level of decentralization of the projects' technical, governance and legal framework. Suggesting axes of classification aims at better understanding the impact of platforms design and governance choices on access to digital resources, sustainability of the hosting platforms and of the produced resources and autonomy. Each of the four areas, depending on the level of centralization or decentralization of architecture or governance will be contextualized with examples of platforms and consequences of such infrastructural choices.

II. DIGITAL INFORMATIONAL RESOURCES GOVERNANCE

Digital information can be considered as a public, non-rival and non-excludable good. After the investment for production of the first unit, it can be distributed through the networks and reproduced by digital technologies for a marginal cost of zero.

Two models of governance have been observed for the production and the distribution of digital informational resources, the market and the commons-based approach [2].

First, information can be treated as a private or club good, and enclosed by providers or producers, for instance by using copyright law, encryption technologies or contracts to restrict access and control reuse. The market approach reestablishes artificial scarcity and excludability by controlling access and reproduction, leading to a "second enclosure movement on the intangible commons" [3].

But because reproduction and distribution can be achieved for free, online communities have also been able to develop other collaboration forms or institutions for collective action, namely "commons-based peer-production" [4], for instance free software. Distributed peer-production has been evaluated as sustainable, people are able to dedicate time to projects and find incentives to participate to communities [5].

It is important to distinguish the property status of the resources, the nature of the resources and the organizational form of production. Peer-production doesn't infer anything about the platform governance and the resources ownership status and it can be distinguished among communities who produce public goods, private goods, club goods and commons pool resources. The architectural design of the infrastructures used by these communities helps identifying the type of institution for collective action. It is claimed that the level of centralization has an effect on the level of excludability.

III. ARCHITECTURE MODELS OF PEER-PRODUCTION ONLINE COMMUNITIES

The level of centralization of the architecture of peer-production online communities can be studied at various levels: the technical infrastructure of the platform, the governance rules of the platform and the ownership of the resources produced by the peers.

A. The Technical Architecture

Online communities, such as applications and networks in general, can be centralized around a server owned and managed by a central authority.

Alternatively to the traditional client-server centralized model, a technical architecture can be called decentralized, distributed, or peer-to-peer, when it works without intermediary or hierarchy, without a central node or centrally-controlled servers. This is the original architecture of the Internet and of peer-to-peer softwares allowing the exchange of files between peers without a central server being responsible or in control of the nodes. Centrally-controlled platforms can also be structured in some decentralized manner, for instance with cloud computing allowing to store resources in external

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servers, but for the purpose of the proposed typology, these services will technically be considered as centralized if they are controlled by a central authority. Even if there are no strictly pure decentralized or centralized communities, the use of such models is helpful to characterize tendencies. An interface design giving more control to the platform owner is centralized while an architecture distributing power, responsibility and freedoms among users will be a decentralized infrastructure.

B. The Governance Architecture

Social architecture institutional arrangements will reflect on participation rules applicable to the users. They can also be classified from open to closed governance architectures. Legal rules governing the ownership of the resource, the right to access and reuse it as also set by the platform's terms of use or license agreement, are also part of the governance architecture.

A platform will have a centralized governance if users are excluded from its design and if the participation rules give control to a central authority. Decentralized governance will involve users in some democratic or participatory decision-making process [2] in which peers will have a word or an action on the design and the rules governing the platform, the participation and the resources.

Centralized ownership will concentrate the property of the resources produced by the peers in the hand of the platform owner. Decentralized ownership system will see the resources commonly or individually owned by the peers who are producing them.

Common property, public property and private property rules can be chosen for both the governance (rules of production and maintenance) and for the appropriation (rules of ownership of the resource output).

IV. ANALYSIS OF COMMUNITIES ACCORDING TO THEIR ARCHITECTURE MODELS

I evaluate the combined impact of the level of distribution/centralization of the architecture, governance and ownership arrangements on the excludability of those platforms, the potential restrictions on consumers' rights and users' rights to create, access and reuse the resource.

The following table illustrates the models breakdowns as analyzed in the following sections according to the level of centralization/decentralization of the architecture and governance.

TABLE I. ARCHITECTURE MODELS

	Centralized Architecture	Decentralized Architecture
Centralized Governance	Flickr Facebook (*section A.*)	Über Skype Wuala 1.0 (*section C.*)
Decentralized Governance	Wikipedia (*section B.*)	Kune Diaspora Faroo (*section D.*)

A. Centralized Architecture and Centralized Governance

Flickr, Facebook or Twitter provide platforms to publish resources produced by peers. They are hosted on central servers controlled by the platform owners. The technical infrastructure embeds the excludability of the user by the platform, allowing arbitrary censorship based on users participation choices and the type of resource.

There is no involvement of the community in the platform design or in the definition of the governance rules. These communities rely on peer production, but the property-regime is not commons-based. The peers can neither control the terms of use of the service, nor retrieve their production from the system and reuse it in another platform.

B. Centralized Architecture and Decentralized Governance

Wikipedia has been studied in the literature as a collective organization for public good provision (e.g. [6]).

Wikipedia has a centralized architecture; the servers are controlled by the Wikimedia Foundation. There is excludability and censorship at the production level for the individual contributor exercised by the peers following the sustainability rules defined by the community. "Without the ability to control the resource provided by a legal right to exclude content, quality could not be maintained" [7]. Governance is distributed among peers, with the re-introduction of a level of centrality through the power of the editors and the administrators.

There is no excludability from the collective contribution because of the copyright institutional arrangement. Open licensing with the use of a copyleft license ensures peer-production will remain commonly owned. The Creative Commons Attribution Share Alike license ensures traceability of the resource and prevents private appropriation or central ownership; no one can restrict others from accessing and reusing the common resource. If a peer wants to reuse and modify the resource, the result should be distributed with the same license, making it available to all. The platform is characterized by:

- A decentralization of the maintenance, the production and the monitoring,
- A relative re-centralization of the excludability of contributions by the administrators and arbitration committee control,
- A centralization of the production servers,
- A relative decentralization of the governance [7]: peers participate to the modification of the rules, the rules can't be modified without a vote,
- A commons-based licensing framework avoiding private/central appropriation of the resource produced by the peers; copyleft can be interpreted as a distributed ownership and a re-introduction of some sort of excludability: the resource is not in the public domain openly accessible for all, but can be used according to some rules aiming at sustainability and availability for the community and everybody. Copyleft property rights are an institutional

arrangement preventing free riders from privatizing resources.

C. Decentralized Architecture and Centralized Governance

Über, Skype, Wuala 1.0 are examples of centrally-controlled platforms using the features of a decentralized technical architecture. Peers are creating information about the localization and the rating of taxis available in the area where the user of the Über mobile phone application is geolocalized. Skype users are becoming nodes for direct communication between peers, and providing online storage for all users of the community. Wuala in its 1.0 version [9] was a peer-to-peer online storage provider coordinating storage of files in the computers of the peers, not only in a central cloud server. Data are fragmented, encrypted and made redundant in order to allow a user to retrieve stored data at any time. There are certain rules and incentives about the amount of time peers have to be online in order to allow the retrieval of data by the other peers at any time.

These services institutions are centralized: governance, terms of use and ownership of the platforms are controlled by central companies. There is excludability in the sense that terms of use are not favorable to users, data security is a black box.

Faroo is a peer-to-peer search engine. The company claims to be a "democratic, attention based ranking search engine", an "alternative to information monopoly". Its architecture protects privacy because queries and results are encrypted, and is resistant to censorship and request of public authorities to access users queries or results because the index of the search results is distributed and redundant. The absence of search logs provides privacy as a resource by architecture, not only by policy.

The governance and appropriation of the results of the work produced by peers, the value produced by the collective searches, is unclear. There are no terms of use, but the platforms are not open source and have closed business models.

D. Decentralized architecture and decentralized governance

Kune is a "free distributed web platform for collaborative work" providing service for the collaborative edition of documents (like Google Doc), the production and management of content between peers (like wikis, mailing-lists, calendars), the storage and sharing of resources among communities (like Dropbox). There is no central point of control, no excludability, no censorship. Projects can be hosted on the server of the choice of the users, avoiding problems of interoperability and appropriation of user generated data which is observed in proprietary platforms providing services in centralized architectures [10].

V. THE IMPACT OF DISTRIBUTED ARCHITECTURES ON USERS CREATIVITY, CONTROL AND ACCESS

The typology proposed to analyze platforms architecture and governance according to their level of decentralization has been illustrated by some examples. Excludability is correlated with the level of centralization.

Centralization characteristics facilitates control, features and terms of use that are not favorable to the user: arbitrary censorship, risk of privatization of the produced resources, restriction to access the platform, to retrieve the production, to reuse it, difficulty to assess privacy and security of the data.

Decentralization features will give more control to the user on its data and on produced resources. The absence of central control system increases robustness and performances as well as resilience against attacks and prevents surveillance [11]. Distributed architecture can be used by projects for privacy and anonymity purposes: Commotion wifi mesh network, Diaspora and Friends of Wikileaks distributed social networks, Tor anonymity peer-to-peer routing project.

Decentralization protects privacy and access to information, but can also facilitate cybercriminality. When data and process are fragmented, it is harder to allocate responsibility and locate actions on one agent. This makes the law apparently more difficult to enforce to peer-to-peer architectures than on centralized platforms that can be controlled and easily closed by public authorities (e.g. Megaupload in 2011).

But some form of decentralized control can be introduced through commons-based peer ownership, with open licensing as a way to reintroduce (decentralized) control on the resources produced by peers in decentralized architectures against exclusion in the form of private appropriation. The effects of the combination of architecture design and policies should be further investigated, in particular to analyze possible forms of regulation in decentralized models, with more systematic and in-depth observation of more platforms.

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