

Blockchain and smart contracts: the missing link in copyright licensing?

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ABSTRACT

This article offers a normative analysis of key blockchain technology concepts from the perspective of copyright law. Some features of blockchain technologies—scarcity, trust, transparency, decentralized public records and smart contracts—seem to make this technology compatible with the fundamentals of copyright. Authors can publish works on blockchain creating a quasi-immutable record of initial ownership, and encode ‘smart’ contracts to license the use of works. Remuneration may happen on online distribution platforms where the smart contracts reside. In theory, such an automated setup allows for the private ordering of copyright. Blockchain technology, like Digital Rights Management 20 years ago, is thus presented as an opportunity to reduce market friction, and increase both licensing efficiency and the autonomy of creators. Yet, some of the old problems remain. The article examines the differences between new, smart-contract-based private ordering regime and the fundamental components of copyright law, such as exceptions and limitations, the doctrine of exhaustion, restrictions on formalities, the public domain and fair remuneration.

KEYWORDS: Blockchain, copyright, smart contracts, distributed ledger technology (DLT), copyright registries, automated licensing, digital rights management (DRM)

INTRODUCTION

Blockchain is the latest in the series of digital technologies that, due to their decentralized, horizontal, distributed and open source nature, are expected to cause fundamental and large scale changes in how our current social, economic, political

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relations and institutions are organized. Roughly 20 years after the declaration of the independence of cyberspace¹ and the crypto anarchist manifesto,² and 12 years after Yochai Benkler outlined how peer production and web 2.0 would enable a brave new world,³ many now believe blockchain will empower an open, decentralized, disintermediated, smart, trustless and cryptographic mode of social organization.⁴ These hopes are partly based on the relative success of Bitcoin. Bitcoin uses distributed ledger technology (DLT) to keep track of the supply and flow of the virtual tokens of a financial instrument in a decentralized, disintermediated and demonstrably secure manner. It is, in the words of its enigmatic creator(s), 'a peer-to-peer electronic cash system' and an ongoing proof of concept.⁵ Even if Bitcoin fails to establish itself as a stable mainstream currency, its underlying technological design allows individuals to anonymously (or at least pseudonymously) exchange tokens of value with each other in a safe and secure manner, with little or sometimes no reliance on traditional trusted intermediaries, like banks.⁶ The high visibility of blockchain in the cryptocurrency area has prompted widespread exploration of its application to other domains, including copyright.

Second generation DLTs may play a role in the realm of copyright. DLTs use enhanced versions of the Bitcoin technology to store transactions of all kinds of tokens, including domain names, identity records (eg driving licenses), ownership deeds, public records (such as land titles), social welfare payments, bank accounts and transactions of fiat currencies.⁷ Blockchain technologies of this type can also store executable software. The code enables nodes in the network to interact with the data stored on a blockchain and act autonomously if some conditions are met. In essence, such code constitutes what is now commonly referred to as a *smart contract*.⁸

In the copyright domain, different elements may be represented by cryptographic tokens: works, ownership metadata, licensing terms and remuneration. With these characteristics, DLTs appear to provide a decentralized platform to build and maintain registries of works. Relying on the registries of such tokenized elements, smart contracts may automate and standardize a multitude of copyright-related transactions, for instance those authorizing the use and exploitation of copyright-protected content, and remuneration. Indeed, despite the early stages of the application of blockchain technology to copyright goods and services, there is booming deployment of applications in this domain, in particular in the online music sector.

1 JP Barlow, *A Declaration of the Independence of Cyberspace* (8 February 1996) <<https://www.eff.org/cyberspace-independence>> accessed 17 July 2018.

2 TC May, *The Crypto Anarchist Manifesto* (22 November 1992) <<https://www.activism.net/cypherpunk/crypto-anarchy.html>> accessed 17 July 2018.

3 Y Benkler, *The Wealth of Networks: How Social Production Transforms Markets and Freedom* (Yale University Press 2006).

4 D Tapscott and A Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World* (Portfolio 2016).

5 S Nakamoto, 'Bitcoin: A Peer-to-peer Electronic Cash System' (2008) 1 <<https://bitcoin.org/bitcoin.pdf>> accessed 16 July 2018.

6 We do not subscribe to the claim that blockchain technology does not have intermediaries.

7 Tapscott and Tapscott (n 4).

8 P Cuccuru, 'Beyond Bitcoin: An Early Overview on Smart Contracts' (2017) 25(3) *International Journal of Law and Information Technology* 179–95.

This article examines the relationship of blockchain technology with copyright, using international copyright law as a frame of reference for the analysis.⁹ Within this general framework, we pay particular attention to rules that may impact the functioning and development of blockchains. These include legal protections afforded to technological protection measures (TPMs) and Rights Management Information (RMI), jointly referred to as Digital Rights management (DRM).¹⁰ The first refers to technologies that restrict acts that can be performed in respect of a copy of a work (for example by preventing the making of a reproduction thereof). The second relates to electronic information attached to a work, for example on ownership and terms of use. RMI or similar metadata is often maintained by collective management organizations (CMOs), by bodies entrusted with the registration of works (eg the US Copyright Office), or other official/authentic registries. Where justified by our analysis, the article goes beyond international law and enters the comparative domain by reflecting the impact of the two major legal systems with distinct traditions in this space, namely the civil law tradition of authors' rights, for which our flag-bearer will be the European Union (EU), and common law copyright, of which the United States (US) is the main protagonist.

The article proceeds as follows. The Section 'Copyright-relevant characteristics of blockchain technology' identifies the key characteristics of blockchain technologies with relevance to our analysis. The Section 'Blockchain and copyright intersections' examines what we perceive to be key issues at the intersection of blockchain technology and copyright law, at least at the current stage of the technology: the use of blockchains for private ordering; their applications in the context of copyright registries; their interface with the legal protection of DRM; and their potential for fairly remunerating artists. In the Section 'Discussion: between promise and hype' the article offers a discussion on the main normative insights arising from the previous analysis. The last section concludes.

COPYRIGHT-RELEVANT CHARACTERISTICS OF BLOCKCHAIN TECHNOLOGY

Blockchain technology can be defined as a distributed, append only database, which enables—without a central trusted intermediary—transactions between human or software agents.¹¹ In reality, there is no such thing as 'the Blockchain'. Instead, there is a range of different DLTs, which share some fundamental principles, but vary inter

9 The most relevant international treaties in copyright law are the Berne Convention for the Protection of Literary and Artistic Works (1971 Act) [hereinafter 'Berne Convention'], the 1994 Agreement on Trade-Related Aspects of Intellectual Property Rights [hereinafter 'TRIPS'] and, in relation to use over digital networks, the 1996 WIPO Copyright Treaty [hereinafter 'WCT'] and WIPO Performances and Phonograms Treaty [hereinafter 'WPPT'].

10 WCT, *ibid* arts 11–12, and WPPT, *ibid*, arts 18–19.

11 We treat specific technological design and implementation choices as mostly external to our discussion. As such, we only address them where relevant to our analysis. Interested readers can find additional information in: J Bacon and others, 'Blockchain Demystified' (21 December 2017). *Queen Mary School of Law Legal Studies Research Paper No 268/2017* <<https://ssrn.com/abstract=3091218>> accessed 16 July 2018; A Narayanan and others, *Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction* (Princeton University Press 2016); P De Filippi and A Wright, *Blockchain and the Law: The Rule of Code* (Harvard University Press 2018).

alia in their design, purpose and affordances.¹² For the purposes of this overview we focus on some of the common characteristics relevant to the copyright domain: distributed ledgers; tokenization and digital scarcity; smart contracts and decentralization. We explain each one in turn below, as well as the relevance of design choices in the characterization of blockchains.

Distributed ledgers

In its simplest description, a blockchain is a distributed ledger, or an append only database, of which every user has a continuously updated authoritative copy. Anyone who has access to the ledger has access to the same full transaction history and the ability to verify the validity of all records.¹³ Sophisticated consensus mechanisms ensure that new entries can only be added to this distributed database if they are consistent with earlier records. This distributed database has the capacity to record any kinds of data. One can save an arbitrary piece of information on blockchain, which becomes part of the permanent record. Ledgers can also be used to keep track of tokens belonging to specific accounts (or ‘wallets’) and the time-stamped transactions of tokens between accounts. In that case, DLTs can ensure that the transactions are consistent over time, and tokens are not spent twice. Depending on the actual technological design, an account holder can be an (anonymous/pseudonymous) individual, a legal entity, a smart contract (software code), or any group or combination thereof. Tokens, as we show in the next section, can represent almost anything: a unit of virtual currency, an asset, a physical object in the world, or any other abstract entity. Beyond these simple facts, different blockchains may follow different designs principles. As we explain later, this fundamentally impacts their functioning.¹⁴

Distributed ledgers are a general-purpose technology, meaning that they are freely configurable to any and every application. In theory, this makes it relatively easy to correspond the core building blocks of blockchain technology to fundamental concepts in copyright law. Consequentially, multiple DLT configurations are being explored in the copyright domain. For example: if tokens represent rights, and wallet holders represent rights holders, DLTs may host public copyright registries, which record—in a transparent manner—the ownership, distribution, use and remuneration of works.¹⁵ Another example would be a private distributed database set up by CMOs to facilitate the inter-organizational identification of works and payment of royalties.

Tokenization and digital scarcity

The distributed ledgers record the ownership and transactions of digital tokens. Virtually any kind of information may be expressed as a token, using a cryptographic

12 For an overview and taxonomy see: X Xu and others, ‘A Taxonomy of Blockchain-based Systems for Architecture Design’ in *Software Architecture (ICSA)*, 2017 *IEEE International Conference on Software Architecture* (IEEE April 2017), 243–52.

13 On public blockchains access is unlimited, in private ones only approved members can read the transaction history. See Narayanan and others (n 11) (Ch 2).

14 See below at sub-section ‘Design choices: from open to closed’.

15 See below at Section ‘Blockchain and copyright intersections’.

signature. Any such token can be 'stored' on a blockchain or distributed ledger. In the copyright domain, tokens can represent a number of different elements.¹⁶

Firstly, they can represent a copy of a protected work. This representation can be made at the moment of creation (eg a digital camera or a word processor can generate a token at the time the work is expressed) or subsequently, by the rights holder or an authorized third party. Secondly, tokens can represent a record of RMI for protected content.¹⁷ Thirdly, tokens can encode a subset of information mentioned under the definition of RMI, namely the terms of use of protected content,¹⁸ for example the standard licensing terms of Creative Commons (CC) licenses.¹⁹ However, it is also possible to envision terms of use that refer to the particular status of a work, such as whether it is an orphan work or in the public domain.²⁰ Terms of use are often static/general or dynamic/conditional. The first are set once and (supposedly) do not change afterwards.²¹ Conversely, dynamic or conditional or conditional terms of use may evolve over time. This is the case for most RMI, which changes every time a copyright is transferred, or the respective conditions of use change. Finally, tokens can represent remuneration for the use of a work, which can be encoded in so-called cryptocurrencies (eg Bitcoin, Bitcash) or fiat currency equivalents, constituting the counter performance for a transaction on the corresponding (copy of a) work.

Individual tokens are unique. Token transactions on a blockchain are organized in a manner that prevents double spending of tokens. In practice, this means that tokens are the vehicle through which blockchain technology re-introduces scarcity into the digital domain.

Smart contracts

The first generation of DLTs, such as the bitcoin blockchain, offered very few built-in tools to automate transactions. The second generation of DLTs, like the Ethereum network, changed that by adding a Turing complete computer-language²² to the technology. This language enables users to write complex software that interacts with the distributed ledger, and is said to share the same characteristics: self-enforcing, immutable, etc. In these second generation DLTs, smart contracts are

16 See, making reference to some of these elements, H Sheraton and B Clark, 'Blockchain and IP: Crystal Ball-gazing or Real Opportunity?' *PLC Maganize* (October 2017) 39–44.

17 As mentioned earlier DLTs can keep track of any information. In practice this means that RMI can be recorded on a DLT without being tokenized. We explore this option briefly later.

18 WCT (n 9), art 12(2), defining RMI as 'information which identifies the work, the author of the work, the owner of any right in the work, or information about the terms and conditions of use of the work, and any numbers or codes that represent such information, when any of these items of information is attached to a copy of a work or appears in connection with the communication of a work to the public'.

19 See Creative Commons, *About the Licenses* <<https://creativecommons.org/licenses/?lang=en>> accessed 17 July 2018.

20 J Goldenfein and D Hunter, 'Blockchains, Orphan Works, and the Public Domain' (2017) 41(1) *Columbia Journal of Law & the Arts*.

21 An example is a term that identifies a work as being in the public domain.

22 Turing completeness in computer science terms means that any and every computing problem can be solved by using the smart contract computer language.

algorithmic account holders on the blockchain. They are pieces of code that generate transactions if the conditions encoded in them are met. In most cases, smart contracts encode ‘if-then’ conditions, such as: if a user pays *X* amount of cryptocurrency to the smart contract account then the contract grants them access to a digital copy of a work. In a similar vein, a smart contract may help the distribution of revenues: if a copyright work generated *Y* amount of remuneration in its corresponding account, the smart contract can distribute the revenue amongst rights holders according to the RMI token *Z*.

As these simple examples hint at, a substantial amount of transactions in the copyright domain could be modelled after such simple if-then rules. This has led to the expectation that smart contracts may be used to reliably automate a large volume of ‘dumb transactions’,²³ where their self-enforcing and automatic nature can lower transaction costs. One could also imagine that smart contracts may play a role in standardizing licensing terms and conditions for copyright works across uses and different jurisdictions, similar to the way in which CC licenses are deployed at a global scale.

Yet, there remain substantial unresolved issues limiting the applicability of smart contracts. Among others, legal systems lack a consensus on how code as contract fits into the traditional concepts of contract law. Open questions include:²⁴ the identification of the pseudonymous parties that are typical for blockchain-based smart contracts; remedial measures for the breach of smart contracts;²⁵ and how to address and resolve jurisdictional conflicts—a crucial question for a markedly territorial right, like copyright.²⁶ More broadly, it is unclear how dispute resolution takes place. For the foreseeable future, this uncertainty surrounding the legal status of smart contracts is likely to limit the emergence of more complex and robust arrangements in the domain of automated copyright licenses in blockchains. Since the detailed analysis of all these contract law related issues is beyond the scope of this article, in the following we discuss the applicability of smart contracts in the copyright domain, thus proceeding under the optimistic assumption that such issues are resolvable in the long run.

Decentralization and disintermediation

One of the most important claims in this field is that blockchains are ‘trustless’.²⁷ This term is used to describe an environment in which there is no need to route

23 Dumb transactions are easily automatable transactions. They are simple and straightforward enough to be described by simple if-then rules, and don’t require sophisticated fallback infrastructures to operate, such as dispute resolution or real-world enforcement.

24 See K Levy, ‘Book-Smart, Not Street-Smart: Blockchain-Based Smart Contracts and The Social Workings of Law’ *Engaging Science, Technology, and Society*, [S.l.], v 3, 1–15 (February 2017), posing identical or similar questions.

25 The so-called DAO hack is usually used to demonstrate many of the unresolved issues between smart contracts and law. See: M Leising, ‘The Ether Thief’ *Bloomberg Markets* (13 June 2017) <<https://www.bloomberg.com/features/2017-the-ether-thief/>> accessed 16 July 2018.

26 On this point, see the discussion below at sub-section ‘Private ordering’ and the Section ‘Discussion: between promise and hype’.

27 We use the term ‘trustless’ in a very narrow, technical sense, which refers to the expectations on the reliability of an individual technical node in a blockchain network. In a wider context, which also takes into account the social, economic, geographical, political contexts in which blockchain networks operate, and

transactions through central trusted third parties for ‘untrusting’ entities to be able to engage with each other. The rules embedded in the design of the technology are meant to ensure that interacting actors remain honest, at least vis-à-vis on-chain transactions.²⁸

This feature can be traced back to the ‘cryptoanarchists’ who worked on early cryptocurrencies with a view to bypass the authority of the State and central banks to regulate financial transactions.²⁹ That this work has empowered a payment system (Bitcoin), which conducts transactions of value without relying on the involvement of traditional financial intermediaries, has led to arguments that decentralization and disintermediation would be a realistic option in other domains as well.³⁰

In the copyright domain, disintermediation would affect incumbents at every level: (i) publishers and music labels, (ii) CMOs, and (iii) online platforms, including those that host user-uploaded content. Some hope that blockchain applications would be able to remove all middlemen between artist and audience, and thus enable a direct relationship where artists can directly authorize uses, distribute their works and collect remuneration.³¹ For the reasons discussed below, complete disintermediation is unlikely. Still, DLTs have the potential to upset the status quo by shifting the relative (institutional, negotiating, financial or other) powers of incumbents through the introduction of new stakeholders to the domain, and the alteration of the cost/benefit calculus for existing ones.

Design choices: from open to closed

DLTs come in many flavours. The underlying software may be open source or proprietary. Permission may be necessary to open an account, and initiate transactions. Different rules may apply to who (and by which means) is able to participate in the transaction validation consensus mechanisms. The different applications may demand different technological architectures, which will in turn have diverse legal and economic consequences.

Bitcoin, the first mainstream blockchain-based application, as well as a number of subsequent cryptocurrencies, are public blockchains. On public blockchains anyone can be an account holder without the need for third party approval, review or interference. If the blockchain is also unpermissioned, anyone can also participate in the

their key components are embedded in, blockchain applications are rarely trustless. On the contrary, a whole new set of trust concerns arise, such as whether data on blockchain can be trusted to accurately represent the underlying reality in the real world, or whether the changes on- and off-chain can be trusted to remain in synchronicity. More on that later in the text.

28 Narayanan and others (n 11) (Ch 5). NB that smart contracts can only ensure that tokens representing certain goods or services are exchanged, but cannot enforce the exchange of the off-chain assets.

29 Q DuPont, ‘The Politics of Cryptography: Bitcoin and the Ordering Machines’ (2014) 1(4) *Journal of Peer Production* 1–10.

30 See: S Davidson, P De Filippi and J Potts, ‘Disrupting Governance: The New Institutional Economics of Distributed Ledger Technology’ (19 July 2016) <<https://ssrn.com/abstract=2811995>> accessed 16 July 2018.

31 See, eg I Heap, ‘Blockchain Could Help Musicians Make Money Again’ *Harvard Business Review* (5 June 2017); <<https://hbr.org/2017/06/blockchain-could-help-musicians-make-money-again>> and J Porter, ‘For its Next Trick, Blockchain Plans on Making Recorded Music Profitable Again’ *TechRadar* (6 February 2018) <<http://www.techradar.com/news/for-its-next-trick-blockchain-plans-on-making-recorded-music-profitable-again>> accessed 16 July 2018.

verification of these transactions.³² Open blockchains also tend to rely on open source code, which anyone can study, alter, and develop. As a consequence, the technological design choices reflect the values and ideologies of the developer community.³³

On the other end of the spectrum, we find closed, private and permissioned blockchains. These blockchains limit access to the distributed ledger and limit who can participate in the transaction validation process. Such DLTs often use proprietary source code, developed by privately owned organizations, who define their design, use, and application.³⁴

In other words, blockchains can be open, like an open marketplace where anyone can come and trade, or closed, like invitation-only trading rooms. Between the two extremes are a number of applications that differ on the extent of openness.³⁵

These different technological architectures may have radically different consequences in terms of the users and the uses of the system, as well as the organization, susceptibility of regulation, and economics of the practices they facilitate. For example, a public blockchain copyright registry needs to be accessible and open on most if not all of its possible dimensions to enable any creator to register their ownership and to fulfil its informative function vis-à-vis third parties (other rights holders, the public, and administrative or judicial bodies). That is to say, such registry would have to rely on an open unpermissioned blockchain, running on open source software developed and managed by a diverse group of developers and other stakeholders. If the history of peer-to-peer file sharing is prologue for blockchain, it will be challenging for copyright law to adjust its rules to open and decentralized systems.³⁶

On the other extreme, for example, the cross-border accounting of royalties among national CMOs could be implemented on a closed model. The transparency of transactions may be a good reason to make a blockchain readable for anyone. However, transaction verification, token generation, and the writing of data on a blockchain is probably best left closed. Such an arrangement is unlikely to lead to decentralization and disintermediation per se, and may even result in the entrenchment of the status quo, especially as the legality of such an arrangement appears unproblematic.³⁷

In other words, blockchain technology in and by itself does not necessarily entail decentralization, disintermediation, or the removal of trusted intermediaries. In some fields, complete disintermediation may not be practical, possible, or even desirable.³⁸ This is illustrated in the field of online music, where many blockchain platforms

32 Narayanan and others (n 11).

33 W Reijers, F O'Brolcháin and P Haynes, *Governance in Blockchain Technologies & Social Contract Theories* (Ledger 2016) 134–51; H Nissenbaum, 'Values in the Design of Computer Systems' [March 1998] *Computers and Society* 38–39; M Flanagan, D Howe and H Nissenbaum, 'Embodying Values in Technology: Theory and Practice' in J van den Hoven and J Weckert (eds), *Information Technology and Moral Philosophy* (CUP 2008).

34 Xu and others (n 12).

35 *ibid.*

36 R Giblin, *Code Wars: 10 Years of P2P Software Litigation* (Edward Elgar Publishing 2011), W Patry, *Moral Panics and the Copyright Wars* (OUP 2009).

37 A similar point is made by M Finck, 'Blockchain Regulation', Max Planck Institute for Innovation & Competition Research Paper No. 17-13 (2017), 6.

38 We describe a variety of possible new models below at Section 'Blockchain and copyright intersections'.

promise disintermediation of the relationship between artist and audience.³⁹ In reality, however, either the platform in question is assuming the role of intermediary or lacks the necessary resources to make good on its promise. This is because current intermediaries control critical assets for disintermediation, such as the type of comprehensive RMI datasets for musical works and sound recordings held by CMOs.

In a weak blockchain future scenario, where applications of this technology play only a marginal role in the wider copyright ecosystem, solutions relying on it may emerge to enable new intermediaries that serve niche markets, as is already the case for instance in some segments of the Dutch Electronic Dance Music licensing market.⁴⁰ In a scenario where blockchain eventually manages to significantly penetrate mainstream copyright licensing markets, a likely outcome is an active competition/cooperation between new and old middlemen.⁴¹ In the Section 'Blockchain and copyright intersections' we outline a number of ways in which this might happen.

BLOCKCHAIN AND COPYRIGHT INTERSECTIONS

The explosive development of blockchain technology and the surrounding hype have led to the emergence of a number of blockchain applications in the domain of copyright, mainly in the online music sector. The development of market applications has been accompanied by a growing body of scholarship that investigates the implications of blockchain from the perspective of information law and technology, with a focus on regulation, smart contracts and an emerging strand of scholarship on privacy and data protection.⁴² Still, there is relatively little research on the intersection of blockchain and copyright law.⁴³

- 39 See for example the pitch of Potentiam, a startup in the music and blockchain domain: 'The Potentiam platform wants to use the blockchain to encourage artists to connect directly with their fans in an effort to cut out the monumental cost of middlemen such as managers, booking agents, digital service providers, and many more entities that take up to 80% of the revenue generated from the music industry.' S Osea, *Potentiam: Revamping the Music Industry Using Blockchain Technology*, Medium.com, <<https://medium.com/potentiam/potentiam-revamping-the-music-industry-using-blockchain-technology-2fda8f4ccdac>> accessed 17 July 2018.
- 40 *Rightshare* is a Dutch company founded by a former director of a CMO. It proved relatively successful in facilitating blockchain-based licensing of electronic dance music in the Netherlands. See *Rightshare*, <<http://rightshare.com>> accessed 16 July 2018.
- 41 K Yeung, 'Regulation by Blockchain: The Emerging Battle for Supremacy between the Code of Law and Code as Law' *Modern Law Review* (forthcoming). (July 2, 2018). Available at SSRN: <https://ssrn.com/abstract=3206546>
- 42 See, eg De Filippi and Wright (n 11); M Swan, *Blockchain: Blueprint for a New Economy* (O'Reilly 2015); Tapscott and Tapscott (n 4); J Bacon and others (n 11); Yeung, *ibid*; M Raskin, 'The Law and Legality of Smart Contracts' (2017) 1 *Georgetown Law Technology Review* 304; S Hassan and P De Filippi, 'The Expansion of Algorithmic Governance: From Code Is Law to Law Is Code' (2017) *Field Actions Science Reports: The Journal of Field Actions* Special issue 17: Artificial Intelligence and Robotics in the City, Open Edition Journals; Cuccuru (n 8); S Shackelford and S Myers, 'Block-by-Block: Leveraging the Power of Blockchain Technology to Build Trust and Promote Cyber Peace' (2017) 19(1) *Yale Journal of Law and Technology* 335–88. On data protection, see eg S Sater, 'Blockchain and the European Union's General Data Protection Regulation: A Chance to Harmonize International Data Flows' (6 November 2017) <https://ssrn.com/abstract=3080987> accessed 17 July 2018; M Finck, 'Blockchains and Data Protection in the European Union' (30 November 2017), *Max Planck Institute for Innovation & Competition Research Paper No. 18-01* <<http://dx.doi.org/10.2139/ssrn.3080322>> accessed 17 July 2018.
- 43 See eg Tapscott and Tapscott (n 4); M O'Dair and others, *Music On The Blockchain*, Blockchain For Creative Industries Research Cluster Middlesex University, Report No 1 (July 2016) <<https://>

This article has identified four copyright domains where the implementation of blockchain technology is both promising and challenging, giving rise to a host of complex (and often interconnected) legal issues. These are the potential overreach of smart contracts and private ordering, copyright registries, the articulation with the legal regime of DRM, and fair remuneration. Our aim is not to be exhaustive but rather to map out the copyright/blockchain intersection in these domains and flesh out some of its normative implications, which we then discuss at a higher level in the Section ‘Discussion: between promise and hype’ of the article. For the sake of the analysis, we assume that blockchain applications will work as promised in this field, while again recognizing the optimistic nature of this assumption.

Private ordering

Fragmentation

Can the blockchain be used as a licensing tool for ‘international’ copyright rights? Although it is not inaccurate to speak of international copyright law, as contained for example in international treaties, there is no such thing as an international copyright right. The treaties recognize the protection of copyright in multiple jurisdictions, but based on the law of each jurisdiction. If the author creates a literary work in, say, Canada or the Netherlands, that work must be protected under the copyright laws of all other 175 member countries of the Berne Union (that is, countries party to the Berne Convention⁴⁴) according to their domestic laws.⁴⁵ For instance, a very short ‘work’ or a creation with functional characteristics may be protected in one jurisdiction but not in another, on the grounds that it lacks originality. Under the Berne Convention, an author thus gets 176 different national bundles of copyright rights, if one counts the author’s own country.⁴⁶

It gets worse, for each of those copyright rights can be spliced and diced. For example, the author of a literary work may license or transfer to a third party only the right to translate the work in a specific different language or market. In other words, each right (the term ‘right fragment’ has been used to illustrate this ‘fragmentation’ of rights⁴⁷) in the copyright bundle can be owned and exploited separately—as far as the Berne Convention goes—176 times.

www.mdx.ac.uk/_data/assets/pdf_file/0026/230696/Music-On-The-Blockchain.pdf accessed 16 July 2018; J Silver, ‘Blockchain or the Chaingang? Challenges, Opportunities and Hype: The Music Industry and Blockchain Technologies’ (2016) *CREATe Working Paper 2016/05* <<https://www.create.ac.uk/publications/blockchain-or-the-chaingang-challenges-opportunities-and-hype-the-music-industry-and-blockchain-technologies/>> accessed 16 July 2018; Goldenfein and Hunter (n 20); Sheraton and Clark (n 16); A Savelyev, ‘Copyright in the Blockchain Era: Promises and Challenges’ (2018) 34 *Computer Law & Security Review* 550–61.

44 Berne Convention for the Protection of Literary and Artistic Works (September 1886), last revised 1971 [hereinafter ‘Berne Convention’].

45 For the membership of the Berne Convention, see WIPO, ‘WIPO-Administered Treaties, Berne Convention for the Protection of Literary and Artistic Works’ <<http://www.wipo.int/treaties/en/ip/berne/>> accessed 17 July 2018.

46 Sheraton and Clark (n 16).

47 MS Van Houweling, ‘Author Autonomy and Atomism in Copyright Law’ (2010) 96 *Virginia Law Review* 549.

It gets worse still. Each country is free to choose which form of ‘exhaustion’ rule it will apply, as this matter is yet to be settled at international level.⁴⁸ There are three main types of exhaustion: national, regional and international. Under a national exhaustion regime, a copy of a work may only be sold with the consent of the copyright holder in that territory.⁴⁹ National exhaustion means that parallel importing⁵⁰ is not permitted because the rights of the copyright holders are treated as having a wholly independent existence in each national market.⁵¹ A variation on this theme is regional exhaustion, a regime under which a copy put on the market legally in a region can be exploited in the entire region. This is the case within the EU for example, at least with respect to sales of physical copies of copyright works.⁵² The other ‘extreme’ is international exhaustion, a regime under which a copy put on the market legally anywhere in the world can be sold in a country, such as the US, that opts for this regime. There are a number of grey areas that need not be belaboured here.⁵³

Then, due to the no-formalities rule, no mandatory registration can be applied at least to foreign authors in any of the 176 countries.⁵⁴

The common law notion of ‘title’ is useful to understand this idea. ‘Title’ is the term used at common law to refer to the legal link between a person who owns property and the property itself.⁵⁵ An ‘international copyright’ (under the Berne Convention) is in reality 176 national bundles of rights each of which can vary in scope and duration. Each right fragment, in each territory, has its own title—that is,

48 See: TRIPS (n 9), art 6 (‘For the purposes of dispute settlement under this Agreement, subject to the provisions of Articles 3 and 4 nothing in this Agreement shall be used to address the issue of the exhaustion of intellectual property rights.’); WCT (n 9), art 6(2).

49 And, one might add, the right holder having the right concerned. For example, a CMO to which only the right of public performance in a musical work had been transferred could not license the making and selling of copies of the work.

50 The notion of parallel importing is not limited to physical products. Electronic transmissions of copyright works and even services that can involve intellectual property, for example, can be parallel imported. By way of example, on 3 April 2014, the United States (US) International Trade Commission (ITC) issued a Summary Notice of Determination affirming an administrative law judge’s conclusion that electronically transmitted information could constitute an ‘article’, thereby asserting ITC jurisdiction over electronic transmissions across borders. See *In the Matter of Certain Digital Models, Digital Data, and Treatment Plans for Use in Making Incremental Dental Positioning Adjustment Appliances, the Appliances Made Therefrom, and Methods of Making the Same*, Inv No 337-TA-833 (10 April 2014) (pending). Under s 337 (19 USC § 1337, *as amended*). See also S Frankel and D Gervais, ‘International Intellectual Property Rules and Parallel Importing’ in I Calboli and E Lee (eds), *Research Handbook on Exhaustion and Parallel Imports* (Edward Elgar 2016) 85–105.

51 Frankel and Gervais, *ibid*.

52 See art 4(2) Directive 2001/29/EC of the European Parliament and of the Council of 22 May 2001 on the Harmonization of Certain Aspects of Copyright and Related Rights in the Information Society, 2001 OJ (L 167) 10–19.

53 For example, there are conflicting views on whether a copy put on the market in a country under a compulsory license may be exported to a country using international exhaustion. See Frankel and Gervais (n 50).

54 A country can decide not to apply Berne Convention protection to its own nationals, as the Convention (assuming the Convention does not form part of national law according to the national legal order of the country in question). This is the case in the United States where US authors are subject to a higher level of obligations (in terms of copyright registration) than foreign authors. See US Copyright Office, *Compendium of U.S. Copyright Office Practices* § 101 (3rd edn 2017) at para 2002.2.

55 Black’s, 8th edn at 1522, WEST GROUP.

each can theoretically have a different owner. If one were to posit that there are on average 10 right fragments per territory for each copyright work, that would mean 1 760 rights fragments and thus 1 760 'titles'. Each such title can be exploited and transferred independently of all others—it being understood that certain uses of works may require more than one right fragment.⁵⁶

The owner of the title to a right fragment may transfer the title, but h/she may decide only to permit its use by a third party under a license. A license may be exclusive or nonexclusive. An example of the former would be when the owner of the right of adaptation in a novel (literary work) authorizes a specific film producer to make a film based on the book. An example of the latter would be when the film producer who then makes the movie and becomes the owner of the copyright of the film authorizes 100 film theatres to show the film at the same time.

The transfer of a copyright title often requires a written instrument. Whether courts interpret smart contracts (or laws are amended to that effect) as constituting a 'written instrument' is a matter we do not cover here, as this will impact many other types of transaction that require written form.⁵⁷ Still, to the extent the consequence attached to a blockchain based transaction is technologically enabled or determined, it will occur *de facto*, even if the desired or corresponding legal effects of the transaction do not occur *de iure*. That is to say: the person giving a token representing a copyright claim away may intend to transfer ownership of the work but the applicable law may impose requirements for the transfer to be valid or effective that are not met by the token transaction.

Licensing coordination

Using blockchain technology for copyright licensing requires a massive amount of coordination both on-chain, and between on- and off-chain transactions. While coordination of strictly on-chain uses and users can be to an extent automated via smart contracts, we argue that conflict resolution may require off-chain institutions. This challenge is by orders of magnitude more complex when it comes to making sure that the reality as represented on a blockchain and the reality as represented through non-blockchain contracts and traditional institutions remains synchronous.

To empower the development of blockchain-based smart contracts, the simplest solution would be that authors retain all their copyright rights. Each author could then allow some uses under exclusive licenses if and when appropriate, and then use blockchain technology to license mass uses on a non-exclusive basis. Because each author would retain, in our hypothetical, all 1 760 titles to each of their works, the smart contracts authorizing their use would be *prima facie* valid in each and every territory.

That does not prevent all potential conflicts, however. A non-exclusive licensee's right to use might conflict with the rights of an exclusive licensee in a given territory—even if both were done through a blockchain. This may then become a matter of contract rather than copyright law (and possible infringement) between the

56 For example, a broadcaster who wishes to make a permanent copy of a musical work on her server and then broadcast it may need both the reproduction right and the right of communication to the public.

57 For a discussion on smart contracts as legal contracts, see De Filippi and Wright (n 11) 72–88.

author and the exclusive licensee. Few, if any, courts would be likely to find the non-exclusive licensee liable in such a scenario and if they did, sanctions would probably be minimal.⁵⁸

Authors could do this by being in direct contact with users. As alluded to in the opening paragraphs, however, it is not clear that this is desirable. Indeed, for mass uses, this seems *undesirable*, if only as a matter of transaction costs. However, the way in which licensing may eventually be fully automated using smart contracts makes this statement subject to caution.

If individual authors were to transfer some but not all of the titles to a work to a third party, for instance a CMO, conflicts could emerge either within a given territory (because licensed uses and licensee rights would overlap) or among territories (because licensed uses and licensee rights would have a cross border dimension). Thus, the need for some form of coordination emerges. This is true as noted above even where an author owns all titles because she may lack the ability to coordinate international exploitation of the work in multiple formats and markets. It is not yet clear how and indeed whether platforms developed using blockchain technology can address this issue.

Authors could work with existing intermediaries with broad licensing expertise, such as CMOs. But even then, making the system work globally presupposes some form of coordination (perhaps technologically automated) among CMOs. To effectuate this type of coordination, one CMO could own all the titles (or at the very least all titles for a certain form of exploitation) to a work, increasing its ability to ensure the orderly licensing of the work worldwide, which might trigger competition law concerns. This coordination role could also be played by other types of entities, for example an author's cooperative.

Furthermore, if a smart contract restricted a use in a way that conflicted with exceptions or limitations in the user's territory, a court could impose an appropriate remedy, such as allowing circumvention of DRM or the reduction of any payment due.

Finally, if an author retained all the titles to a work worldwide, conflicts could emerge between smart contracts and 'normal' or traditional licenses. A *desynchronization* of a blockchain can happen if off-chain transactions are not properly recorded on a digital ledger. Hence, rather than reducing information uncertainty and increasing trust, the introduction of a blockchain-based system may have the opposite effect. Does this require yet another layer of coordination? Not necessarily. Conflicts can be avoided either by foregoing entirely non-blockchain licenses or, more realistically, by ensuring that the same coordinating entity has responsibility for both. Even assuming automated coordination will one day be possible for uses licensed through smart contracts—a possibility yet to be demonstrated on any credible scale—, avoiding this type of conflict with non-blockchain licenses cannot be achieved by automated means.⁵⁹ It will require human coordination and access to all pertinent information. Ensuring that rights are pooled may make this task easier.

58 The user would have recourse against the licensor (author).

59 In the literature so called Oracles are proposed to provide authoritative information for on-chain actors on the off-chain state of the world. Much less information is available on how the reverse flow of

Registries

Formalities

By ‘copyright registries’ we mean the range of DLT applications that create a registration of information regarding works. As noted above, such information can refer to a protected work (eg initial ownership, moment of creation/expression), RMI, terms of use (eg orphan status of a work) or any other related element.

Registries can be voluntary or mandatory. A real world attempt at creating a voluntary registry is the joint project between a group of different CMOs: Société des auteurs, compositeurs et éditeurs de musique (SACEM), American Society of Composers, Authors and Publishers (ASCAP) and PRS for music.⁶⁰ This project aims to develop a proof of concept on the use of blockchain to improve data accuracy for rights holders. The objective is to create a prototype for a shared system that manages authoritative music copyright information. The system would consist of a decentralized database of metadata on musical works ‘with real-time update and tracking capabilities’. It would manage the links between two existing music recordings standard codes.⁶¹ The idea of a reliable central database on music ownership and use has long been a purported goal of the music industry, one with which it has failed to achieve.⁶²

DLT based registries can also be passive or active. In passive form DLTs are used to record RMI information as a time-stamped entry into a public ledger that anyone can consult. Given that such information is only useful if it is authoritative, RMI is most likely to be maintained by trusted intermediaries (such as CMOs). In such a scenario DLT is one, but certainly not the only, or even the most effective way to publish and maintain an authoritative public record of RMI. In the active DLT based registry scenario rights are tokenized, rights holders are account holders, so DLTs not just record, but facilitate the transactions of rights.

Assuming applications of this type are scalable and reach a critical mass, one could envision a world where the exploitation of works (at least of a certain type, such as sound recordings) in the digital realm is dependent on registration in a digital ledger. Copyright works within this blockchain-based system could be easily licensed, their use tracked (and the corresponding remuneration paid), and of course enforced if that function can be performed by the accompanying smart contract. Works outside

information is organized, and the types of actors, who could make sure that on-chain transactions’ potential off-chain consequences are executed and enforced. While current intermediaries in the copyright domain are best positioned to fulfil the dual roles of Oracles and Enforcers as Coordinators, they are the most threatened by the disintermediation effect of the technology.

- 60 SACEM, ASCAP, SACEM, AND PRS FOR MUSIC initiate joint Blockchain Project to improve data accuracy for rightsholders <<https://societe.sacem.fr/en/press-resources/per-publication/press-releases/ascap-sacem-and-prs-for-music-initiate-joint-blockchain-project-to-improve-data-accuracy-for-rightsholders>> accessed 17 July 2018. SACEM is the French Society of Authors, Composers and Publishers of Music. ASCAP is the American Society of Composers, Authors and Publishers. PRS for music is the UK Performing Right Society.
- 61 Namely, the International Standard Recording Code (ISRC) and the International Standard Work Code (ISWC). See ISRC, *The International Standard Recording Code* <<http://isrc.ifpi.org/en/>> accessed 17 July 2018; and ISWC International Agency, ‘Home’ <<http://www.iswc.org/>> accessed 17 July 2018.
- 62 See: K Milosic, ‘GRD’s Failure’ Berklee College of Music Music Business Journal (August 2015) <<http://www.thembj.org/2015/08/grds-failure/>> accessed 17 July 2018; Goldenfein and Hunter (n 20) 12.

the system would have a hard time securing this level of protection, providing the necessary (if in itself inadequate) incentive to register. While not imposed by law, registration on such a ledger would become de facto an essential prerequisite to exploitation. The main legal issue that arises in this context is whether such a registry would constitute a prohibited formality under international law.

Article 5(2) of the Berne Convention prohibits formalities that affect the ‘enjoyment’ or ‘exercise’ of protected rights in relation to non-domestic works.⁶³ There are different types of formality, including registration, recordal of transfers of ownership, notice requirements, and deposit.⁶⁴ The enjoyment of rights relates to author’s rights coming into existence and being recognized absent any formality. In essence, the prohibition rules out constitutive and maintenance formalities in respect of works of non-domestic origin, as well as those that function as ‘conditions to sue for infringement’.⁶⁵ Conversely, certain declaratory formalities are allowed.⁶⁶

Voluntary registration of works in a blockchain-based system could be viewed as a variant of ‘new-style formalities’. These are ‘legal tools that establish a link between works, their creators, and/or the current copyright owners’, including ‘metadata-tagging of digital works, the storage of rights management information in digital repositories’, and other digital tools.⁶⁷ In our view, it is difficult to argue that a blockchain-based voluntary registry contravenes the Berne Convention. In practice, an author’s only way to exploit a particular right fragment is often to join a CMO, as in the case of licensing broadcasting of music. That is not a prohibited formality under the Berne Convention. Nor is, for example, the need to comply with a court’s rule of procedure or evidence in a particular country. Only copyright-specific, government imposed formalities are prohibited. Put differently, a de facto ‘obligation’ to join a system meant to enable the collective or individual exercise of rights of copyright is not a prohibited ‘formality’ under Berne.⁶⁸

Orphan works and the public domain

An orphan work may be defined as one where none of the right holders is identified or, even if one or more of them is identified, none is locatable despite a diligent search.⁶⁹ Goldenfein and Hunter have proposed using ‘a blockchain to register attempts to find the authors of orphan works, and otherwise facilitate use of the

63 NB the prohibition is not absolute. See D Gervais, ‘Collective Management of Copyright: Theory and Practice in the Digital Age’ in D Gervais (ed), *Collective Management of Copyright and Related Rights* (3rd edn, Kluwer Law International 2016) 3, 30.

64 S van Gompel, *Formalities in Copyright Law: An Analysis of Their History, Rationales and Possible Future* (Kluwer Law International 2011) 15–27.

65 S van Gompel, ‘Copyright Formalities in the Internet Age: Filters of Protection or Facilitators of Licensing’ (2013) 3 *Berkeley Technology Law Journal* 1439.

66 These include for example formalities that present only evidentiary or procedural advantages, operating as incentives rather than obligations. See van Gompel, *ibid* 1439.

67 *ibid* 1435. See also C Sprigman, ‘Berne’s Vanishing Ban on Formalities’ (2013) 28 *Berkeley Technology Law Journal* 1565–82, mentioning new-style formalities.

68 For an overview of different models of collective rights management, see: Gervais (n 63); JP Quintais, *Copyright in the Age of Online Access: Alternative Compensation Systems in EU Law* (Kluwer Law International 2017) 85–138.

69 Art 2 Directive 2012/28/EU of the European Parliament and of the Council of 25 October 2012 on certain permitted uses of orphan works OJ L 299, 27.10.2012, pp 5–12 [hereinafter ‘Orphan Works Directive’].

works'.⁷⁰ In their proposal, an artificial intelligence system would carry out the diligent search for copyright owners of an orphan work. A blockchain would then be developed and implemented to record all diligent searches.⁷¹ Finally, the law would be amended so as to qualify the work as an orphan and allow its use upon satisfaction of the diligent search requirement.⁷² The use of blockchain technology in their proposal is aimed at overcoming the problems posed by the diligent search requirement.

EU law contains a representative example of this requirement, generally deemed compliant with international copyright law.⁷³ It functions as follows. First, only certain EU cultural institutions can benefit from the orphan works regime.⁷⁴ To establish the orphan status of the work (or phonogram), these institutions must carry out a prior diligent search for each work, done by 'consulting the appropriate sources for the category of works and other protected subject-matter in question'.⁷⁵ Such appropriateness is determined by each member state in consultation with rights holders and users, and the list of sources must include at least those identified in the annex to the directive.⁷⁶ In general, the search must be carried out in the member state of first publication.⁷⁷ The beneficiary institutions must 'maintain records of their diligent searches' and provide a set of related information to competent national authorities.⁷⁸ Finally, member states must implement a centralised database for that information managed by the European Union Intellectual Property Office (EUIPO).⁷⁹ If a work qualifies as an orphan, the beneficiary institutions are granted an exception for certain non-commercial uses linked to their 'public-interest missions', and tied to a fair compensation right.⁸⁰

In practice, the 'diligent search' requirement is cumbersome, and has resulted in a low rate of rights clearance by cultural institutions.⁸¹ To address this issue, Goldenfein and Hunter propose a blockchain platform 'that collects and records every time a search for the owner of a work is completed'. The functions of the platform may vary depending on the underlying legal scheme of the system. Where, like in the EU, that scheme relies on a copyright exception, a blockchain-based registry

70 Goldenfein and Hunter (n 20) 1–3.

71 *ibid* 3–4.

72 *ibid*; The authors identify different *ex ante* and *ex post* legal schemes that may have this effect: exceptions or limitations (the EU approach), limitations on liability, statutory licensing, or extended or voluntary collective licensing.

73 *ibid* 4. See art 3 of the Orphan Works Directive.

74 Publicly accessible libraries, educational establishments and museums, archives, film or audio heritage institutions and public-service broadcasting organisations. Orphan Works Directive (n 69) art 1(1).

75 *ibid* art 3(1).

76 *ibid* art 3(2).

77 *ibid* art 3(3), with further specificities in this respect. In addition, if evidence exists to suggest relevant information on ownership to be available in other countries, sources in those countries must be consulted. *ibid* art 3(4).

78 *ibid* art 3(5).

79 *ibid* art 3(6). See EUIPO, 'Orphan Works Database' <<https://euipo.europa.eu/ohimportal/nl/web/observatory/orphan-works-database>> accessed 17 July 2018.

80 Orphan Works Directive (n 69), art 6. If an author puts an end to the orphan status of the work she may receive compensation for the use of that work made by the beneficiary institution.

81 S Schroff, M Favale and A Bertoni, 'The Impossible Quest – Problems with Diligent Search for Orphan Works' (2017) 48(3) *International Review of Intellectual Property and Competition Law* 286.

would, in combination with an automated search system, function as a database to ‘publicize that a certain work could be used under the copyright exception and provide a record of the search for owners’.⁸²

Assuming the feasibility of the automated diligent search software, the use of the proposed blockchain registry in an exception-based system could be possible without legislative changes. Under the Orphan Works Directive, it would be sufficient for a member state, in cooperation with the EUIPO, to define a certain blockchain-based platform as an appropriate source for carrying out a diligent search, in combination with the list of sources in the annex to the directive. This platform could come to contain all information on works included in those sources.

The exact design choice—open versus closed—for the platform is a matter for debate. On the one hand, the limited range of beneficiaries in an exception-based orphan works regime, the general interest nature of the registry, and the lack of clear incentive structure for private parties, all argue for implementing a closed blockchain.⁸³ On the other hand, the network effects of crowdsourcing in building such a digital ledger, particularly helpful for rights clearance,⁸⁴ together with the ‘social useful function’ of a public registry suggest the adoption of an open blockchain.⁸⁵ From an international copyright law perspective, there seem to be no hurdles to implementing this proposal.⁸⁶

In theory, such a system could go one step further: a combination of smart contracts with a blockchain registry could enable the automatic licensing of these works. Such a system could encompass other licensed works (say, under CC), out-of-commerce works, or even those that are in the public domain. It could even ‘automate attribution mechanisms’ so as to enable the ‘irreversible’ dedication of a work to the public domain.⁸⁷ A system of dedication to the public domain based on a blockchain registry would have the required signalling function worldwide but its legal effect is unclear in each of the territories. A number of countries recognize the principle, as is arguably the case in US law.⁸⁸ But legal questions remain to be explored, including whether the dedication can be taken back and, in the affirmative, what are the rights of third parties who relied on the public domain status,⁸⁹ and

82 Goldenfein and Hunter (n 20) 39, noting that in a system of compulsory licensing, the blockchain could in addition ‘support payment and escrow of a license fee’.

83 *ibid* 10–11, raising these points when discussing the governance of blockchains in general.

84 See: K Erickson, ‘How Crowdsourcing Might Solve the Astronomical Challenge of Copyright Clearance’ *CREATe Blog* (8 January 2016) <<http://www.create.ac.uk/blog/2016/01/08/how-crowdsourcing-might-solve-the-astronomical-challenge-of-copyright-clearance/>> accessed 17 July 2018; M Borghi, K Erickson and M Favale, ‘With Enough Eyeballs All Searches Are Diligent: Mobilizing the Crowd in Copyright Clearance for Mass Digitization’ (2016) 16(1) *Chicago-Kent Journal of Intellectual Property* 135–66.

85 Goldenfein and Hunter (n 20) 42.

86 *ibid* 28–30.

87 *ibid* 23–24. On the latter point, see D Gervais and D Renaud, ‘The Future of United States Copyright Formalities: Why We Should Prioritize Recordation, and How to Do It’ (2013) 28 *Berkeley Technology Law Journal* 13–40.

88 See *Singer Mfg Co v June Mfg Co*, 163 US 169, 186 (1896); and, in the specific context of copyright, *Micro Star v Formgen Inc*, 154 F.3d 1107, 1114 (9th Cir 1998) (‘It is well settled that rights gained under the Copyright Act may be abandoned.’).

89 This is reminiscent of the debate in both *Eldred v Ashcroft*, 537 US 186 (2003) and *Golan v Holder*, 132 S.Ct 873 (2012). See D Gervais, ‘Golan v. Holder, A Look at the Constraints Imposed by the Berne Convention’ (2011) 64 *Vanderbilt Law Review en banc* 147–63.

what if anything can be done with moral rights, especially in jurisdictions—many of which European—where such rights are unwaivable.

Rights management information

The World Intellectual Property Organization (WIPO) Treaties impose obligations to provide adequate legal protection and effective legal remedies against: (i) the circumvention of effective TPMs used by authors, performers or phonogram producers in connection with the exercise of their rights and that restrict acts not authorized by rights holders or permitted by law; and (ii) the removal or alteration of RMI, as well as a number of unauthorized uses of works, phonograms or performances with knowledge that RMI on them has been removed or altered.⁹⁰ The effects of these provisions have been far ranging. To illustrate, the WIPO Copyright Treaty (WCT) has 96 members, including most of the developed economies. Every member's national law now provides for this additional layer of 'paracopyright' protection.⁹¹

In this article we do not discuss in any detail the TPM aspects of blockchain applications, as we do not foresee their widespread use. For that to occur would require that these measures be embedded in a sufficient amount of end-user devices so as to make them useful for the prevention and enforcement of copyright infringement. As long as cheaper and less complicated alternatives, such as simple peer-to-peer file sharing protocols remain widely accessible, there is little reason to expect blockchain applications to address enforcement in a meaningful way. Our focus is instead on the RMI aspects of blockchain applications.

Blockchain-based systems make it easier for various players to cooperate. This is the case, for example, of numerous stakeholders in the music industry that may each own a 'piece' of music, including songwriters, performers, publishers and record companies. As a matter of political economy, ownership or at least control of the data is often perceived as a source of power, an aspect that disincentivises the 'sharing' of data openly. Absent the cooperation of major RMI holders, a database of such information could be built through crowdsourcing.⁹²

One major problem in that regard is the possibility of conflicting claims on the same work. Blockchain technology may be excellent at safeguarding the validity and provenance of information already in the distributed ledger, but cannot in any meaningful sense check the validity of the information when it is first put into the system. Any blockchain-based solution must ensure that only truthful, valid, verified information gets into the ledger, and that there are appropriate dispute-settlement instruments to handle conflicting claims. Blockchain-based transparency may diminish the

90 WCT (n 9), arts 11–12, and WPPT (n 9), arts 18–19.

91 The term 'paracopyright' is taken from Peter Jaszi, 'Intellectual Property Legislative Update: Copyright, Paracopyright, and Pseudo-Copyright', talk delivered at the Association of Research Libraries Conference, Eugene (May 1998) <<http://old.arl.org/resources/pubs/mmproceedings/132mmjaszi~print.shtml>> accessed 16 July 2018.

92 There are only a few at least partly successful efforts to crowd-source the creation of RMI (like) datasets. Open Library is an open database for bibliographic metadata. Discogs, freeDB and MusicBrainz are open source datasets of varying quality of sound recording metadata. Despite the relative success of some of these efforts, there aren't any open, crowdsourced RMI datasets that could provide up-to-date, reliable information on the identity of all the rights holders associated with a copyrighted work in any domain, or territory.

need to have a third party determine ownership, but it does not eliminate the need for other functions provided by such third parties. That said, a shift is likely to occur once (and if) a significant amount of data is entrusted to one or several blockchains. As this pool of open data grows, proprietary control of rights data becomes proportionally less attractive and the incentive to cooperate increases.

Fair remuneration

In the context of ensuring creator remuneration, blockchain technology can play three types of role. Firstly, it can enable payments similar to those already taking place through existing platforms. Secondly, it may open up uses currently licensed through statutory or compulsory licenses and collective rights management schemes to smart contract licensing. Thirdly, blockchains may provide greater transparency, especially from the perspective of authors and performers.

An example of the first role might be ‘a blockchain-empowered rights and payments’ system⁹³ used by an artist or even a CMO, especially for a one-off license to perform or use musical works and recordings. In our view, if the system merely adds a mode of payment, then its impact will be minor. Whether cryptocurrencies will be commonly used to conduct micropayments by a substantial number of users for a substantial number of uses, is orthogonal to our analysis. Even if they do, the existence of an additional payment channel for normal uses of works does not raise fundamental challenges to the status quo in copyright law. It may affect which CMO collects what, which in turn raises issues of the role of CMO in national economies.⁹⁴ There would have to be measurable transparency benefits for a new blockchain-based system to make a notable difference in this scenario.

An example of the second type of role would be a full switch to a rights and royalties management system based on blockchain technology, as EY and Microsoft have proposed in a joint project.⁹⁵ The claim is that blockchains may negate the original conditions that historically led to the development of compulsory licensing and, as a result, may render this legal instrument obsolete in general, or as regards its application to particular cases. Compulsory licenses developed for a number of different reasons, such as refusal to deal, inadequate supply, public interest, or because of transactions costs in the analogue era prohibited the exact monitoring of mass use, and therefore individual licensing.⁹⁶ In the context of blockchain technologies, this

93 Heap (n 31). UJOMusic, a blockchain platform has been offering a few music albums, Including Imogen Heap’s Tiny Human for sale for the Ethereum cryptocurrency. See: <www.ujomusic.com> accessed 17 July 2018. The results so far are somewhat disappointing. See: D Gerard, ‘Ujo Attempts Music On The Blockchain A Second Time With: EGO By RAC [Op-Ed]’ (*Hypebot.com*, 2017) <<http://www.hypebot.com/hypebot/2017/11/ujo-attempts-music-on-the-blockchain-a-second-time-with-ego-by-rac.html>> accessed 17 July 2018.

94 See D Gervais, ‘The Cultural Role of Copyright Collectives’ (2018) 40(6) *European Intellectual Property Review* 349–56.

95 EY and Microsoft launch blockchain solution for content rights and royalties management for media and entertainment industry, 20 June 2018, <<https://www.prnewswire.com/news-releases/ey-and-microsoft-launch-blockchain-solution-for-content-rights-and-royalties-management-for-media-and-entertainment-industry-300669800.html>> accessed 17 July 2018.

96 See: C Correa, ‘Intellectual Property Rights and the Use of Compulsory Licenses: Options for Developing Countries’ (Geneva: South Centre 1999); DJ Brennan, ‘The First Compulsory Licensing of Patents and Copyright’ (2017) *Legal History* 1–45.

last reason—rooted in transaction costs—appears to be most relevant.⁹⁷ It is too early to tell whether blockchain-based rights management systems will simply operate within extant compulsory licensing schemes⁹⁸ or whether they will question the need for such licenses. Market forces and evolving practices should indicate the trajectory that use of blockchain technology will take in this space.

As economists have pointed out, where works have a relatively small value, but have a relatively large number of users and right holders, prohibitively high transaction costs prevent efficient licensing. Transaction costs include identifying and matching rights holders and users, the high costs of monitoring use, the costs of enforcement, and the complexities of setting the price and negotiating the terms of use.⁹⁹ Collective management has been successful because it offers substantial economies of scale, making collectively managed licenses preferable to individual licensing.

In that context, two of the aforementioned DLT functions may lower the costs of transactions to a level at which individual licensing may become the most efficient model. Firstly, DLTs have the theoretical capacity to ‘solve’ the problem of a comprehensive RMI registry. The costs of identifying the rights holders of a work make up a substantial chunk of transactions costs. CMOs, as well as an increasing number of online platforms, currently exercise exclusive control over RMI datasets. Should an RMI registry be publicly available, direct licensing would theoretically be a more accessible option.

Secondly, smart contracts may automate such direct licensing, further lowering transaction costs. Collective rights management schemes rely on blanket licensing of repertoires. For reasons of fair distribution, however, CMOs generate, collect and process considerable amounts of information on the uses of licensed works. Digital content intermediaries have first-hand information on usage, while digital fingerprinting technologies offer high-resolution insight into the online use of works at a reasonable cost to a wide group of stakeholders, including CMOs.

The better availability of both RMI and usage information have already transformed licensing, allowing major rights holders, including a number of music publishers, to bypass CMOs and enter into direct deals with major digital service providers. The same data may also be used in smart contract-based licensing solutions that further lower the number of intermediaries between the rights holders and their audience.¹⁰⁰

Smart contract-based automated licensing also has the potential of creating global licensing standards. CC licenses are an early example of a globally standardized hybrid copyright licensing, combining legal and software code. Their success demonstrates the potential impact of machine-readable standardized solutions.¹⁰¹

97 See J Ginsburg, ‘Fair Use for Free, or Permitted-but-Paid?’ (2015) 29(3) Berkeley Technology Law Journal 1383–446.

98 Such as the compulsory license for mechanical reproduction of musical works contained in s 115 of the US Copyright Act.

99 See: S Besen and SN Kirby, *Compensating Creators of Intellectual Property – Collectives That Collect* (The RAND Corporation 1989); C Handke and R Towse, ‘Economics of Copyright Collecting Societies’ (2007) 38(8) International Review of Intellectual Property and Competition Law 937–57.

100 See B Rosenblatt, ‘Watermarking Technology and Blockchains in the Music Industry’ (2017) *Digimarc*.

101 See the Creative Commons Metrics page for an (unfortunately outdated) set of statistics on license adoption: <<https://wiki.creativecommons.org/wiki/Metrics>> accessed 17 July 2018.

DLT-based smart contracting has the potential to aid similar standardization for commercial licenses.

It remains to be seen to what extent DLTs that now transcend national and jurisdictional borders remain a low-friction infrastructure for cross-border transactions. But at least in theory, a standardized, smart contract based licensing approach that runs on a global distributed ledger network seems to be an ideal fit for the online usage logics which show little respect of, or interest in the nationally issued statutory and compulsory licenses.¹⁰² In any case, a standardized, planetary scale, self-enforcing smart contract-based licensing infrastructure may substantially change the economic calculus in this field, making collective rights management and compulsory licensing comparatively costlier. However, this potential future scenario is still far in the horizon.

Thirdly, blockchain-based licensing may meet one of the key demands of important creator groups in the online environment, namely transparency in financial flows.¹⁰³ Secret deals between the three music majors ('labels') and online platforms, like Spotify, have left music creators vying for a spot at the table. Monies paid to labels in some cases as stock shares, options or in other forms have not been shared with creators but the extent to which this may be unfair is hard to judge without the data (and perhaps that is the point). In other words, a more open environment might not by itself reorient financial flows but it would likely shed light on a situation that many see as both unfair and unsustainable.¹⁰⁴ Here again, blockchain may shed crucial light on an area where it is sorely needed. Whether that potential is put to good use remains to be seen.

DISCUSSION: BETWEEN PROMISE AND HYPE

In 2017, when we launched the debate that led to this article,¹⁰⁵ we asked how blockchain and copyright interact. The initial discussion concluded that, at best, blockchain was an opportunity for incremental improvement of efficiency and transparency of online music licensing and rights management, while offering artists an additional avenue for direct licensing. At worst, blockchain was a seriously overhyped fad with none of the predicted revolutionary potential. A more measured, theoretical, normative analysis, as the one we try to provide in this article, reveals both promises for improving copyright based practices, and frictions between the design of the technology and the legal architecture. In this part, we hope to set the level of expectations to a somewhat realistic level. To better understand the possible role of blockchain technology, a quick look back at the purpose of copyright seems useful.

Copyright emerged in the UK in the Statute of Anne (1709–1710) as a means of creating scarcity (mostly of physical copies) of books, sheet music and other works

102 For our purposes these two terms can be seen as synonyms. See Quintais (n 68) 25–27, 126–32, with a conceptual analysis of the terms.

103 E Schwartz, 'Coda: Fair Trade Music: Letting the Light Shine in' in S Frankel and D Gervais (eds), *The Evolution and Equilibrium of Copyright in the Digital Age* (CUP 2017) 312–16.

104 *ibid.*

105 JP Quintais, B Bodó and L Groeneveld, 'Blockchain Copyright Symposium: Summary Report' *Kluwer Copyright Blog* (3 August 2017) <<http://copyrightblog.kluweriplaw.com/2017/08/03/blockchain-copyright-symposium-summary-report/>> accessed 17 July 2018.

of art and literature.¹⁰⁶ The purpose of the Statute, which was more or less copied by many colonies of the future US and which finds a direct echo in the 1790 US Copyright Act and in the state statutes that preceded the formation of the republic, was to replace a monopoly on book publishing granted decades earlier to the Stationers Company.¹⁰⁷ Later, legal protection was extended to public uses of copyright material, such as live performance of theatrical plays and music, and radio and television broadcasting.¹⁰⁸ Most such uses could easily be tracked and pursued as infringements if unlicensed. Many passengers in the innovation bus driving down Schumpeter's highway have thrown this notion out the window, technologically and possibly normatively as well. Technologically, uses of copyright material are now mostly online. As an illustration, YouTube is the largest source of access to music and much audio-visual content but a meagre source of income for creators.¹⁰⁹ In many parts of the Internet, tracking uses and licenses is often difficult, ineffectual and frustrating.

Copyright is regularly used to *prevent* some of the possibilities offered by the Internet, often simply because licensing seems impossible, ie a market failure. Yet, copyright was not meant to prevent access to books, but rather to organize the market for books.¹¹⁰ Preventing access is in no one's interest: authors and creators want their material to be accessed and hopefully enjoyed; publishers and producers must have 'users' to generate revenue, and intermediaries need content to generate usage, which they can monetize by selling advertising. Policies designed to remove or block access are, therefore, in no one's interest.

DRM was one of the technologies meant to prevent or allow access only in specific instances set by right holders. In that respect, DRM mostly failed to deliver on its promises. In this failure may be lessons for advocates of blockchain in the licensing of copyright works. One such is in the regulatory sphere: as a result of misplaced expectations, the misunderstanding of technological capabilities and social practices, hasty legislation produced a deeply entrenched protection of a technology the time of which has mostly passed. The WCT, which embedded DRM technology protection into the international copyright framework, was adopted in policy haste in December 1996 as the World Wide Web was in its infancy and still far from its current capacity due to poor bandwidth and the inability to accurately predict future application development.¹¹¹

In the case of blockchain it is hard, at least as of 2018, to detect high levels of enthusiasm that would lead, in the short term, to the legal recognition/protection of copyright-replacing blockchain-related technological innovations. The questions

106 L Bently and B Sherman, *Intellectual Property Law* (OUP 2014).

107 *ibid.*

108 JP Liu, 'Owning Digital Copies: Copyright Law and the Incidents of Copy Ownership' (2001) 42(4) *William and Mary Law Review* 1245–366, 1255; JP Quintais and J Poort, 'A Brief History of Value Gaps: Pre-Internet Copyright Protection and Exploitation Models' in PB Hugenholtz (ed), *Copyright Reconstructed: Rethinking Copyright's Economic Rights in a Time of Highly Dynamic Technological and Economic Change* (Kluwer Law 2018).

109 IFPI. Global Music Report 2017 (IFPI 2018).

110 M Sentfleben and others, 'The Recommendation on Measures to Safeguard Fundamental Rights and the Open Internet in the Framework of the EU Copyright Reform' (2018) 40(3) *EIPR* 149, 156–58.

111 See arts 11 and 12 WCT.

before us are different. Given the extreme complexity of copyright, could blockchain technology be used by right holders to bypass copyright's structural complexity and replace it with standardized technological solutions? Will DLTs standardize RMIs? Will smart contracts standardize mass produced licensor–licensee relationships?¹¹² Do blockchains really represent a point of discontinuity in the history of copyright, an opportunity to reimagine, from scratch, the protection and use of intellectual properties, this time optimized for the affordances of a planetary scale, highly standardized and automated technology?

The question to ask, therefore, is not whether copyright has approached the end of its useful life, for the simple answer to that question is no. For one thing, it still works well in the offline market. Copies of physical books, paintings, sculptures are protected; theatres license the works they perform in public; and broadcasters pay license fees.¹¹³ In the online environment, will the new possibilities that can be deployed using blockchain technologies affect copyright's role?

A possible future path built with blockchain technology could look like this: Authors publish their works on a blockchain creating a quasi-immutable¹¹⁴ record of initial ownership, and use smart contracts to automate the control of who has access to their works and under which conditions. Remuneration can theoretically happen on the same platform as the distribution of works. Would it be easy? Not necessarily. First, it may be challenging to map smart contracts onto individual uses of works. Moreover, some individual uses may not need to be licensed because they amount to privileged private or fair use, for example. Indeed, finding a definitive legal answer to which uses of a work require a license would, in theory, entail going to court case-by-case. This would amount to insurmountably high-transaction costs. Finally, why would smart contracts be bound or limited by the 'fake scarcity' and exceptions thereto that copyright aims to create in the online environment? In other words, what is to prevent a smart contract from coding a level of exclusivity beyond that allowed by copyright law?

At a higher level of abstraction, why would a blockchain contract need to map onto any of the exclusive rights and exceptions in the copyright bundle? And then, in which jurisdiction? Recall that copyright varies in scope and by territory. For example, some jurisdictions have created separate rights in digital transmissions and the making available of copyright material online.¹¹⁵ Then the US has basically no moral right to speak of, even when compared to the minimum rights protected under Article 6bis of the Berne Convention—to which the US is nonetheless a party. The

112 J Beniger, *The Control Revolution: Technological and Economic Origins of the Information Society* (Harvard University Press 2009).

113 Gervais (n 63).

114 As pointed out by Finck, a blockchain is immutable only 'to the extent that its human creators decide not to intervene'. See Finck (n 37) 3.

115 Contrast the US approaches in the US and EU, discussed eg by J Ginsburg and L Budiardjo, 'Liability for Providing Hyperlinks to Copyright-Infringing Content: International and Comparative Law Perspectives' (2018) 41 *Columbia Journal of Law & the Arts* 153.

term of rights may also vary for at least two reasons. First, some countries (eg Canada and New Zealand) protect rights for the life of the author plus 50 years, the minimum standard under Berne. A vast number of major jurisdictions, including the EU and the US, have moved to 70 years after the death of the author.¹¹⁶

If blockchain-based smart contracts are a form of private ordering not tied to a particular jurisdiction, then they are problematic from the perspective of international copyright law because, as explained at the beginning of the Section 'Blockchain and copyright intersection', there is no such thing as an international copyright right. Although international treaties recognize the protection of copyright in multiple jurisdictions, a copyright work is protected under the copyright laws of the 176 member countries of the Berne Union according to their domestic laws.¹¹⁷ And the rights in each such national law can be split by market, type of medium, language, etc. Moreover, as also explained above, each country is free to apply which form of 'exhaustion' rule it will apply.¹¹⁸

Does a blockchain-based copyright system, registry or smart contract have to reflect all the layers and facts of this legal complexity? We can only offer a partial answer. Firstly, if a use of a work was allowed under a smart contract in a territory but not by the correct holder of the relevant right fragment in that territory, the user might still face an infringement action.¹¹⁹ Secondly, however, if the use was restricted in a way that limits the scope of an exception or limitation, then the user would have little recourse. Although the term 'user right' has been used in this context, few courts have vindicated such 'rights' when restricted by private contract or DRM.¹²⁰ Thirdly, nothing prevents the use of notice-and-take-down systems to target an intermediary in a territory in which the right holder would claim that a work is used illegally in spite of the existence of a smart contract. The user would then have to resort to a counter-notice or other redress mechanism and possibly take the matter to court, which in practice seldom happens.¹²¹

Fragmentation suggests that the optimal way to exploit the potential of smart contracts is to decouple them from international copyright's national bundles of rights. How? Absent an internationally recognized mechanism for authors to permanently dedicate a work to the public domain¹²² and thus 'get rid' of copyright for works so

116 This gets even more complicated because the principle of national treatment does not apply mandatorily here. This means that a country using a life plus seventy years term may refuse to protect works originating from a country where the shorter term applies beyond that shorter term.

117 See (n 45) above.

118 See TRIPS (n 9), art 6 ('For the purposes of dispute settlement under this Agreement, subject to the provisions of Articles 3 and 4 nothing in this Agreement shall be used to address the issue of the exhaustion of intellectual property rights.');

WCT (n 9), art 6(2).

119 The user who is presumably in good faith would likely face reduced penalties and would have a recourse against the 'wrong' licensor.

120 L Guibault, *Copyright Limitations and Contracts: An Analysis of the Contractual Overridability of Limitations on Copyright* (Kluwer Law International 2002).

121 J Urban, J Karaganis and B Schofield, 'Notice and Takedown in Everyday Practice' *UC Berkeley Public Law Research Paper No 2755628* (22 March 2017), 44 ('... by all accounts, the actual use of counter notices is extremely infrequent').

122 The Creative Commons CC0 license is perhaps the closest we have come. See Creative Commons, *Public Domain, CC0*, <<https://creativecommons.org/share-your-work/public-domain/cc0/>> accessed 17 July 2018.

dedicated, a world in which smart contracts put in place a form of technologically enforceable private ordering to replace copyright, while technically feasible, seems a very distant goal indeed.

A second method of action would be legislative responses recognizing the role of smart contracts in this environment. But this raises three big issues of blockchain regulation: why, how and by whom? When confronted with the global nature of on-line exploitation of copyright, the tendency over the past two decades has been to increasingly target intermediary service providers. These providers, while benefiting liability exemptions or 'safe harbours', are also subject to series of measures and obligations to prevent the use of their services by third-party users for the infringement of copyright, including injunctions, duties of care, removal of infringing content (takedown) and even filtering.¹²³ Beyond targeting current intermediaries with the existing system, however, it is not obvious how regulating blockchain-specific intermediaries (eg miners), as has been suggested for cryptocurrencies, would work in this context.¹²⁴

To some extent, there is a feeling of 'old wine in new bottles' to blockchain and copyright debate. More than a decade ago, in the DRM discussion, new technology was wrongly presented as an efficient enforcement tool: the answer to the machine was in the machine.¹²⁵ This time, technology is presented not as the enforcer but rather as possible replacement for copyright. It is seen as an opportunity to reduce market friction, and increase both the efficiency of transactions and the autonomy of creators. The framing, and the incentives to adopt blockchain technology in this context are markedly different from those that characterized copyright.

CONCLUSION

Copyright-based practices have changed almost beyond recognition: from a scarcity and exclusivity-based monetization model, to an all-you-can-eat access based one; from a one-to-many dissemination model curated by professionals, such as publishers and producers, to a mostly unfiltered many-to-many infrastructure where major internet platforms generate revenue by maximizing access to 'content'. Enter the blockchain and the smart contracts it empowers: does it provide the means to retool copyright, or will it replace it?

123 Regarding so-called safe-harbors, see, in EU law, arts 12–15 of Directive 2000/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market, 2000 OJ (L 178) 1–16 and, in the US, 17 USC § 512 (Limitations on liability relating to material online).

124 'Miners' or 'mining nodes' are a set of computers in a DLT network tasked with the validation of transactions broadcasted by network participants or wallet holders. As neither wallet holders nor other validator nodes are to be trusted, sophisticated algorithms must ensure that only the only transactions validated are those consistent with earlier records. As a result, miners are by design the enforcers the technologically encoded rules on a blockchain. Since the physical location of, as well as the operating (legal) entities behind these validator computers are relatively easy to uncover (and current economic incentives encourage the concentration of mining activities in the hands of a few large entities), miners are ideal regulatory enforcement targets. See A Efe Gencer and others, 'Decentralization in Bitcoin and Ethereum Networks' *arXiv.org* (9 February 2018) <<http://arxiv.org/abs/1801.03998>> accessed 17 July 2018.

125 See, eg the often-cited C Clark, 'The Answer to the Machine is in the Machine' in P Bernt Hugenholtz (ed), *The Future of Copyright in a Digital Environment* (Kluwer Law International 1996) 139.

By now, it is clear that if there is a friction, it is not between a particular technology and copyright. Rather, the friction is between the social, economic, and political conditions that produced the blockchain technology ecosystem, on the one hand, and the social, economic, and political premises from which the current copyright system developed. Perhaps strangely, there is some conceptual alignment—on the surface, at least—between copyright’s exclusivity–scarcity paradigm and the exclusivity–scarcity logic of blockchains and smart contracts. However, when digging deeper, structural incompatibilities emerge. Chief among them is the challenge of reconciling the hyper-fragmentation of copyright law with the impersonal, borderless, standardized, and automated regulatory solution offered by blockchain technology.

Yet, fragmentation is neither mandatory nor totemic. Not all uses and users require multiple right fragments to use a copyright work. Smart contracts may well prove a powerful way to license copyright material and to provide higher levels of transparency in financial flows to creators. Blockchain-based solutions can also be used to provide a vast and secure repository for RMI, at least in certain sectors. However, these achievements and the promise they hold are largely dependent on blockchain technologies achieving a degree of development, scalability, reliability and market adoption difficult to foresee at this stage. Indeed, it is possible that the technology falls short of its promise.¹²⁶ Still, should blockchain technology reach its market potential, it may have significant—perhaps transformative—impact on copyright in the digital environment.

126 For a powerful criticism of blockchain technologies, including their application in the music industry, D Gerard, *Attack of the 50 Foot Blockchain: Bitcoin, Blockchain, Ethereum & Smart Contracts* (2017) Ch 12.