Enabling Patent Transactions Through the Use of Blockchain Technology

by **Arina Gorbatyuk and Thomas Gils** *

Abstract: Access to complete, accessible, up-to-date, and accurate patent information is a prerequisite for transacting patents efficiently. Whereas patent registers administered by patent offices aim to communicate patent information to the public, they face limitations in the era of rapid innovation, partially due to manual input and verification of data. In this paper, we argue that integrating blockchain technology into patent registers could assist in remedying certain limitations of conventional 'reference' registers by combating territorial fragmentation, improving patent ownership tracing, and increasing the visibility of patents that could be traded. We further investigate to what extent blockchains are conducive to enabling patent transactions and explore the possibility of transforming patent registers into patent marketplaces.

Keywords: Intellectual Property, Patents, Patent Transactions, Ownership Transparency, Patent Registers, Blockchain, Distributed Ledger Technology

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A. Introduction

1 Blockchain technology is regarded as a game changer in the information technology world as it allows recording and exchanging information in a decentralised manner on an unprecedented level. Since the introduction of the technology more than a decade ago, its application to various fields has been explored both in theory and practice. Intellectual property (IP) is not an exception. IP practitioners, scholars, and policymakers have been actively examining whether blockchains can be instrumental in registering, managing, and enforcing IP rights.[1]

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1 Marco Barulli, 'IP Is a Journey: Blockchain and Encrypted Storage Are Your Best Friends' [2021] WIPO Magazine <https://www.wipo.int/wipo_magazine_digital/en/2021/article_0002.html> accessed 1 September 2023; Balázs Bodó, Daniel Gervais and João Pedro Quintais, 'Blockchain and Smart Contracts: The Missing Link in Copyright Licensing?' (2018) 26 International Journal of Law and Information Technology 311; Birgit Clark, 'Blockchain and IP Law: A Match Made in Crypto Heaven?' [2018] WIPO Magazine 6; Birgit Clark, 'Crypto-Pie in the Sky? How Blockchain Technology Is Impacting Intellectual Property Law' [2019] Stanford Journal of Blockchain Law & Policy <https://stanford-jblp.pubpub.org/pub/blockchain-and-ip-law> accessed 1 September 2023; Gönenç Gürkaynak and others, 'Intellectual Property Law and Practice in the Blockchain Realm' (2018) 34 Computer Law & Security Review 847; Julia Hugendubel, 'Blockchain Technology and Intellectual Property – A Basic Introduction' [2021] SSRN Electronic Journal <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3917801> accessed 1 September 2023; Anne Rose, 'Blockchain: Transforming the Registration of IP Rights and Strengthening the Protection of Unregistered IP Rights' [2020] WIPO Magazine <https://www.wipo.int/wipo_magazine_digital/en/2020/article_0002.html>

2 Currently, this technology is mainly applied to processes regarding creative works that are subject to copyright protection. The benefits that this technology provides are evident as it can tackle many notorious flaws of copyright protection. As creative works are generally not subject to registration, it poses challenges for identifying and verifying authorship and offering centralized visibility of developed works.[2] In particular, one of the most popular implementations of blockchain technology in the field of copyright is proof-of-ownership (such as WIPO PROOF, Pixsy, Bernstein[3]) that allows users to obtain a digital 'fingerprint' (in the form of a token accompanied by a blockchain certificate) of any file, including files containing copyright-protected assets, potentially useful to verifying authorship and enforcing copyright.[4] Furthermore, multiple blockchain-based non-fungible token (NFT) marketplaces, such as Monegraph, Crypto.com or OpenSea,[5] have recently been created to support the development and exchange of digital art, music, or other digital assets.[6] Such platforms also frequently assist in managing associated IP rights.

3 The utility of applying blockchain technology to patents is less explored, with fewer initiatives related to applying blockchain technology in the domain of patents being implemented to date. While at first glance this technology can be advantageous, for instance, in combating hurdles associated with territoriality of patents or manual processing of data. In this paper, we claim that to efficiently establish patent transactions interested parties need access to complete, accessible, up-to-date, and reliable patent data that patent offices at times fail to provide. We investigate whether the current drawbacks could be remedied by integrating blockchain technology into patent registers and to what extent blockchains are conducive to facilitating patent transactions by matching the 'seller' with the 'buyer'.

4 To stimulate openness and visibility of developed knowledge, patent offices have already established registers to disclose patent-related information.[7] However, patent information is fragmented as it is gathered by various offices. In addition, patent offices apply different standards to disclosing the assembled patent information to the general public which affects its 'global' accessibility.[8] Furthermore, patent offices are predominantly in charge of patent prosecution and do not play an active role in patent exploitation and patent transactions.

5 Facilitating patent transactions is indispensable to securing the efficient functioning of the patent system which is meant to advance science and technology. More than three million patent applications are filed annually worldwide, and more than one and a half million are granted.[9] The EPO alone received a record number of patent

accessed 1 September 2023; D Tapscott and A Tapscott, Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World (Penguin Publishing Group 2016).

2 Marie-Christine Janssens and others, 'Copyright Issues on the Use of Images on the Internet', *Research Handbook on Intellectual Property and Cultural Heritage* (Edward Elgar publishing; Cheltenham 2022).

3 For more information on WIPO PROOF see <https://www.wipo.int/wipoproof/en/)>; Pixsy - <https://www.pixsy.com/register/>; Bernstein - <https://www.bernstein.io/> accessed on 1 September 2023.

4 Frederick Mostert, 'Digital Date-and-Time-Stamping: The Evidentiary Value and Practical Significance of WIPO PROOF' [2021] *WIPO Magazine* <https://www.wipo.int/wipo_magazine_digital/en/2021/article_0001.html> accessed 1 September 2023. This digital fingerprint is also used to obtain a timestamp on developed know-how and trade secrets that can be instrumental to generate evidence in case of disputes.

5 For more information on Monegraph, see https://www.monegraph.com/technology/; Crypto.com - <https://crypto.com/nft/marketplace>: OpenSea - <https://opensea.io/about> accessed on 1 September 2023.

6 Hugendubel (n 1) 1; Seyed Mojtaba Hosseini Bamakan and others, 'Patents and Intellectual Property Assets as Non-Fungible Tokens; Key Technologies and Challenges' (2022) 12 Scientific Reports 2178, 2; Nikos Kostopoulos and others, 'Demystifying Non-Fungible Tokens (NFTs)' (EU Blockchain Observatory and Forum 2021) 4 <https://www.eublockchainforum.eu/news/new-thematic-report-demystifying-nfts> accessed 1 September 2023.

7 The accessibility of those registers, however, depends on how technologically advanced are the respective patent offices.

8 In particular, WIPO acknowledges the importance of the digital transformation of IP offices for the efficient functioning of the global IP system and states that "most offices in developing countries have limited resources and face challenges to adopt digital business services", such as "online services, including search, registry and filing systems; efficient and standardized business processes for IP administration; integration into regional and international IP systems to enable the digital exchange of data and documents". See WIPO, 'IP Office Business Solutions' <https://www.wipo.int/global_ip/en/activities/ip_office_business_solutions/index.html> accessed 4 September 2023.

9 WIPO, 'World Intellectual Property Indicators 2021' (2021) <https://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2021.pdf> accessed 1 September 2023.

filings in 2021,[10] which was promptly broken with a 2.5% patent application increase in 2022.[11] These trends make it ever more challenging for all the relevant actors to navigate through the maze of patent rights to secure their freedom to operate. As will be explained in Section B, patents cannot be exploited without explicit authorisation from rightsholders, unless an exception or limitation applies.[12] As a result, enhancing the efficiency of establishing patent transactions comes to the fore, as most patent transactions are still established by virtue of 'classical' lengthy and costly contractual negotiations. Furthermore, to establish any transaction, third parties should not only be aware of the content of the patented invention but also have the means to identify current rightsholders in a certain and efficient manner. As will be highlighted in Section C, accurate information on patent rightsholders changes may not always be promptly obtainable by patent offices.

6 In Section D, we argue that integrating blockchain technology into patent registers is an instrumental solution that allows (within the boundaries of identified limitations) to (1) combat the territorial fragmentation of patent registers, (2) tackle the lack of transparency of patent ownership by enabling improved patent ownership tracing, and (3) increase the visibility of patents that could be licensed or assigned. Furthermore, blockchain technology could facilitate the establishment of patent transactions by offering the possibility to digitise and (semi-) automate certain associated processes. In particular, one could even tokenise a patent, trade patents in an NFT form and automate this process by relying on smart contracts, as explored by private actors (such as IPwe).[13] Whether the theoretical benefits of automating trade in patents are in line with the nature of patent protection remains to be analysed.[14] Moreover, the implementation of blockchain technology as means of (allegedly more efficient) governance and exchange of patents is not without (legal) hurdles that are hard not to notice and even harder to overcome.[15] Some limitations of this technology in the context of enabling patent transactions are concisely addressed.

7 Finally, in Section E, this article debates the issue of privatisation of patent governance in light of the launch of private patent marketplaces.[16] Patent disclosure and dissemination of patent information are currently predominantly governed by patent offices as intermediaries guarding the legislatively established balance between the interests of patent owners and society, the so-called 'quid-pro-quo' of the patent system (also known as a 'social contract').[17] However, the implementation

10 EPO, 'Patent Applications in Europe Reach Record Level in 2021' (2022) <https://www.epo.org/news-events/news/2022/20220405.html> accessed 1 September 2023.

11 EPO, 'Innovation Stays Strong: Patent Applications in Europe Continue to Grow in 2022' <https://www.epo.org/news-events/news/2023/20230328.html> accessed 4 September 2023; EPO, 'Patent Index 2022 - Statistics at a Glance' <https://www.epo.org/about-us/annual-reports-statistics/statistics.html> accessed 4 September 2023.

12 For more information, see <https://www.wipo.int/patents/en/topics/exceptions_limitations.html> accessed on 1 September 2023.

13 Hugendubel (n 1) 6; Bamakan and others (n 6) 2.

14 On a more fundamental level, the tension between the law and blockchain technology has been thoroughly studied by Primavera De Filippi and Aaron Wright, Blockchain and the Law: The Rule of Code (Cambridge, Massachusetts : Harvard University Press 2019). In essence, they claim that the rules of law and the rules of code could coexist and even achieve certain synergy. In particular, they state that "blockchain-based protocols and smart contracts can be used to model or represent laws and embed them directly into the fabric of a blockchain-based network to ensure the automatic execution and ex-ante enforcement of these rules". Nonetheless, open-ended legal provisions to date are not suited for implementation via a computer code.

15 See Section D.II.2.

16 For the purpose of clarity, we would like to explain the terminology applied in this article. By 'patent register' we understand a conventional 'reference' patent register or database governed by a patent office. The term 'blockchain-based patent platform' is used to refer to a patent register that has been transformed into a platform by means of integrating blockchain technology into the patent register. Such a platform may or may not support a transactional functionality. By using the term 'blockchain-based patent marketplace' we signal that the platform supports a transactional functionality (in other words allows to trade patents via the platform).

17 In brief, the patent system is based on the utilitarian premise that without patent protection inventors (or by succession other associated parties) would not be sufficiently motivated to innovate since they would not be able to recuperate invested resources as any third party could replicate their invention without investing the same efforts and enduring the same costs. In return for these exclusive patent rights, patent applicants are instructed to publicly disclose their work to disseminate related technological information to the public, reduce wasteful duplication of innovative efforts, and stimulate cumulative innovation. This legislatively established balance is just and straightforward, yet fragile. Robert P Merges, Justifying Intellectual Property (Cambridge, Mass : Harvard University Press 2011) 2.

of blockchain-based patent marketplaces governed by private actors (such as IPwe[18]) may distort this fragile balance as they partially aim at taking over functions of patent registers without abiding by the principles of transparency and accessibility of patent information to any interested third party. This article concludes that if patent marketplaces were to be established, patent offices with the aid of blockchain (or another digital) technology would be best placed to offer such services as, contrary to private solutions, they have the potential of developing a 'global' marketplace, instead of a 'local' shop access to which is restricted to selected members.

B. Patents as valuable assets

8 Patents have increasingly become one of the core corporate assets. It is even claimed that patents (as well as other IP rights) can be far more valuable than tangible assets as their trade can generate significant revenues.[19] A trend toward patent monetisation is observed by economic and managerial scholars in the increasing number of patent transactions and associated generated profits.[20] This trend corresponds with the upturn of so-called 'markets for technology'.[21]

9 The rise of patent monetisation or patent trade can be linked to multiple trends, among which are the increase in research and development (R&D) decentralisation and specialisation and the expansion of overlapping patent rights, also known as patent thickets.[22] As a patent gives its owner the right to exclude others from exploiting the patented technology in any way, apart from the exempted ones, third parties interested in getting access to certain technology do not have many options but to attempt to obtain the required authorisation from a relevant rightsholder. Thus, interested third parties are expected to engage in various types of patent transactions, such as assignment or (cross-) licensing agreements, with patent rightsholders to avoid infringing granted rights.

10 As for any (intellectual) property transaction, the main prerequisites of a patent transaction are the knowledge of a subject matter that is potentially available for trade and the identity of a person who is authorised to grant permission to exploit a patented invention on negotiated terms. The subject matter of a patent transaction is rather easy to track as patents are registered rights.[23] However, the identification of relevant rightsholders can cause difficulties. At times, it may be challenging to trace them as patents can be assigned or certain patent rights licensed without it being reflected in patent registers.[24] Considering that these two prerequisites are essential for enabling patent transactions, it is instrumental to ensure that the information on both the subject matter and the identity of a relevant rightsholder is accessible to third parties.

11 Especially for patent-dense industries, in which patent thickets are prominent, the creation of various forms of patent pools has been seen as a solution to ensure that patented technologies can be exchanged in an efficient manner. In this context, bilateral negotiations can be time-consuming and impractical as access to multiple patented technologies is often required to ensure the freedom to operate. These pools can take different forms and are subject to various governance schemes.[25] The core function of patent pools is the creation of an ecosystem in which members share access to selected patented inventions that are related to a particular technology in a certain industry sector

18 For more information on IPwe, see <https://ipwe.com/> accessed on 1 September 2023.

19 Jeffrey Cohen, *Intangible Assets: Valuation and Economic Benefit* (Wiley 2005); Henry William Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Harvard Business Press 2003).

20 Peter C Grindley and David J Teece, 'Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics' (1997) 39 California Management Review 8; Kevin G Rivette and David Kline, Rembrandts in the Attic: Unlocking the Hidden Value of Patents (Harvard Business School Press 2000).

21 Alfonso Gambardella, Ashish Arora and Andrea Fosfuri, *Markets for Technology: The Economics of Innovation and Corporate Strategy* (Cambridge, Mass: The MIT Press 2004).

22 Luis Miotti and Frederique Sachwald, 'Co-Operative R&D: Why and with Whom?: An Integrated Framework of Analysis' (2003) 32 Research Policy 1481, 1482; Bronwyn H Hall and others, 'A Study of Patent Thickets' (Intellectual Property Office 2013) 17 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4094057> accessed 1 September 2023; Bruce S Tether, 'Who Co-Operates for Innovation, and Why: An Empirical Analysis' (2002) 31 Research Policy 947, 947; Carl F Fey and Julian Birkinshaw, 'External Sources of Knowledge, Governance Mode, and R&D Performance' (2005) 31 Journal of Management 597, 600.

23 See Section C.

24 See Section C.

25 WIPO, 'Patent Pools and Antitrust - A Comparative Analysis' (2014) 6 <https://www.wipo.int/export/sites/www/ip-competition/en/docs/patent_pools_report.pdf> accessed 1 September 2023.

(e.g., COVID-19 Technology Access Pool (C-TAP)[26]; Medicines Patent Pool (MPP)[27]). To simplify, various patents are contributed to pools by their owners with the aim of cross-licensing, whereas other interested parties are typically allowed to have access to the pooled patents on standard contractual terms.[28] The clear advantage of such pools is the optimisation of granting access to selected patents without engaging in lengthy bilateral negotiations with multiple patent holders that entail high transaction costs.

12 Patent pools are currently one of the core mechanisms used to optimise patent transactions. However, they are applied only in specific cases that are often related to public health or telecommunication standards. Such efficiency does not exist when exchanging other patented technologies, and interested parties are expected to gather all the relevant information to initiate patent transaction negotiations on an individual basis. Blockchains may, however, open opportunities for simplifying patent trade, as explained in Section D, by increasing transparency of patent data, digitising transactions, and reducing associated administrative and transaction costs.[29]

C. Patent registers as patent databases

13 Patent offices are bound by the obligation to secure the visibility of patent-related information by disclosing to third parties the data collected from patent applicants.[30] The disclosure function of the patent system is considered to be one of the core benefits for society as it prevents wasteful duplication of R&D efforts and stimulates follow-on innovation.[31] By making this information public, patent offices signal which inventions are currently protected and cannot be exploited without the authorisation of relevant rightsholders. The shared patent information also allows third parties to study disclosed inventions and use them within the established exceptions and exemptions[32] during the patent term and without any limitations after the protection lapses. It additionally indicates which patent assets are potentially available for trade.

14 The collected information is generally communicated via patent bulletins and patent registers governed by IP offices on national or regional levels. Patent registers serve as patent databases transmitting patent data to the public. The scope of shared information and mode of access differ per office. Some IP offices developed user-friendly publicly accessible (patent) databases, such as the European Patent Office (EPO) Espacenet[33] and the World Intellectual Property Organization (WIPO) Patentscope[34], which disseminate patent documents of national and regional patent offices, as well as international Patent Cooperation Treaty (PCT)[35] applications. The shared information contains multiple valuable details, including the content of inventions (delimiting the scope of protection), the territory of protection, relevant dates (priority, application, publication, grant), classifications, and other important bibliographic data, such as information on inventors, applicants, and owners of patents or patent applications.

15 Patent registers and databases provide sufficient information to third parties interested in obtaining

26 For more information, see <https://www.who.int/initiatives/covid-19-technology-access-pool> accessed on 1 September 2023.

27 For more information, see <https://medicinespatentpool.org/> accessed on 1 September 2023.

28 Robert P Merges, 'Institutions for Intellectual Property Transactions: The Case of Patent Pools', *Expanding the Boundaries of Intellectual Property* (Oxford University Press 2001).

29 Bamakan and others (n 6) 2; Hugendubel (n 1) 10; Ronny Hauck, 'Blockchain, Smart Contracts and Intellectual Property. Using Distributed Ledger Technology to Protect, License and Enforce Intellectual Property Rights' (2021) 1 Legal Issues in the Digital Age 29 <https://lida.hse.ru/article/view/12369> accessed 1 September 2023.

30 For instance, many patent offices are obliged to publish patent applications after the expiry of a period of eighteen months from the date of filing or the priority date (e.g. Art. 21 Patent Cooperation Treaty, Art. 93 European Patent Convention, United States Code, Title 35, Section 122 (35 U.S.C. 122).

31 Arina Gorbatyuk and Adrián Kovács, 'Patent Notice (Failure) in the Era of Patent Monetization' (2022) 53 IIC - International Review of Intellectual Property and Competition Law 506, 510; Benjamin N Roin, 'The Disclosure Function of the Patent System (Or Lack Thereof)' (2005) 118 Harvard Law Review 2007, 2009; Edmund W Kitch, 'The Nature and Function of the Patent System' (1977) 20 The Journal of Law and Economics 265, 278.

32 For more information, see <https://www.wipo.int/patents/en/topics/exceptions_limitations.html> accessed on 1 September 2023.

33 For more information on the EPO Espacenet, see <https://worldwide.espacenet.com/> accessed on 1 September 2023.

34 For more information on the WIPO Patentscope, see <https://patentscope.wipo.int/search/en/search.jsf> accessed on 1 September 2023.

35 Patent Cooperation Treaty (PCT) 2002.

access to patents. However, they have several major limitations that may hinder the efficient and smooth establishment of patent transactions.

16 First, even though the scope of collected data is largely harmonised, thanks to international cooperation and underlying treaties[36], the collection and communication of the patent data is decentralised, as patents are granted on national or regional levels. The PCT route could be viewed as an exception as it centralises the application process. This decentralisation creates fragmentation which hinders the accessibility and visibility of collected data. The issue of fragmentation is partially mitigated through the introduction of 'global' patent databases, such as EPO Espacenet and WIPO Patentscope. However, the completeness of those databases depends on the level of digitisation of data collected by underlying national or regional patent offices. Furthermore, one of the apparent constraints on the accessibility of data are languages in which patent applications are instructed to be filed. The EPO and WIPO attempt to overcome this barrier by inbuilding automatic translations into their databases.

17 The collection, processing, and maintenance of the data are currently primarily conducted manually, even when relying on electronic systems, such as ePCT (WIPO), myEPO (EPO), or DPMAdirektPro (the German Patent and Trade Mark Office (DPMA)).[37] This means that the (electronically) communicated data must be first processed by the patent office before being displayed in patent registers. Thus, the trade-off faced by patent offices at the moment is between the immediate availability of updated patent data (so-called real-time updates) and data reliability (ensuring that the data is accurate and complete). The preference is currently given to reliability. Patent applicants or owners commonly have no means to insert information directly into the registers. They are first asked to provide the requested information to responsible patent office officials. This trade-off is justifiable as communication of inaccurate information without any subsequent verification is potentially more harmful than a delay in disseminating the relevant information.

18 Second, patent applicants and owners are responsible for communicating any legislatively required updates to patent offices to ensure that patent registers contain accurate data. For instance, they are generally instructed to register assignment and licensing agreements to ensure that all relevant rightsholders are known to the public. Despite the underlying obligations[38], rightsholders, at times, fail to communicate this information to patent offices, which limits the transparency of patent rightsholders.[39] Thus, third parties interested in establishing a patent transaction may be forced to endure unnecessary costs to obtain this essential information to initiate a negotiation process.

19 Finally, patent databases governed by patent offices are 'reference' databases. Patent offices are instructed to disclose essential patent-related information to society, but they are not legislatively expected to act as active intermediaries between patent rightsholders (potential 'sellers') and third parties (potential 'buyers'). These business relationships are currently predominantly governed privately. However, considering the importance of patent trade, it is high time to examine whether patent offices, in fact, should take on board additional functions that could be of value to knowledge exchange and technological advancement and whether the integration of blockchain technology into patent registers could remedy the identified challenges and shortcomings of current patent registers.

D. Patent blockchains as digital patent platforms

20 To establish whether blockchain technology could be instrumental in facilitating patent trade, it is first necessary to comprehend its essential technical characteristics. Understanding the functionality of this kind of distributed ledger technology will allow us to demonstrate how it can assist in resolving some of the identified constraints of conventional 'reference' patent registers.

36 Susy Frankel and Daniel J Gervais, *Advanced Introduction to International Intellectual Property* (Edward Elgar 2016) 88, 98.

37 For more information on ePCT see <https://www.wipo.int/pct-eservices/en/index.html>; myEPO - <https://www.epo.org/applying/online-services/myepo.html>; DPMAdirektPro - <https://www.dpma.de/service/elektronische_anmeldung/dpmadirekt/index.html> accessed on 1 September 2023.

38 For instance, in Belgium the notification of a license needs to use a specific form made available by the Belgian Intellectual Property Service, whereas in Turkey patent assignments need approval of a notary public. See, Belgium: Art 34 of the Royal Decree of 2 December 1986 on the application, granting and maintenance of patents for inventions. Turkey: Gürkaynak and others (n 1) 858. Other differences in legislative norms can be reviewed in Section 5 'The Recording of Patent Ownership Changes' in Gorbatyuk and Kovács (n 31).

39 Gorbatyuk and Kovács (n 31) 516.

I. Essential characteristics of blockchain technology

21 The key characteristics of blockchains are in their structure and functionality. Structurally, blockchains should be thought of as shared ledgers or databases, distributed over the participants to a network ('nodes'), consisting of time-stamped 'blocks' that are chained to each other by including a reference to the preceding block. Functionally, they are intended to store individually accessible information in a transparent and tamper-resistant manner, while possibly also supporting a transactional functionality.[40]

22 There are several types of blockchains hosting different types of nodes.[41] Some nodes are rather passive (*read*-permission), while others can fulfil a more active role (*write-*/*commit*-permission).[42] A '*read*'-permission allows a node to access the ledger and see transactions, whereas a '*write*'-permission empowers a node to create transactions and send them to the network. A '*commit*'-permission grants a node the ability to update the state of the ledger (e.g., miners or validator nodes).

23 In *permissionless* blockchains, as depicted in Table 1, every node has a *commit*-permission, which allows them to validate transactions and let (mining) nodes add blocks. A *permissioned* blockchain, on the other hand, will reserve *write*- and/or *commit*-permissions to a subset of the nodes in the network. In other words, only some of the nodes are able to validate transactions and add blocks to the chain (*commit*) or enter into transactions (*write*).[43] These blockchains are considered less transparent and are not regarded as pure *peer-to-peer* networks.

24 Another relevant distinction is the one between public and private blockchains. *Public* blockchains are open to and available for anyone (e.g., by downloading the relevant software, one can join the respective blockchain network).[44] Conversely, *private* blockchains are not open to everyone and only admit certain participants (*read*-permission). This type of blockchain often falls in the category of 'enterprise blockchains'.

25 As a consequence of their transparency and accessibility, *public permissionless* blockchains (e.g., Bitcoin) employ encryption and run on so-called consensus mechanisms (e.g. Proof-of-Work, Proof-of-Stake).[45] These mechanisms ensure a certain level of infrastructural security to hold off possible attacks of maleficent nodes and guarantee the tamper-resistance of added information. *Private permissioned* blockchains do generally not need these security measures as participants trust each other and have different prerogatives.[46]

40 Aaron Wright and Primavera De Filippi, 'Decentralized Blockchain Technology and the Rise of Lex Cryptographia' [2015] SSRN Electronic Journal 4–8 <https://www.ssrn.com/abstract=2580664> accessed 1 September 2023; Konstantinos Christidis and Michael Devetsikiotis, 'Blockchains and Smart Contracts for the Internet of Things' (2016) 4 IEEE Access 2292, 2293; European Commission and others, *Study on Blockchains: Legal, Governance and Interoperability Aspects* (Publications Office 2020) 26–28 <https://op.europa.eu/en/publication-detail/-/publication/939fe2cc-5784-11ea-8b81-01aa75ed71a1/language-en> accessed 1 September 2023.

41 Tapscott and Tapscott (n 1) 66–67.

42 Garrick Hileman and Michel Rauchs, 'Global Blockchain Benchmarking Study' (Cambridge Center for Alternative Finance 2017) 20–21 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3040224> accessed 1 September 2023.

43 ibid.

44 An example is the Ethereum-blockchain, see <https://ethereum.org/en/run-a-node/> accessed on 1 September 2023.

45 Christidis and Devetsikiotis (n 40) 2293–2295.

46 Michel Rauchs and others, '2nd Global Enterprise Blockchain Benchmarking Study' (Cambridge Center for Alternative Finance 2019) 13 <https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/2nd-global-enterprise-blockchain-benchmarking-study/> accessed 1 September 2023.

47 However, this requires substantial investment in, for instance, hardware for mining or cryptocurrency in the hypothesis of a PoW-/respectively a PoS- consensus mechanism.

TYPE OF BLOCKCHAIN	Private	Public
Permissioned	ENTERPRISE BLOCKCHAINS - participation (read-privilege) is restricted and write and commit-privileges are awarded to a single node or a limited number of nodes.	PUBLIC PERMISSIONED BLOCKCHAINS - participation (read-privilege) is unrestricted but write- and commit-privileges are awarded to a single node or a limited number of nodes.
Permissionless	CONSORTIUM BLOCKCHAINS - participation (read-privilege) is restricted but write- and commit-privileges are awarded to all authorised nodes.	CRYPTOCURRENCY BLOCKCHAINS - participation (read-privilege) is unrestricted and write- and commit-privileges are awarded to all nodes.[47]

Table 1: '*Taxonomy of blockchains*' [48]

26 Finally, one has also to take into account that blockchain networks have different modes of governance: (1) centralised or decentralised and (2) on-chain or off-chain.[49]

27 Centralised governance means that only one or a limited set of actors determines the rules of operation of the blockchain network and decides on, for instance, the admission of new nodes.[50] Private blockchains are often governed centrally.[51] On the contrary, decentralised governance implicates that a variety of actors, possibly spread over the various levels of the technology stack (network – protocol – application layer), can contribute to decisions. Such governance is more typical for public blockchains.[52]

28 The distinction can also be made between on-chain and off-chain governance. The difference between the two lies in the manner in which the decision-making occurs and how these decisions are implemented. On-chain governance entails that the decision-making procedures are embedded in the blockchain protocol, i.e., the blockchain protocol itself ensures that stakeholders make decisions. With off-chain governance, the decision-making occurs elsewhere whereby stakeholders can rely on, for instance, existing forms of corporate governance such as a management board or articles of association. The decisions made must be subsequently imported into the blockchain protocol.[53] On- and off-chain governance can also be combined.[54]

II. Relevance of blockchain technology for patent registers

29 In theory, as discussed in Part 1, blockchain technology may resolve some of the challenges encountered by conventional patent registers. However, in Part 2 we then highlight the many issues and limitations that a blockchain implementation would have to deal with in order to ensure the feasibility and usefulness of transforming current patent registers into blockchain-based patent platforms.

1. Transitioning from 'reference' patent registers to blockchain-based patent platforms

30 Taking into account these technical characteristics of blockchain technology, one can conceptualise theoretically how said technology could improve the functionality of patent registers by allowing relevant stakeholders to update patent registers

48 Table 1 is based on S Nascimento and others, 'Blockchain Now And Tomorrow: Assessing Multidimensional Impacts of Distributed Ledger Technologies' (Publications Office of the European Union 2019) 14–15 <https://publications.jrc.ec.europa.eu/repository/handle/JRC117255> accessed 1 September 2023; Christidis and Devetsikiotis (n 40) 2297–2298; Hileman and Rauchs (n 42) 20–21.

49 European Commission and others (n 40) 41–45. Blockchain governance is sometimes also referred to as 'social consensus', see Rauchs and others (n 46) 14–15.

50 Rauchs and others (n 46) 14.

51 ibid 40–41.

52 Decentralised governance generally requires certain incentive structures which are not discussed in the context of this article.

53 Both systems come with (dis)advantages. For a discussion, see Nascimento and others (n 48) 17; Michael Borella, 'The Compelling Implications of Using a Blockchain to Record and Verify Patent Assignments' (*Patent Docs*) <https://www.patentdocs.org/2022/07/the-compelling-implications-of-using-a-blockchain-to-record-and-verify-patent-assignments.html> accessed 1 September 2023; European Commission and others (n 40) 43–44; Tom Lyons and Ludovic Courcelas, 'Governance of and with Blockchains' (EU Blockchain Observatory and Forum 2020) 10–13 <https://www.eublockchainforum.eu/reports/governance-and-blockchains> accessed 1 September 2023.

54 Lyons and Courcelas (n 53) 14, 18–21.

in a synchronised, transparent, and decentralised manner as well as enter into and validate patent transactions.[55] Thus, by relying on blockchains, patent registers could potentially transition from 'reference' databases to multifunctional patent platforms that may even support a transactional functionality turning a register into an online marketplace.

31 In a nutshell, one can envisage a blockchain application through which actors can establish, per jurisdiction, which patents have been applied for or granted and who has rights in those patents. Each patent (application) could have a unique hash recorded on the underlying blockchain (a so-called 'proof of existence').[56] Such hash could function simultaneously as a digital representation of respective patents as well as a central link through which all the related patent information (e.g., patent file, bibliographic information, as discussed in Section C) can be accessed (in existing patent registers or databases).[57] Furthermore, relevant patent transactions, such as licenses and assignments, could also be imported and featured on the blockchain. This could be realised by supplementing the hash with numeric identifiers representing the parties involved in transactions related to the patent and linking to the possible profile of the actor. Moreover, the application could provide additional transactional functionality (which goes beyond merely displaying transactions) using public-private key cryptography, allowing interested parties to assign or license patents and record those transactions on the blockchain.[58,59] The graphical representation of this hypothetical blockchain is provided in Figure 1.

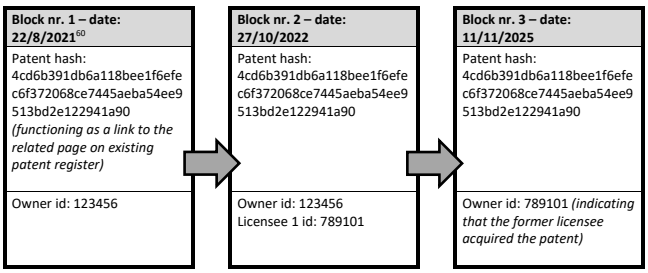

Figure 1: *'Graphical representation of the patent information in a blockchain'*

32 In such (theoretical) application, several features of blockchain technology may thus remedy certain issues or problems that the current, conventional patent registers encounter:[61]

33 **Distributed nature**: The distributed nature of blockchain technology ties in with the existing decentralised patent system. Introducing a single type of technology to be used by all patent offices could lead to more complete, uniform, and digitised patent data.[62] Moreover, by integrating them into

55 Nascimento and others (n 48) 14–20, 75; Borella (n 53); Clark (n 1) 31–34; Lois Hoyal, 'Talking about a New Revolution: Blockchain' (European Patent Office 2018) 9 <http://documents.epo.org/projects/babylon/eponet.nsf/0/FB134B001751B1FAC12583BD00317B47/$File/Talking_about_a_new_revolution_blockchain_conference_report_en.pdf> accessed 1 September 2023.

56 This hash could be incorporated into some sort of token, see Bodó, Gervais and Quintais (n 1) 314–315.

57 A hash (a 32 or 64-bit long sign combination) is the output of an encryption algorithm and is uniquely related to its input, while it is impossible to deduce the original input from the hash. Thomas Gils and Christine Frison, 'Blockchain Technology for Food Security? Resilience Potential and Risk Identification for the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture', *The Transformation of Environmental Law and Governance - Risk, Innovation and Resilience* (Edward Elgar 2021) 210–211; Philip Boucher, 'How Blockchain Technology Could Change Our Lives' (European Parliamentary Research Service 2017) 10–11 <https://data.europa.eu/doi/10.2861/926645> accessed 1 September 2023.

58 Borella (n 53); Atharv Chandratre and Abhinav Pathak, 'Blockchain Based Intellectual Property Management' [2019] SSRN Electronic Journal 5–6 <https://www.ssrn.com/abstract=3800734> accessed 1 September 2023; Christidis and Devetsikiotis (n 40) 2295–2296.

59 This would require agreement by stakeholders on some form of a formal template outlining the information that should be reflected by specific assignments/licenses. Those fields could include the parties, date, the patent number(s), date, applicable fees, duration, exclusivity, choice of jurisdiction, and applicable law. A solid reference point could be current templates provided by patent offices to register licenses and patent assignments. For instance, the EPO forms 5055 and 5070, see <https://www.epo.org/applying/forms.html> accessed on 1 September 2023.

60 The date could be the patent application or grant, or even the technical import date into the blockchain, depending on the actual practical implementation of a blockchain application.

61 Christidis and Devetsikiotis (n 40) 2293–2297; Nascimento and others (n 48) 13–25; Tom Lyons, Ludovic Courcelas and Ken Timsit, 'Blockchain for Government and Public Services' (EU Blockchain Observatory and Forum 2018) 9–10, 12, 14–18 <https://www.eublockchainforum.eu/reports/blockchain-government-and-public-services> accessed 1 September 2023.

62 Lyons and Courcelas (n 53) 18.

one platform, the accessibility of national patent registers will be enhanced. More importantly, the fact that information is replicated by all the participating nodes entails that the data will persist even if a node fails (resulting in increased resilience and security).

34 **Tamper-resistant**: Due to the use of consensus mechanisms or the deliberate distribution of commit-privileges, blockchains are resilient against fraudulent transactions and avoid the possibility of double entries.[63]

35 **Transactions**: Blockchains can support a transactional functionality, allowing participating nodes to interact, transfer patents, and register such transactions on the underlying blockchain. These transactions are added to the chain automatically and in real-time, increasing the visibility and reliability of said data.[64] Blockchain enthusiasts even speculate about the possibility of automating such patent transactions relying on smart contracts (as further discussed in the following section).[65]

36 **Transparency and auditability**: Once a patent features on the blockchain, the subsequent related transactions would be shown automatically to nodes or users with a read-permission. Hence, information on subsequent owners or licensees would be disclosed efficiently, while also easing up the task of patent offices of gathering and communicating such information. Additionally, due to the use of cryptographic hashes and the 'chained' nature of the blocks, interested parties could easily retrace the origin of a patent and verify the integrity of its transactional history.[66]

37 **Lower costs and increased efficiency:** As registering patent transactions with a variety of patent offices is often not without costs (e.g., due to language, paper filing requirements, and registration fees), automating this procedure will reduce the related costs and render the registration less language-sensitive.[67] Furthermore, the use of a common data standard will improve the efficiency of patent registers worldwide. [68]

63 Nascimento and others (n 48) 24–25.

64 Christidis and Devetsikiotis (n 40) 2295–2296.

65 Hauck (n 29) 18, 20; Gürkaynak and others (n 1) 849.

66 Clark (n 1) 32; Lyons and Courcelas (n 53) 18.

67 Gorbatyuk and Kovács (n 31) 523; Gürkaynak and others (n 1) 858.

68 Lyons, Courcelas and Timsit, 'Blockchain for Government and Public Services' (n 61) 18.

38 To our knowledge, not a single patent office has attempted (to date) to integrate blockchain technology into its register. However, private entities have explored the possibility of trading patents through blockchains. One of the most prominent blockchain-based patent marketplaces currently offered is IPwe.[69] Apart from various IP analytical and managerial tools, the platform offers means to trade patents on an individual basis or contribute them to IPwe-governed pools. Whereas the project certainly is a step forward in optimising patent transactions, it has several limitations, which are further addressed in Section E.

2. Limitations of blockchain-based patent platforms

39 Although blockchain technology could, in theory, help overcome multiple challenges of existing patent registers and databases governed by patent offices, it will also bring about various issues that have to be mitigated, some of which are addressed in this section.

40 First, when designing a 'patent blockchain' one has to select its technical characteristics. As mentioned in Section D.I., blockchains can either be private or public and permissioned or permissionless. Taking into account the addressed public disclosure obligation imposed on patent applicants and enforced by patent offices, it is asserted that such blockchain should be a 'public' one (i.e., all interested parties could obtain a read-permission). At the same time, a database or platform is only valuable if the communicated information is accurate and reliable.[70] The advantage of *permissioned* blockchains is that in such networks trusted entities can be granted the competence to administer the blockchain and decide on the veracity of the data to be added. However, even if a blockchain is permissioned, it is not necessarily guaranteed that the inputted data is accurate, as the blockchain administrators may not be able to verify the lawfulness and accuracy of the inputted data in their entirety, which could lead to disputes, including patent infringements.[71] Nonetheless, it is asserted that a public permissioned blockchain seems to be the most evident type of blockchain in the current patent context,[72] as a permissionless blockchain would entail a much

69 For more information, see <https://ipwe.com/> accessed on 1 September 2023.

70 Also known as the issue of garbage in/garbage out. See e.g. De Filippi and Wright (n 14) 114.

71 Hileman and Rauchs (n 42) 18.

72 Chandratre and Pathak (n 58) 3.

	Patent offices	Patent actors	Third parties
Administration	✓	*	*
Permissions management	✓	X	X
Gatekeeping	✓	X	X
Transaction processing	✓	*	*
Transaction initiation	X	✓	X
Transaction validation	✓	✓	✓

Table 2: *'Suggested allocation of tasks'*[77]

higher level of disintermediation that would require a thorough discussion on the role of patent offices and their relationship with other stakeholders in the management of patent registers.[73] Moreover, such a blockchain would likely require a significant upgrade of the computing resources of the stakeholders who wish to be involved, reducing its practical feasibility.

41 Choosing a type of blockchain is, however, closely related to the intertwined questions of blockchain governance, the participants to the network, and the allocation of tasks.[74] Rauchs et al. (2019) provide a useful distinction between network operators and network participants with their respective, non-mutually exclusive tasks.[75] Network operators are responsible for administration (including network governance and setting of protocol rules), permissions management, and gatekeeping (admit/exclude network participants). Network participants can contribute to transaction processing (i.e., commit-permission) and transaction validation (i.e., read-permission). Transaction initiation (i.e., write permission) should also be added to the list.

42 Patent offices should be attributed an important role in accordance with their competencies under the existing legal framework. As depicted in Table 2, those tasks can be, for instance, (patent) transaction processing (including inputting patents into the network (both existing patents as well as newly granted ones)), administration, permissions management, and gatekeeping.[76] Organisations willing to enter into patent transactions ('patent actors') should, at least, be entitled to transaction initiation and validation. Other third parties (e.g., researchers or civil society) could be awarded transaction validation privileges. It remains to be reviewed which role patent actors and third parties should play in the governance/administration of a patent blockchain and to what extent they could contribute to transaction processing.

43 Due to the involvement of multiple patent offices in the envisaged network, there will be no single leader entity per se. Whether or not patent actors and third parties obtain a role in the blockchain administration will, however, determine the actual level of the decentralisation of governance. If such an initiative aims to gain support from all stakeholders, there will be no alternative but to assign them a certain role. Given the highly political nature of decisions regarding the international patent system, it can also be expected that governance will or should remain predominantly off-chain for the foreseeable future. This off-chain governance role could be awarded to the WIPO due to its administrative, neutral, and intergovernmental nature.[78]

44 Second, to increase the global visibility and tradability of patents, information provided on patent platforms should be globally available and as complete as possible. Global availability may be an issue as certain parts of the world (e.g., the "Global South") lack the digital infrastructure others have (e.g., North America, Europe and certain parts of Asia), rendering a successful global patent blockchain implementation rather difficult. Logically, this also impacts the possible initial allocation of tasks: one can imagine that certain patent offices do not dispose of the necessary computing resources required to run a full node.[79] Vice versa, certain large corporations or, for instance, universities likely do, which makes it difficult to precisely allocate the tasks for patent actors and third parties, as outlined in Table 2.[80]

45 Regarding completeness, it should be taken into

73 For a similar discussion under copyright law, see Bodó, Gervais and Quintais (n 1) 316–319.

74 Lyons and Courcelas (n 53) 17–22.

75 Rauchs and others (n 46) 24.

76 Clark (n 1) 32; Christidis and Devetsikiotis (n 40) 2295–2296.

77 '√' – direct task; 'X' – not permitted task; '*' – potentially permitted task.

78 This also follows from the choice for a permissioned blockchain network. In a permissionless network, on-chain governance is more important as no recourse can be made to any 'leading' authority and to ensure the security of the network and the balance of power. See Lyons and Courcelas (n 53) 11.

79 See footnote 8.

80 For further relevant considerations, see Lyons and Courcelas (n 53).

account that the mere availability of a 'global' blockchain network supported by patent offices will unlikely instantly incentivise patent actors to register their licenses or assignments on it. Hence, imposing an enforceable obligation on actors (backed up by negative or positive incentives) to record their transactions on the blockchain should be considered.[81] Currently, the main barriers to recording the named agreements are administrative burdens and associated costs, especially elevated due to patent territoriality. Blockchain technology could increase recordation efficiency and lower associated costs, as it permits overcoming administrative challenges posed by territoriality.

46 Third, there are many legal and regulatory hurdles that may stand in the way of a swift adoption of blockchain technology for patent registers.[82] Typical challenges include identifying applicable law, jurisdiction, enforcement, liability, data protection, issues regarding dispute resolution and blockchain governance, as well as matters relating to the transactions to be conducted (e.g., complicated patent agreements). For instance, as patents are territorial rights, the registration of the related licenses or assignments with national patent offices needs to comply with national requirements. Resolving these issues may not only require well-conceived blockchain applications that integrate these requirements into their functioning but possibly also legislative amendments.[83]

47 Another important legal issue is related to the possibility of the 'tokenisation'[84] of patents by issuing patent-specific NFTs and allowing trade in such NFTs (as done by IPwe). NFTs are distinct digital assets and should be considered separate from the real-world assets they represent (e.g., patents).[85] This means that when an NFT relating to a patent is assigned, only the NFT changes owner. The patent rights remain with the previous owner unless an additional agreement is entered into.[86] Moreover, existing formal requirements under (national) patent and contract laws will not allow for patent assignments or licenses through the transfer of an NFT.[87]

48 Fourth, an additional step in the transactional functionality could be to not just represent patents through a hash on the blockchain, as depicted in Figure 1, but incorporate them in a 'smart contract' expressing a license or assignment.[88] A smart contract functions as an autonomous actor on the blockchain network: it has its own account and will execute itself if the relevant conditions are met.[89] This automatic execution is, allegedly, one of the core benefits of smart contracts, as it entails immediate enforcement of established contractual obligations by using autonomous code.[90] However, smart contracts are deterministic and follow a strict 'if-then' logic.[91] This means that only precise, defined, and straightforward obligations can be transposed into code in an underlying smart contract and registered on a blockchain.[92] On the contrary, smart contracts are currently unable to sufficiently reflect flexible or sophisticated legal obligations conditioned on multiple factors.[93] Hence, their use appears to be difficult to reconcile with complex patent licenses and assignments, which can hardly be translated into a list of if-then statements. Moreover, there is no room for negotiation as their conditions are fixed once they are deployed on the blockchain.[94] Thus, the idea of acquiring or licensing

81 For more information, see Section 7 'Recommendations for Improving the Transparency of Patent Ownership Changes' in Gorbatyuk and Kovács (n 31) 534–538.

82 Bodó, Gervais and Quintais (n 1) 320–322, 331–335; Gürkaynak and others (n 1) 856–858; Tom Lyons, Ludovic Courcelas and Ken Timsit, 'Legal and Regulatory Framework of Blockchains and Smart Contracts' (EU Blockchain Observatory and Forum 2019) 22–25 <https://www.eublockchainforum.eu/reports/legal-and-regulatory-framework-blockchains-and-smart-contracts> accessed 1 September 2023.

83 Lyons, Courcelas and Timsit, 'Legal and Regulatory Framework of Blockchains and Smart Contracts' (n 82) 33–35.

84 Faustine Fleuret and Tom Lyons, 'Blockchain and the Future of Digital Assets' (EU Blockchain Observatory and Forum 2020) 5-7, 12 <https://www.eublockchainforum.eu/reports/blockchain-and-future-digital-assets> accessed 1 September 2023.

85 Kostopoulos and others (n 6) 4–5, 41–42.

86 Bodó, Gervais and Quintais (n 1) 314–315.

87 On top of that, trading in NFTs comes with its own risks. See Kostopoulos and others (n 6) 41–42.

88 Clark (n 1) 32–33; Gürkaynak and others (n 1) 849, 853, 857–858.

89 Christidis and Devetsikiotis (n 40) 2296–2297.

90 De Filippi and Wright (n 14) 72–88.

91 Christidis and Devetsikiotis (n 40) 2296–2297.

92 Bodó, Gervais and Quintais (n 1) 315–316.

93 De Filippi and Wright (n 14) 199–201; Lyons, Courcelas and Timsit, 'Legal and Regulatory Framework of Blockchains and Smart Contracts' (n 82) 24–25.

94 This means that smart contracts are a 'take it or leave it'

a patent with 'one click' is tempting but, at this point, arguably unrealistic. It is hard to imagine that any lawyer or representative of a legal department would advise their client to accept standard terms inbuilt into a smart contract in the form of code without any attempt nor a possibility to renegotiate. As mentioned above, what could be executed in the form of a 'smart' contract, is the formal validation of new transactions. Finally, hosting smart contracts on a blockchain network has technical consequences which can impact transaction throughput.[95]

49 Fifth, there are also a variety of relevant concerns regarding the scalability, interoperability, and sustainability of blockchain technology.[96] A first remark relating to scalability is the question of which information would/should actually be stored on the blockchain.[97] In our hypothetical example, visualised in Figure 1, we chose to only incorporate the cryptographic hash values in the blocks (which function as a link), whereas the underlying information (e.g., the actual patent file and the related bibliographic information) would be kept 'off-chain' in a regular patent register or a database.[98] In that manner, blocks would only contain the necessary amount of information (i.e., the transaction and a link to the related repository). This would keep the blockchain application more efficient and scalable, as the majority of data would be stored elsewhere. However, even in this scenario such patent blockchain will, in principle, only grow, resulting in an increasing amount of data that needs to be stored by the nodes. Hence, it can be expected that running a node in such a network for a longer time will require significant storage capacity.[99]

50 Subsequently, there is the interoperability aspect of blockchain technology. Due to the young market for blockchain technology and the variety of blockchain (network, application, service) providers, the deployed technology can still vary significantly.[100] This can be detrimental to users (e.g., vendor lock-in or lack of cross-chain communication) and necessitates the establishment of standards and interoperability requirements.[101] Another dimension of this issue is the required interoperability with existing, non-blockchain infrastructure, which may remain in operation or be gradually replaced.[102]

51 Finally, sustainability is another often discussed issue regarding blockchain technology. Indeed, the bitcoin blockchain consumes large amounts of energy due to its reliance on mining in the context of the PoW consensus mechanism.[103] This is different, however, for permissioned blockchains, which reach consensus in a different manner (and do not rely on energy-intensive consensus mechanisms). [104] Nonetheless, sustainability should remain a concern for every technology being developed nowadays.

E. Governance of blockchain-based patent marketplaces: choosing between patent offices or private entities

52 To date, none of the patent offices has attempted to introduce blockchains into their patent registers. However, the European Union Intellectual Property Office (EUIPO) has turned to blockchain to optimise its trademark and design databases. The organisation acknowledges the many benefits this technology could offer for the maintenance of trademark and design data on a global level and is gradually adding national trademark offices to its blockchain

proposition. Gürkaynak and others (n 1) 849.

95 This relates to the difference between a so-called UTXO-model or an account-based model. See Christidis and Devetsikiotis (n 40) 2295–2297.

96 Tom Lyons, Ludovic Courcelas and Ken Timsit, 'Scalability, Interoperability, and Sustainability of Blockchains' (EU Blockchain Observatory and Forum 2019) 5–21 <https://www.eublockchainforum.eu/reports/scalability-interoperability-and-sustainability-blockchains> accessed 1 September 2023.

97 The scalability issue is determined by the so-called *blockchain trilemma* in which the transaction volume and speed have to be weighed against the required level of security and the amount of decentralisation. *In casu*, by using a permissioned blockchain, the level of decentralisation is reduced which allows to preserve scalability and security. Vitalik Buterin, 'Why Sharding Is Great: Demystifying the Technical Properties' (2021) <https://vitalik.ca/general/2021/04/07/sharding.html> accessed 1 September 2023; Lyons, Courcelas and Timsit, 'Scalability, Interoperability, and Sustainability of Blockchains' (n 96) 10–11.

98 Chandratre and Pathak (n 58) 3-4, 6.

99 Gürkaynak and others (n 1) 860.

100 Rauchs and others (n 46) 21–63.

101 Hoyal (n 55) 19; Gürkaynak and others (n 1) 861.

102 Lyons and Courcelas (n 53) 21.

103 European Commission and others (n 40) 33; Lyons, Courcelas and Timsit, 'Scalability, Interoperability, and Sustainability of Blockchains' (n 96) 12–13.

104 European Commission and others (n 40) 33; Lyons, Courcelas and Timsit, 'Scalability, Interoperability, and Sustainability of Blockchains' (n 96) 12–13.

network.[105] Outside of the IP field, blockchain technology has been successfully introduced by public services managing, for instance, land registries.[106]

53 Nonetheless, blockchain-based patent marketplaces (which go beyond the functionality of blockchain-based patent platforms by offering the possibility to transact) are currently being developed by private entities, such as IPwe (introduced in Section D.II.). This dynamic triggers fundamental concerns about the privatisation of patent governance, as private entities allegedly attempt to commercialise partially publicly available patent data and appropriate certain functions of patent registers.

54 The core underlying motivation behind blockchain-based patent marketplaces established by private entities is most often profit-generation. They attempt to offer stakeholders a multifunctional platform that provides a variety of customer-oriented services on commercial terms. Facilitation of patent transactions and their registration is frequently one of the offered services. For instance, IPwe aims to become a go-to place for managing IP portfolios without relying on IP experts, such as patent attorneys, permitting to minimise associated transaction costs. Apart from the possibility to trade patents, the platform also provides its users with AI-generated IP analytics, including analysis of the value of certain IP assets or assessment of IP-related risks.[107]

55 Considering the rise of blockchain-based patent marketplaces, it is essential to review whether patent offices or private entities are in the best position to offer blockchain-based patent trade-related services. In general, powering patent registers by blockchain technology could be justified by public interests inherent in the 'quid-pro-quo' of the patent system. It aspires to further increase 'active' transparency of patent information (the disclosure function)[108] to stimulate the exchange of knowledge and technological progress. However, as explained in Section C, patent offices do not involve themselves in such business-related matters as patent trade, as their core tasks are patent examination and dissemination of patent information. The only patent trade-related obligation they currently impose on patent rightsholders is the registration of licenses and assignments to ensure transparency of rightsholders in patent registers. However, this obligation is regularly neglected due to the rather weak underlying enforcement mechanisms.[109] Even though facilitating patent transactions is not a direct obligation of patent offices, by taking on board this task patent offices, in our view, can significantly simplify patent trade.

56 To facilitate knowledge exchange and decrease associated costs of patent transactions, blockchain-based platforms or marketplaces should ideally contain complete, accessible, up-to-date, and reliable/accurate patent data. As explained in Section D.II., blockchains are particularly suited to efficiently transmit up-to-date data due to their automated and decentralised nature. The accuracy of transmitted data may not always be guaranteed, but certain shortcomings can be mitigated depending on the selected structure, functionality, and governance of the underlying blockchain. Thus, both blockchain-based marketplaces governed by public or private actors can disseminate up-to-date data. Similarly, neither can assure absolute data accuracy. Yet, blockchain-based platforms or marketplaces governed by patent offices have clear advantages over private initiatives with regard to the dissemination of complete and accessible data.

57 By increasing cross-patent register cooperation and stimulating digitisation of patent information (in line with the criteria put forward in

105 For more information, see <https://euipo.europa.eu/ohimportal/en/news/-/action/view/8662923> accessed on 1 September 2023. So far, the network has four participants: the EUIPO, the Maltese Commerce Department, Estonian Patent Office and the Lithuanian State Patent Bureau. See EUIPO, 'Blockchain at the Service of IP Owners and Consumers' (*Alicante News*, 2022) <https://euipo.europa.eu/ohimportal/en/web/guest/-/alicante-news-july-2022-blockchain-at-the-service-of-ip-owners-and-consumers?inheritRedirect=true&redirect=https%3A%2F%2Feuipo.europa.eu%2Fohimportal%2Fen%2Fweb%2Fguest%2Fsearch%3Fp_p_id%3Dcom_liferay_portal_search_web_portlet_SearchPortlet%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26_com_liferay_portal_search_web_portlet_SearchPortlet_keywords%3D9454411> accessed 1 September 2023.

106 Lyons, Courcelas and Timsit, 'Blockchain for Government and Public Services' (n 61) 12, 28.

107 For more information, see <https://ipwe.com/your-secure-gateway-to-efficient-ip-monetization-and-risk-mitigation/> accessed on 1 September 2023.

108 "The principle of transparency is one of the key principles of property law and can be divided into "passive transparency" and "active transparency". Whereas the objective of passive transparency is to ensure that certain information is available and accessible, the objective of active transparency is to ensure that information is not only available but is also complete, accurate, reliable, and useful." Gorbatyuk and Kovács (n 31) 534; Arina Gorbatyuk, 'Rethinking Registration of Intellectual Property: The Issue of (the Lack of) Transparency of Intellectual Property Ownership', *Rethinking IT and IP law* (Intersentia 2019) 237.

109 Gorbatyuk and Kovács (n 31) 527.

Section D.II.), blockchain-based patent platforms (with or without transactional functionality) can offer a complete 'global' patent dataset to their users, as patent offices are responsible for collecting this data in the first place. On the contrary, blockchain-based patent marketplaces established by private entities (e.g., IPwe) only contain patents that patent rightsholders are interested in displaying or offering for trade. They rely on stakeholders' interest to join their commercial platform and utilise the offered services. Thus, in its scope, such marketplaces are currently closer to a 'local store' for a selected group of interested individuals (customers) than a revolutionary global patent marketplace. It is highly unlikely that private entities could develop a dataset equivalent to the one offered by patent registers unless they attempt to privatise publicly available patent information. Even if a relatively large dataset could be assembled, another quest would be to attract a large number of patent rightsholders interested in trading their patents via the offered privately governed blockchain-based marketplace. In this case, patent offices again have an advantage as many digitally advanced patent offices have already adopted digital procedures (e.g., myEPO), involving user-profiles and cybersecurity measures (e.g., passwords and electronic signatures) whose function could be extended to the blockchain network.

58 The accessibility of patent information is one of the core goals of patent disclosure obligations. It offers third parties the possibility to access collected patent information without any barriers and free of charge. Patent offices share this valuable data with third parties through their bulletins, registers, and databases on a nonpecuniary basis. Private entities, establishing patent marketplaces, are not under any legislative obligation to either give access to their dataset to any interested third party (it is also not in line with their commercial interests) or cooperate with patent offices. Thus, if patent rightsholders opt to trade their patents via privately governed blockchain-based marketplaces, there is a risk that the information on patent transactions becomes largely non-transparent. It is important to ensure that patent offices provide an appealing alternative to those private initiatives to ensure that the information on patent transactions is processed by patent offices and is accessible to all interested third parties.

59 It can be concluded that it is in the public interest to incentivise patent offices to consider developing blockchain-based platforms (and possibly marketplaces) or other innovative digital alternatives or enhancements of their existing practices. By doing so, they can prevent legal uncertainty and fragmentation of important patent information (such as up-to-date information on rightsholders), which would be the result when such marketplaces are managed by private entities. Thus, private entities could focus on offering their users patent-related business analytics but should refrain from asserting the role of patent trade intermediaries, as their interference may distort the legislatively established 'quid-pro-quo' balance of the patent system.

F. Concluding remarks

60 Incorporating blockchain technology into patent registers holds the potential to improve the efficiency of patent transactions. As opposed to other authors who argue that 'searchable archives of accepted patents [...] cannot be replaced by blockchain technology'[110], we do believe that blockchain technology could improve and advance the functionality of patent registers. To facilitate patent transactions and decrease related costs, relevant actors should ideally have access to complete, accessible, up-to-date, and accurate patent information, not only vis-à-vis the subject matter of inventions but also rightsholders. By integrating blockchain technology into their patent registers, patent offices can turn their (national or regional) patent registers into global and automatically updated platforms that could come closer to providing this 'ideal' patent data.

61 To illustrate how blockchains could facilitate patent trade, we put forward a (partial) proposal on how such a blockchain-based patent platform can be configured. In particular, patent offices could collectively govern a public permissioned blockchain to exchange and publicly disclose their patent data and related updates. Although this hypothetical blockchain may not be categorised as distributed ledger technology *sensu stricto*, we believe that it provides an insightful framework to start rethinking the current functioning and structure of patent registers.[111]

62 We claim that patent offices are best placed to set up and govern such a blockchain-based patent platform. In close cooperation, they can offer their users complete patent data and provide the technological basis for a 'global' patent market instead of 'local' patent stores currently provided by private entities. We acknowledge that this complete 'global' patent market is a long-term goal as it is conditioned on a high level of digitisation of processes of all patent offices and patent actors involved. In addition, access to a blockchain-based patent platform governed by patent offices is to be granted free of charge to any interested party in conformity with their regulatory

110 Boucher (n 57) 11.

111 Rauchs and others (n 46) 11, 20.

obligation to disseminate patent information and in line with their goals to improve the accessibility and transparency of patent data.[112]

63 Conversely, as private entities are not bound by any legal obligations to give access to their platforms or cooperate with patent offices, the 'privatisation' of blockchain-based patent platforms and marketplaces can further increase fragmentation of patent data, limit its accessibility, and diminish transparency on patent rightsholders. Consequently, patent offices should take charge of this discussion and involve other stakeholders in the patent and blockchain community to uncover possible (digital) alternatives to the existing processes and infrastructure and identify political, legal, economic, and technical challenges hindering the transition from 'reference' patent registers to a global blockchain-based patent platform.

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112 EPO, 'Annual Review 2020' (2021) 50 <https://www.epo.org/about-us/annual-reports-statistics/annual-report/2020/goal4.html> accessed 3 January 2023; Michelle K Lee, 'The Benefits of Transparency Across the Intellectual Property System' (2014) <https://www.uspto.gov/about-us/news-updates/benefits-transparency-across-intellectual-property-system> accessed 4 September 2023.