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Open Standards and Open Source: Characterisation and Typologies

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IP as a complex adaptive system

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Declaration of Standard-essential Patents (SEPs) - Strategic use of IP policies of standard-setting organisations by patent holders

Vicente Zafrilla
Project: ESR7

Research Question

The competitive and technological dynamics in the standardization environment shape the way Standard Essential Patents are declared, leading to a scenario where not all the essential patents are declared (underdeclaration) and not all declared patents are essential (overdeclaration). Both deviations have the potential of affecting the evolution of competition and innovation in the ICT sector by reducing interstandards competition, extracting unduly royalties through patent ambush or conditioning technological decisions, among others. On the other hand, Internet of the Things (IoT) technological and market dynamics might alter existing assumptions on the interaction of standards with competition and innovation. The following research questions ensue:

1. What are over and underdeclaration from a legal point of view?
2. What are the causes for over and underdeclaration? What incentivizes or discourages them?
3. How over and underdeclaration affect innovation and competition?
4. Which measures are suitable to prevent over and underdeclaration and/or their negative effects?
5. Might IoT change the answers to the prior questions?

Methodology

- Descriptive study of key concepts from a legal and economic perspective
- Empirical assessment of causes for over and underdeclaration based on semi-structured interviews
- Normative analysis of over and underdeclaration from Competition Law perspective
- Evaluative analysis of existing measures to fight over and underdeclaration

Societal impact

Over and underdeclaration entail a number of negative effects for society. Particularly, them might imply that licensees pay for patents that they do not actually need, leading to lower degrees of efficiency or, conversely, over pay for patents that should have been licensed in FRAND terms. Additionally, both over and under declaration might negatively impact on innovation, by reducing the incentives to create competing standards and by hampering disruptive innovation. By proposing measures towards reducing over and underdeclaration and its negative effects, we aim to contribute to reduce such cost inefficiencies and to remove obstacles for innovation, which will benefit society as a whole. The goal is to achieve more legal certainty for SDOs, SEP holders and implementers, based on an assessment of competition concerns' full picture, and addressed in consequence. A clearer framework will help to reduce transaction costs and discourage free riding to achieve higher levels of efficiency and welfare.

Open Standards and Open Source: characterisation and typologies

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Carlos Muñoz Ferrandis ++

Abstract

Open standards and open source have become essential for ICT markets from an innovation, business, technical, and policy approach. Openness is one of the core values in standardisation settings. When it comes to the definition of 'open', some views have pointed to a 'clear-cut' division between open and close standards. Rather than a pure binary approach this paper holds that the openness of a standard is a matter of degree, and moreover, that openness should be referred to three different dimensions: innovation; standardisation and intellectual property exploitation. This paper sets a taxonomy of the different existing typologies of ICT standards and aims to evaluate their degree of openness in each of these dimensions. The main objective is to propose a framework for assessing the openness of ICT standards - which might be useful to understand and analyse the competitive and innovative dynamics of each type of open standards.

Key words: open standards; open source; innovation; standardisation; exploitation; IP.

1. Introduction

The growing importance of open standards in an interconnected society[1] is undeniable: standards contribute to enable compatibility, connectivity or data portability and they are a key driver of innovation.[2] In addition openness of the standard has been considered a prerequisite `to enjoy the full effects of network effects´.[3]

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[1] See O Vermessan, P Fries (eds), *Building the Hyperconnected Society: IoT Research and Innovation Value Chains, Ecosystems and Markets* (RP 2015). See also JA Anderson, *After Digital: Computation as Done by Brains and Machines* (OUP Oxford 2017).

[2] See European Commission, 'ICT Standardisation Priorities for the Digital Single Market' 2016 <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0176&from=EN> accessed 19 April 2020.

[3] P Swann, *The economics of standardization: An update* (2010) UK BIS, 12. <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/461419/The_Economics_of_Standardization_-_an_update_.pdf> accessed 15 April 2020.

While defining what a standard is not very troublesome[4], the definition of open standard is more challenging.[5] The discrepancies have quite a simple explanation: the use of "open" in standardisation has turned to be a buzzword that is indistinctly used to refer to very different aspects: "open" can be referred to the type of innovation – "open innovation"; to the nature of the process of standardisation itself – "open standardisation"; and finally to the exploitation terms of the intellectual property – "open exploitation".

Unsurprisingly, two of these different – yet not necessarily incompatible – definitions[6] are arguably the definition of the "OpenStand" principles[7] and the definition advocated by the Open Source Initiative.[8] While the former relies on principles such as due process, consensus, transparency and openness to all interested parties – which points to the "open standardisation" definition; the latter falls within the scope of "open exploitation": public availability, royalty-free/non assertion and no-agreements principle.[9] None of their definitions makes a mention whatsoever to the "open" nature of the innovative process as such – although none of them excludes it, in principle.

Hence, when scholars, policymakers or practitioners speak about "open" they might refer to one, two or the three types of openness. As a consequence, a standard can be open according to a definition and not open according to a different one.

This debate acquires a different dimension due to the convergency of two standardisation models[10] which have been claiming to be open in their respective spheres of influence: Open

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[4] Despite some existing differences among definitions. See for example ITU´s definition ` Document approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method.´ or the European Union definition `a technical specification, adopted by a recognised standardisation body, for repeated or continuous application, with which compliance is not compulsory […]´. Article 1 Regulation No 1025/2012 of the European Parliament and of the Council of 25 October 2012 on European standardisation [2012] OJ L 316, 14. Nevertheless these definitions leave outside those standards which are not formally approved by any organisation, but adopted as a standard by the market – de facto standards.

[5] JP Kesan, 'Open Standards' in JL Contreras (ed), *Cambridge Handbook of Technical Standardization Law*, vol 2 (CUP Cambridge 2019) 167.

[6] CB Biddle, 'No Standard for Standards: Understanding the ICT Standards-Development Ecosystem' in JL. Contreras (ed), *The Cambridge Handbook of Technical Standardization Law: Competition, Antitrust, and Patents* (CUP Cambridge 2017) 22.

[7] 'Principles' (*OpenStand*, 2019) <https://open-stand.org/about-us/principles/> accessed 15 April 2020

[8] 'Open Standards Requirement for Software' (*Open Source Initiative*, 2019) <https://opensource.org/osr> accessed 15 April 2020.

[9] The no-agreements principle requires the absence of "any requirement for execution of a license agreement, NDA, grant, click-through, or any other form of paperwork to deploy conforming implementations of the standard" ibid.

[10] The Linux Foundation, *Linux Foundation Networking and Orchestration White Paper: Harmonizing Open Source Standards in the Telecom World* (White Paper 2017) 7-8 < https://www.linuxfoundation.org/publications/2017/05/new-networking-harmonization/> accessed 15 April 2020; The Linux Foundation, *Harmonization 2.0: Open Source and Standards Bodies Are Driving Collaboration Across IT* (White Paper 2018) 11 < https://www.linuxfoundation.org/wp-content/uploads/2019/01/LF_StandardsOpenSource_Whitepaper_012418.pdf> accessed 15 April 2020; K Blind, M Böhm and N Thumm, *The Relationship Between Open Source Software and Standard Setting*

Source Standardisation and Open Standards created in the framework of Standard Developing Organisations (SDOs).[11]

The aim of this paper is to shed light in which are the criteria to understand that a standard is open or closed in each of the three proposed dimensions – ie innovation, standardisation and exploitation (section 2), to later propose a taxonomy of different types of standardisation efforts according to their relationship with each type of openness, sketching some of their characteristics at innovation and business level (section 3) to finally conclude (section 4).

2. What is an open standard?

As anticipated in the introduction, it is barely feasible to achieve consensus on what an "open standard" is.[12] Although the discussion has been largely focused on the dichotomy between open standardisation vs open source exploitation[13], for a better assessment of the effects of the standard in competition and innovation it is better to switch from a bidimensional approach to openness to a three-dimensional one which includes the openness of the innovative process.

Such inclusion is justified, first, because some of the effects on innovation and competition of a given standard could only be evaluated against the nature of the innovative effort. Secondly, the inclusion of the "open innovation" dimension allows to also better capture the different strategies and business models that are involved in standardisation.

Yet the question is not as straightforward as it might seem at first sight. Outside from very dogmatic approaches to what "open" should be, the degree of openness – and consequently its effects on competitive and innovative dynamics – is not a binary issue, but a matter of degree.[14]

(2019) JRC, 21ff <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/relationship-between-open-source-software-and-standard-setting> accessed 15 April 2020

[11] There is a low intensity controversy among scholars and practitioners as per naming the organizations: Standard Developing Organizations or Standard Setting Organizations. Those who argue in favour of the former, understand that using "setting" underestimates the work performed by technical committees. We will use the term SDO - more aligned with the open innovation approach - following Biddle´s proposed taxonomy where SDOs are a subgroup within the wider SSOs concept, which include other typologies of standard promoters, such as consortia or single promoters. See CB Biddle, 'No Standard for Standards: Understanding the ICT Standards-Development Ecosystem' 18 and JS Borghetti, I Nikolic and N Petit, 'FRAND Licensing Levels under EU Law' <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3532469> accessed 23 April 2020 1 fn 3.

[12] N Matteuci, 'Open Standards Interoperability in EU Digital TV: Economics and Policy Issues' (2008) 5(2) RERCI 52.

[13] What Larouche and Van Overalle defines as emphasis on open process versus emphasis on open access/use, respectively. P Larouche and G Van Overwalle, 'Interoperability standards, patents and competition policy' in P Delimatsis (ed), *The Law, Economics and Politics of International Standardisation* (CUP Cambridge 2015) 391.

[14] E Harison, *Intellectual Property Rights, Innovation and Software Technologies: The Economics of Monopoly Rights and Knowledge Disclosure* (EE 2008) 97; A Gupta, 'Are open standards a prerequisite to open source? A perspective in light of technical and legal developments' (2009) 15(1) CTLR 2; A Cunningham, 'Open Source, Standardization, and Innovation' in N Shentov, I Walden, *Free and Open Source Software: Policy, Law, and Practice* (OUP Oxford 2013) 363ff, 376; K Balka, C Raasch, C Herstatt,

An example that can illustrate this gradual approach is to consider whether there is a threshold – in terms of number of companies involved – to argue that an innovative process has been open or not. Similarly, it might be argued that standardisation taking place in a closed consortium grouping most of the companies in a given sector is, to a certain extent, open. Finally, IPRs subject to certain freedoms related to their exploitation[15] might also meet the "open exploitation" requirement.

2.1 Open innovation vs closed innovation

The "open innovation" concept refers, broadly speaking, to the innovation that takes place beyond the formal structure of a company, receiving inputs from other stakeholders and accessing external streams of information shared within the industry – a setting which has been referred as to "innovation commons".[16]

The switch from a closed to an open innovation paradigm takes place, in the words of Chesbrough, when `(t)he distribution of knowledge has shifted away from the tall towers of central R&D facilities, toward variegated pools of knowledge distributed across the landscape [...] Companies must structure themselves to leverage these distributed pools, instead of ignoring them in the pursuit of their internal R&D agendas´.[17]

Open innovation presents several advantages vis-à-vis traditional "closed" innovation models, the most relevant is the access to a body of knowledge that otherwise may have been split between the R&D departments of a myriad of companies. In addition, such cooperative approach contributes to reduce the "tunnel vision"[18] that might affect such departments.

There are two main criteria against which the degree of "innovative openness" can be evaluated: the number of companies and the degree of involvement/volume of contributions of each of them.

In principle the involvement of more than one company would allow to talk about, at least, partially open innovation. On the other side, speaking of fully open innovation requires a more demanding threshold: it can be argued that the number of companies should be considerable

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'How Open is Open Source?', in C Herstatt, D Ehls (eds), *Open Source Innovation – The Phenomenon, Participant's Behavior, Business Implications* (Routledge 2015) 217, 225.

[15] Eg Apache 2.0 or BSD licensing.

[16] `An innovation commons is thus a kind of club, where the price of admission into the community is to contribute technical resources, which is in effect a screening mechanism: if you cooperate in the first you get access to the second. But once in this club, entrepreneurially relevant information circulates. That is the reason that people are there, in the innovation commons, namely, to gain access to entrepreneurially relevant information´. J Potts, *Innovation Commons: The Origin of Economic Growth* (OUP Oxford 2019) 5.

[17] HW Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (HBSP Harvard, 2003) 40.

[18] Referred herein to the inability to face technological development from a perspective other than the own company´s one and/or to consider different approaches.

enough to capture a substantive part of the existing knowledge in the sector, rather than representing the mere addition of the knowledge owned by a small group of companies. Fixing a numerical threshold would be impractical and arbitrary.

Additionally, the relative degree of contributions of participants should be taken into account: it is not the same an innovation effort where an sponsor creates the core functionalities and the rest of companies enter into play in a very late stage and/or make minor contributions, than an innovation created from scratch by a group of companies where each participant can have a certain impact on the final result.[19] Arguably, only the latter can be considered as a genuinely open innovative effort, while the former can be, at its best, a partially open one.

2.2 Open standardisation vs closed (de facto) standardisation

The second meaning of "openness" is used to refer to open standardisation, and is closely connected to open innovation, to a point where consensus-based standardisation, developed in the framework of SDOs[20] might well be the epitome of "open innovation" where competitors sit together to discuss the potential solutions to technical problems.

Even though the rules and steps for either developing or setting a standard depend on the sector and/or the concerned SDO, there are some traits and steps which are common to most of them: the process starts with the definition of the technical goal of the standard in terms of functionalities and requirements.

Second, the workload is split between different technical committees, or working groups, whose objective is to decide what is the best technical solution to achieve the standard´s objective. To do so, representatives from the involved companies propose and discuss different technical alternatives to finally choose the best one, usually by consensus.

Finally, all the contributions accepted are included, shaping the standard. SDO-based standardisation is not merely open innovation but an example of truly collaborative innovation, and, apart from the positive effects linked to open innovation, implies a number of positive effects that have been echoed by the literature: they contribute to a better innovative

[19] In principle the innovative path might be very different if different companies pool their knowledge from a very early stage compared to the cases where a promoter of the standard creates core aspects of the technology and only at a very late stage of the innovative process opens it for third parties' contributions. Leonard and Sensiper identify four aspects that can benefit from sharing tacit knowledge in the framework of collaborative innovation efforts: problem solving, problem finding and prediction and anticipation. The later this information is shared the less would be the benefits. D Leonard and S Sensiper, 'The role of tact knowledge in group innovation' (1998) 40(3) CMR 114.

[20] There is a low intensity controversy among scholars and practitioners as per naming the organizations: Standard Developing Organizations or Standard Setting Organizations. Those who argue in favour of the former, understand that using "setting" underestimates the work performed by technical committees. We will use the term SDO - more aligned with the open innovation approach - following Biddle´s proposed taxonomy where SDOs are a subgroup within the wider SSOs concept, which include other typologies of standard promoters, such as consortia or single promoters. See CB Biddle, 'No Standard for Standards: Understanding the ICT Standards-Development Ecosystem' 18.

performance and help to achieve critical mass leading to a faster adoption of the technology and the subsequent network effects.[21]

The degree of standardisation´s openness is also graded based on the existence and the strength of restrictions to access to the standardisation efforts. In certain cases, such as some Linux-based operating systems, there are no restrictions to participation and virtually anybody can contribute by merely writing code.[22]

In SDO-based standardisation, the costs of membership and attendance might be perceived as restrictions to participation[23], however such costs are usually attenuated in case of SMEs and, moreover, they offer an institutional coverage which ensures the fulfilment of the transparency, due process and consensus principles – which is not necessarily the case in Linux-OS.

Each one of the approaches or their combination thereof have its own advantages and while open – SDO based – standardisation together with proprietary (or arguably semi open) licensing models have been the rule in the handsets and telecommunication infrastructure, the software industry has mostly relied on the establishment of de facto standards either based in proprietary or OSS models.[24]

Both cases should be deemed to be "open standardisation", although both one and the other could prospectively have different effects on innovation and competition.

On the other hand, the alternative to open standardisation is closed, de facto, standardisation: de facto standardisation takes place were a single company – arguably a reduced group too – offer a technology in the market which beats other technologies in the market and ends being the standard in the market.[25]

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[21] P Swann, The Economics of Standardization: An Update 9; C Stolwijk, M Punter, C Montalvo, ''Smart Industry' and the confluence of standards' in R Hawkins, K Blind, R Page (eds), *Handbook of Innovation and Standards* (EEP 2017) 214; K Blind, 'The economic functions of standards in the innovation process' in R Hawkins, K Blind, R Page (eds), *Handbook of Innovation and Standards* 39.

[22] ES Raymond, *The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary* (O'Reilly M 1999) 12 Knowledge, Technology & Policy 2-3, 29**;** A Gaudeul, 'Open Source Licensing in Mixed Markets, or Why Open Source Software Does Not Succeed' (2008) CCP Working Paper 08-2 4; TR Eisenmann, G Parker, M Van Alstyne, 'Opening Platforms: How, When and Why?', in A Gawer (ed.), *Platforms, Markets and Innovation* (EE 2009) 1-2.

[23] For an overview of the barriers to participation in SDOs see CAF Riillo, 'Profiles and Motivations of Standardization Players' (2013) 11 International Journal of ITSSR 17 20. With a special focus on SMEs Henk De Vries *et al*, *SME access to European standardization: Enabling small and medium sized enterprises to achieve greater benefit from standards and from involvement in standardization* (2009), 18ff. <https://www.erim.eur.nl/fileadmin/default/content/erim/content_area/news/2009/smeaccessreport %202009.pdf> accessed 19 April 2020.

[24] K Blind, M Böhm and Nikolaus Thumm, *The Relationship Between Open Source Software and Standard Setting* 66, 113; A Cunningham, 'Open Source, Standardization, and Innovation' 356ff; U Gasser, 'Interoperability in the Digital Ecosystem' (CBP 2015) 14.

[25] R Hawkins, K Blind, 'Introduction: unravelling the relationship between standards and innovation' (n18) 5.

In-between open and closed standardisation, there are certain types of relatively open and relatively closed standardisation models that usually take place within private consortia. This degree of openness should be evaluated against the degree of fulfilment of the "OpenStand" principles.

2.3 Open exploitation

The third level of openness, "open exploitation" is related to the terms for the exploitation of the intangible assets required for implementing the technology: the level of openness in exploitation can be graded.

Strictly speaking, for a software to be considered Open Source it must be publicly available for anyone, enabling the use, inspection, modification and distribution of the code[26], according to the conditions set by the Open Source Initiative.[27] Nonetheless, there are some cases of OSS licensing terms, such as GNU GPL[28] or Lesser GPL[29], which are deemed to be "less open" or quasi-open.[30]

In case of standards that include patents[31], however, the criteria against which the openness are to be evaluated differ. On the one hand, the technology should be available[32] to any interested party. If the holder`s commitment allows him to arbitrarily refuse-to-license to a prospective licensee, the exploitation terms may not be deemed to be open.[33]

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[26] L Rosen, *Open Source Licensing*: *Software Freedom and Intellectual Property Law* (PH 2004) 2.

[27] The Open Source Initiative established the main features that an OSS license must comply with, based on the 'Debian Free Software Guidelines' established by B Perens back in 1997. <https://opensource.org/osd > accessed 15 April 2020.

[28] GNU GPL open source license, < https://www.gnu.org/licenses/gpl.html> accessed 15 April 2020.

[29] Lesser GPL open source license, < https://www.gnu.org/licenses/lgpl.html> accessed 15 April 2020.

[30] Even though these licenses might be considered less 'open' at a first glance, the rationale behind is to secure the broadest possible access to every single subsequent version the open source project under a GPL license (dynamic openness). A distinction has to be made between 'static openness', derived from permissive licenses' settings, in which access to subsequent innovations is foreclosed once commercial ramifications are set (closed or semi-open exploitation); and 'dynamic openness', derived from 'restrictive licenses', in which open access to subsequent innovations is secured against flexibility of exploitation terms of subsequent versions of the initial open source version. Henceforth, depending on the angle taken to analyse GPL-style licenses, the latter might be considered less open (from the angle of static openness) or more open (from the angle of dynamic openness).

[31] For an analysis of the conflicts between patents and Open Source in software-based sectors see DS Evans and A Layne-Farrar, 'Software patents and open source: the battle over intellectual property rights' (2004) 9 Va JL & Tech 1 11ff.

[32] Particularly in the case of FRAND-pledged patents, the question on whether available means "license to all" or "access to all" has been object of a fierce dispute which is substantially represented by the discussion Rosenbrock v Huber. See KH Rosenbrock, 'Why the ETSI IPR Policy Requires Licensing to All' <http://www.fair-standards.org/wp-content/uploads/2017/08/Why-the-ETSI-IPR-Policy-Requires-Licensing-to-All_Karl-Heinz-Rosenbrock_2017.pdf> and B Huber, 'Why the ETSI IPR Policy Does Not and Has Never Required Compulsory 'License to All': A Rebuttal to Karl Heinz Rosenbrock' <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3038447>. For an overview see Juan Martinez, 'FRAND as Access to All versus License to All' (2019) 633 GRUR International.

[33] There might be situations where the refusal-to-license might be justified – eg the licensee does not want to pay FRAND royalties – and this should not automatically render the exploitation "not open".

With regards royalties, the bottom line is that the patent holder cannot of offer the same conditions that would offer under a pure proprietary scheme. Royalty-free terms are the most open model (in terms of pricing).

There has been a substantial debate on whether FRAND terms are incompatible with Open Source licenses.[34] The positions range from those who argue that there is an inherent incompatibility[35], to those who argue that the compatibility depends substantially on a case-by-case analysis[36] to those which plainly consider that the incompatibility is a false conflict.[37]

Other aspects can also argue in favour or against the openness of the exploitation model, such as the granting of other "freedoms" according to OSS criteria – availability of the code, allowing for derivatives etc – or commitments of non-enforcing the IPRs – eg non-assertion clauses.

While the absence of the obligation of signing a licensing agreement – the so-called "no-agreement" principle[38] – is a requisite, it is substantially based on a software (Open Source) approach. The different scope of patent protection, that fact that the holder might be interested in limiting the scope of the license to the compliance with the standard and the need of sharing confidential know-how for the implementation, argues in favour of taking a more flexible approach to the "no agreement" principle in the case of patents.

One possibility is to 'standardise' some licensing terms to reduce transaction costs and limiting the bargaining power of the SEP holders. However, its usefulness it is highly case-specific and while they might be useful for some standards, others – particularly those which require an extensive exchange of know-how and/or confidential information might require a more tailored approach.

Nevertheless, when patents enter into the picture it might be worth it to rely in a negative definition of open exploitation – ie what is not open exploitation. One of the criteria which might discard the openness is the imposition of conditions which are alien to the IPR subject matter.

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[34] For a practical example see, CM Ferrandis, C Tapia, 'Integrating Open Source into De Jure Standardization: Beyond a Call for the Appropriate License' (2018) 53 les Nouvelles – LES; J Li, 'Intellectual property licensing tensions: utilising open source software in the formal standard-setting context' (2018) 9(2) EJLT.

[35] Van Lindberg, 'OSS and FRAND: Complementary Models for Innovation and Development' (2019) 20 CSTLR 269-70.

[36] JP Kesan, 'The Fallacy of OSS Discrimination by FRAND Licensing: An Empirical Analysis' (2011) IPLRP and M Husovec, 'Standardization, open source, and innovation: Sketching the effect of IPR policies' in JL Contreras (ed), *Cambridge Handbook of Technical Standardization Law*, vol 2 (CUP Cambridge 2019) 196.

[37] And moreover, that such pretended incompatibility is due to ideological and business approaches. DJ Kappos, 'OSS and SDO: Symbiotic Functions in the Innovation Equation' in JLContreras (ed), *Cambridge Handbook of Technical Standardization Law*, vol 2 (CUP Cambridge 2019) 201.

[38] There MUST NOT be any requirement for execution of a license agreement, NDA, grant, click-through, or any other form of paperwork to deploy conforming implementations of the standard. 'Open Standards Requirement for Software' (*Open Source Initiative*, 2019) <https://opensource.org/osr> accessed 15 April 2020.

From this point of view, for example, share-alike, non-derivatives or non-commercial clauses do not pose particular problems, while a cross-licensing requirement does.

Yet the most important criteria to characterise a licensing scheme as open are the irrevocability and consistency of the pre-defined terms: if the IPR holder does not commit from the beginning to grant an irrevocable license – for reasons other than a breach of the predefined licensing terms – and/or is entitled to unilaterally modify the licensing terms (eg as the owner of an open source project does), the license could hardly be deemed to be an open standard.[39]

A type of clause which presents problems with this negative definition of open definition is retaliation clauses inasmuch they imply a revocation of the license for causes which are not related to the scope of the IPR itself. It does not imply that retaliation clauses must be forbidden, but rather that licenses including such clauses cannot be considered to be open.[40]

2.4 Interim conclusions

The conclusions drawn from the analysis above, is that it is not feasible to propose a single definition of what an open standard is without reconciling the three dimensions of "openness" – ie innovation, standardisation and exploitation. All these three types of "openness" may, or may not, concurrently happen.

Therefore, and open standard stricto sensu should be a standard which is open in all the three dimensions. A broader definition of open standard is those which are open in one of the dimensions and (at least) partially open in the other two.

3. Typologies of (more or less) open standards

Depending on how "open" is ranked in each of the three aspects – innovation, standardisation and exploitation – it is feasible to differentiate among eight typologies of standards (table 1). Nevertheless, it should be recalled that the boundaries between these typologies are frequently blurred, inasmuch being open or closed is not necessarily a binary option but rather a matter of degree.

Table 1: Standards´ typologies depending on their "openness"

	Innovation	Standardisation	Exploitation
Fully open platforms	**O**	**O**	**O**

[39] The revocability of the commitment raises high competition law concerns.

[40] And depending of the cases, not even FRAND. See M Husovec, 'Standardization, open source, and innovation: Sketching the effect of IPR policies' 192.

Open standardisation – proprietary exploitation	**O**	**O**	**C**
(Semi) closed consortia – (semi) closed exploitation	**O**	**C**	**C**
Traditional proprietary standards	**C**	**C**	**C**
De facto standardisation – open exploitation	**C**	**C**	**O**
Sponsored Standard Setting (Open Exploitation)	**C**	**O**	**O**
Proprietary Standard Setting	**C**	**O**	**C**
Closed standardisation built over collaborative work	**O**	**C**	**O**

3.1 Fully open platforms

Fully open platforms are the result of a collaborative development process (open innovation). This decentralised innovation process is based on a fast-paced iterative approach which substantially builds over the community´s feedback, ultimately leading to innovation efficiencies. Consequently, the technical result of this self-growing innovation platform potentially leads to a broad acceptance of the technology by the market (open standardisation) – also due to its licensing terms (open exploitation).[41]

Linux operating system is an example of a fully open platform. Initially created in 1991 by Linus Torvald, Linux kernel code has been distributed under a strict open source license (GPL).[42] As a result, an entire community of developers gradually joined the Linux community – contributing to increase its attractiveness – and nowadays the Linux ecosystem continues to attract more and more users and business to its operating system.[43]

3.2 Open Standardisation – proprietary exploitation

The proprietary open standardisation model is characterised by the development of technologies in a collaborative way (open innovation), usually in the framework of umbrella organisations[44] within which participants cooperate to create the standard (open standardisation). The returns over their IPR protected technologies are usually obtained by means of royalties – but not exclusively (closed or proprietary exploitation).

[41] The technology can later be accredited by a formal standardisation body.
[42] GNU GPL open source license, < https://www.gnu.org/licenses/gpl.html> accessed 15 April 2020.
[43] Yet the Linux operating systems represent only a 1,83% of the whole operating system market. On the other hand, the initially Linux-based Android amount to a 40,47% of the market. For an analysis of Linux as a standard see J West and J Dedrick, 'Open Source Standardization: The Rise of Linux in the Network Era' (2001) 14(2) KT&P.
[44] Such as SDOs or big consortia.

Nowadays, however, it is very difficult to find pure examples of proprietary exploitation of open standards since the potential competition law concerns around standards settings and business practices have led to a scenario where the technologies are exploited in semi-closed (or semi-open) terms.[45]

One paradigmatic example of open standardisation - semi-closed exploitation - are the ICT standards developed in the framework of 3GPP.[46] 3GPP is structured into three Technical Specification Groups which are, at the same time, divided into various working groups (WG). Virtually any company interested in contributing its technology to a standard can join a working group.[47]

Briefly, the WG dynamics entail that a number of companies meet together to decide which technology(ies) are more suitable to achieve a specific technical result.[48] Rather than a binary decision – opting for technology A or B[49] – the WG participants develop new ones in order to achieve the best possible technical result.[50]

Once the standard is released, the participants are able to claim royalties but with certain limitations, since contributors need to commit beforehand to license their technologies in FRAND terms.[51] As a consequence, Standard Essential Patent (SEP) holders cannot plainly refuse to license their SEPs to companies that aim to implement the standard, neither demand non-reasonable royalties from them.

According to the abovementioned requirements, it can be argued that ETSI´s licensing policy[52] can be deemed to be, at least, a model of semi-open exploitation[53], since the commitment to license in FRAND terms is irrevocable and ensures the availability of the technology for all the interested parties.[54]

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[45] See 2.3 above.

[46] 3GPP is an organization that brings together seven SDOs telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC) to develop cellular telecommunications, and it has been responsible for the creation of 3G (UMTS), 4G (LTE) and 5G (NR).

[47] Although sometimes the cost of membership and participation in these meetings might deter some companies from participating.

[48] Usually such technical result has been previously defined with relation to the standard requirements.

[49] which is more common in traditional standard “setting”.

[50] K Gupta, 'How SSOs Work: Unpacking the Mobile Industry’s 3GPP Standards' in JL Contreras (ed), *The Cambridge Handbook of Technical Standardization Law: Competition, Antitrust, and Patents* (CUP Cambridge 2017) 33 and JS Borghetti, I Nikolic and N Petit, 'FRAND Licensing Levels under EU Law', 1 fn 3. <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3532469> accessed 23 April 2020.

[51] Strictly speaking, 3GPP does not contemplate any licensing terms but refers to the ones established by each 3GPP organizational partner on their respective IPR policies, which are quite aligned in terms of demanding a FRAND licensing commitment.

[52] Article 6 of ETSI IPR Policy < https://www.etsi.org/images/files/IPR/etsi-ipr-policy.pdf > accessed 26 January 2020

[53] Despite the discussion revolving around the compatibility between Open Source and FRAND addressed in subsection 2.3.

[54] See also CEN-CENELEC Guidelines for Implementation of the Common Policy on Patents (2nd edition, 2019) 6 < ftp://ftp.cencenelec.eu/EN/EuropeanStandardization/Guides/8_CENCLCGuide8.pdf > accessed 15 April 2020.

3.3 (Semi) closed consortia – (semi) closed exploitation

This typology of standards is created in the framework of joint research projects or collaborative projects (open innovation) and becomes a standard either by competition in the market (de facto standard), by means of its endorsement by more or less closed consortia, or a combination thereof. The licensing terms range from proprietary to semi-closed. An example[55] of this typology of standards is Bluetooth which is an open consortium (open or semi-open innovation) where the promoter members[56] have important privileges with regards the technological evolution of the standard (closed or semi-closed standardisation).[57] Rather than a proper licensing scheme, Bluetooth grants Freedom-to-Operate to all companies which join the Special Interest Group (SIG) at least as adopters.[58]

3.4 Traditional proprietary standards

This type of standards is created on the basis of in-house (closed) innovation[59] to later on be commercialised within the market in exchange of a price or a royalty. Traditionally, this kind of standards are designed as "one-stop-solution" to a specific interoperability or portability need and become the standard upon acceptance from the market.

A prototypical example of this typology is Windows OS. From the first Windows version, Microsoft created a full operating system which was compatible with almost any PC hardware configuration and licensed it either to PC manufacturers or directly to final users in exchange of a royalty. At first, Microsoft successful marriage with IBM allowed, first MS-DOS, and later Windows, to gain traction as a standard – increasing their market acceptance, and subsequently the close cooperation with INTEL (the so-called WINTEL) has ensured a smoother performance of the processor – operating system pairing.[60]

3.5 De facto standardisation – open exploitation

De facto standardisation – open exploitation model consists in the full development of a technology by a company or a reduced group of companies which later is established as a standard via competition in the market. Open exploitation implies that the sponsor(s) of the technology refuses[61] up-front to obtain revenues by means of royalties derived from the IPRs that eventually might protect the technology – usually patents or copyright.

A crystal-clear example of a de facto standardisation – open exploitation case is Android. Android´s creation was based on a Linux kernel – and therefore benefited to a certain extent from open innovation – however after the acquisition of Android Inc. by Google, the

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[55] Another example might be the NFC Forum, a private group elaborating Near Field Communication protocols < https://nfc-forum.org> accessed 15 April 2020

[56] Namely Microsoft, Lenovo, Intel, Apple, Ericsson, Nokia and Toshiba.

[57] To enjoy full participation rights in the standard development, companies need to be at least associate members. Bluetooh, 'Membership' <https://www.bluetooth.com/develop-with-bluetooth/join/membership-benefits/> accessed 15 April 2020.

[58] Depending on the type of membership and the annual revenues the annual membership fee ranges from 0 to $35,000.

[59] Arguably also if the innovation is developed by a reduced number of companies.

[60] E Steinmueller, 'Platforms and standards: a historical perspective' in R Hawkins, K Blind, R Page (eds), *Handbook of Innovation and Standards* (EEP 2017) 92.

[61] Or at least limits them by means of a FRAND commitment.

development of Android was primarily driven by Google and by the Open Handset Alliance[62], in which Google takes the leading role.[63]

After its launch in 2008, Android competed within the smartphone operating system market against other operating systems such as Windows Mobile or Symbian – which opted for a proprietary exploitation model.[64] Nowadays Android hold a 74,13%[65] of such market and arguably the only segment that it has not being able to penetrate is Apple´s close ecosystem where iOS holds the leadership.[66]

Google made Android open in two different directions, on the one hand, any smartphone manufacturer can install Android for free on its device, and on the other, Google facilitates access to developers of applications – complementary products. By doing so, Google managed to attract a critical mass of users to Android, which made the platform more attractive to app developers. The subsequent increase in availability of apps resulted in more attractiveness for users, thus conforming a constant feedback loop as a consequence of network effects.[67] However, the findings of the European Commission in the Google Android case put at stake whether such "openness" is conditional and irrevocable.[68]

3.6 Sponsored Standard Setting (Open Exploitation)

Within this category, a firm develops internally (closed innovation) a technical solution, which will then become a standard due to its success in the market and consequently, its certification as a formal standard by a standardisation body (open standardisation). No royalties being charged for the use of the technology (open exploitation).

A real case illustrating the above category is the PDF standard.[69] Adobe developed the Portable Document Format software in the 90s and made it available free of charge.[70] Although it faced

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[62] Open Handset Alliance, 'Android' <https://www.openhandsetalliance.com/> accessed 11 January 2020

[63] It his highly doubtful that any strategic decision with regards the core aspects of Android will be taken without Google´s approval and therefore the innovation model should be deemed relatively closed. Googles has been referred to as the "orchestrator" of Android platform. See S Vezzoso, 'Android and Forking Restrictions: On the Hidden Closedness of "Open"' (2018) 2 MCLR 19; A Cunningham, 'Open Source, Standardization, and Innovation' in N Shemtov and I Walden (eds), *Free and Open Source Software: Policy, Law, and Practice* (OUP Oxford 2013) 363ff.

[64] Both Symbian and Windows Mobile switched – arguably too late – to open exploitation models.

[65] Statcounter GlobalStats, 'Mobile Operating System Market Share Worldwide Dec 2018 - Dec 2019' (*Statcounter*, 2019) <https://gs.statcounter.com/os-market-share/mobile/worldwide> accessed 15 January 2020

[66] A Cunningham, 'Open Source, Standardization, and Innovation' in N Shemtov, I Walden (eds), Free and Open Source Software: Policy, Law, and Practice (OUP Oxford 2013) 363ff.

[67] See 3.1 below.

[68] Inasmuch the implementers need to sign certain contracts to access the full catalogue of Google apps for Android. Commission, *Google Android* '(Case AT40099) Commission Decision' [*2018*] C(2018) 4761 final paras 155ff.

[69] C Shapiro and HR Varian, *Information Rules: A Strategic Guide to the Network Economy* (HBSP Harvard 1999) 254. Other relevant cases are the Java and XML standards, see TM Egiedy, *Beyond Consortia, Beyond Standardisation? New Case Material and Policy Threads* (EC Report 2001).

[70] A Gupta, 'Are open standards a prerequisite to open source? A perspective in light of technical and legal developments' 15(1) CTLR 5 and AK Baran, P Eckhardt, I Hohmann, M Kullas, B Van Roosebeke, *Competition Challenges in the Consumer Internet Industry: How to Ensure Fair Competition in the* EU (Centre for European Policy 2016) 15.

strong competition at the early stages by other formats, it became the dominant technology and was certified years later by the International Standards Organization as an open standard.[71]

3.7 Proprietary Standard Setting

The sponsor develops the base technology for the platform (closed innovation) and improves it due to the subsequent developments in a private alliance or consortia – which contribute to the engagement of firms with the platform and its adoption as a formal standard. The sponsor invests on the integration of the technical solution in a formal SDO and its certification as a formal standard, aiming to achieve wide adoption (open standardisation). Even if the standardisation process is said to be open, the ex-post exploitation of the technology will be subject to the license of essential IPRs encumbered in the specification(s) (closed exploitation).

A practical example is Nokia's strategy in the mobile ICT sector with the DVB-H standard. Nokia took the early lead in the setting of the DVB-H standard, developed its own in-house technology and promoted it in the DVB forum[72], a private alliance integrating a broad range of ICT firms. This move fostered a first acceptance of the technology by a considerable number of firms in the ICT sphere. Henceforth, this led to the later recognition by ETSI of the standard as a formal standard. More tellingly, the European Commission integrated the DVB-H standard in the EU list of standards, the latter becoming the preferred standard in the EU[73]. Namely, Nokia managed for its technology to be recognised as an open standard and overcame Qualcomm's MediaFLO.[74]

3.8 Closed standardisation built over collaborative work

This typology refers to a scenario where collaborative efforts are achieved via technical contributions of several firms within a closed or semi-closed technical architecture – similar starting point as the closed consortium scenario, aiming to set an open access standard implementation. In other words, a private alliance of firms dedicated to set an open access standard and build an ecosystem around.

An interesting practical example for discussion is the Open Neural Network Exchange (ONNX)[75] platform, initially founded by Facebook and Microsoft and hosting nowadays more than 28 firms

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[71] V Torti, *Intellectual Property Rights and Competition in Standard Setting: Objectives and Tensions* (Routledge 2016) 52.

[72] See C Eltzroth, 'IPR Policy of the DVB Project: Negative Disclosure, FR&ND Arbitration Unless Pool Rules OK' (2008) 6(2) JITSR 21.

[73] A Cohen, 'EU Leans Toward Nokia For Mobile-TV Standard' (2007) The Wall Street Journal <https://www.wsj.com/articles/SB118280363728447514> accessed 13 January 2020

[74] In that regard, as analysed by Ballon and Hawkins, Nokia and Qualcomm competed for the dominance of their technologies in the digital TV context. Qualcomm developed in-house the MediaFLO standard. The firm adopted a proprietary strategy towards its product, and this would later turn against the company as it was forced by market - industry - pressure to de-lock its standard. Even if the MediaFLO standard was considered technically superior in some aspects, the DVB-H standard received greater support by industry. Nokia achieved a control position over this consensus-based "open" standard under the ETSI umbrella and went further securing a mass adoption of its own product specifications offering them on FRAND terms. See more in P Ballon, R Hawkins, `Standardization and Business Models for Platform Competition: The Case of Mobile Television´ (2009) 7(1) JITSR 1, 5ff and R Hawkins, P Ballon, 'When standards become business models: reinterpreting "failure" in the standardization paradigm' (2007) 9(5) JPRSTIM 20, 25.

[75] Open Neural Network Exchange < https://onnx.ai > accessed 15 April 2020.

contributing to the platform (semi open innovation). The platform focuses on enabling interoperability (portability) between different artificial intelligence (AI) – machine learning – frameworks, under an open source-based scheme.[76] For instance, ONXX allows a firm which has developed a training model under the Pytorch[77] – Facebook's AI software – framework to obtain the inferences derived from this model under the framework provided by Tensorflow[78] – Google's AI software.[79]

ONNX follows a strategy which seeks to maximise the adoption and participation within their platforms.[80] The main aim is to create an entire ecosystem benefiting from network effects. In this particular case, Microsoft and Facebook – the sponsors – stablished the core technical features (closed standardisation).[81]

4. Conclusions

Defining what an open standard is requires analysing its openness in three different dimensions: innovation, standardisation and exploitation. A standard, strictly speaking, will only be open if it is open on the three dimensions. A broader definition of open standard may also include those standards which are open in one of the dimensions and at least partially open in the other two.

However, the business, technical and legal complexities make difficult to identify pure examples of each one of these categories in real life standards. Strategies addressed to capture the standard at early phases, the aim of benefiting from network effects at a faster pace or the coexistence of different IPR monetisation strategies – and different IPRs[82] – explain why these three types of openness combine differently in different subsectors of the ICT sector.

It is feasible to distinguish up to eight different typologies of open – or not that open – standards. Each typology is appropriate to solve different technological challenges and it is more prone to certain IPR exploitation models. This taxonomy opens further avenues for research at two levels: on the one hand it paves the way to analyse the innovation and competition dynamics associated to each of the typologies, and on the other offers a different perspective for the analysis of the convergence of some of these types of open standards.

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[76] Software dedicated to the project is distributed under the MIT license < https://github.com/onnx/onnx/blob/master/LICENSE > accessed 15 April 2020.

[77] Pytorch is an open source machine learning framework. < https://pytorch.org > accessed 15 April 2020.

[78] Tensorflow is an open source machine learning framework < https://www.tensorflow.org > accessed 15 April 2020.

[79] To know more about current leaders in the AI framework market see Developer Economics, 'The Battle: Tensorflow vs Pytorch' < https://medium.com/@DevEconomics/the-battle-tensorflow-vs-pytorch-61d90b04f33b > accessed 15 April 2020.

[80] I Haddad, *Open Source AI: Projects, Insights, and Trends* (The Linux Foundation 2018) 98ff.

[81] F Xu, P Roy, 'Interoperable AI: High-Performance Inferencing of ML and DNN Models Using Open-Source Tools' < https://medium.com/@ODSC/interoperable-ai-high-performance-inferencing-of-ml-and-dnn-models-using-open-source-tools-6218f5709071 > accessed 15 April 2020; N Axtmann, 'Portability of Deep Learning Frameworks - with ONNX' (codecentric 2019) < https://blog.codecentric.de/en/2019/08/portability-deep-learning-frameworks-onnx/ > accessed 15 April 2020.; O Kharkovyna, 'Top 10 Best Deep Learning Frameworks in 2019' (2019) < https://towardsdatascience.com/top-10-best-deep-learning-frameworks-in-2019-5ccb90ea6de > accessed 15 April 2020.

[82] Namely copyright and patents.

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