What Blockchain Can and Can't Do for Copyright

Annabel Tresise, Jake Goldenfein and Dan Hunter* Published 6 August 2018

This article explains how blockchain platforms – the technology underlying Bitcoin and other cryptocurrencies – are likely to affect copyright law. After briefly outlining the technical features of blockchain technologies, it examines five main areas where copyright is likely to be affected – in registration processes, the creation of open digital rights management systems, the development of automated licensing, the reduction of the need for collective management organisations, and the identification of orphan works.

I. INTRODUCTION

Blockchain technologies use a technical protocol to create a secure, transparent ledger that reports transactions to everyone within the network.[1] It is the core technology of Bitcoin, Ethereum, Ripple and the countless cryptocurrencies and Internet Coin Offerings (ICOs) that are cropping up daily in people's newsfeeds, bank accounts and imaginations.

Although it is not the magic pixie dust that the pundits and hucksters would have you believe, blockchain technology will affect copyright law significantly over the next decade. It is already being applied to a host of areas – in licensing and digital rights management (DRM), for example – and while the hype may fade, the growth in applications is unlikely to slow. In this article we seek to explain the areas where blockchain technology is most likely to affect copyright law and the business practices that rely on copyright. After discussing the basics of the technology in the next section, we look at five main areas: copyright registration, DRM, licensing, collective management organisations (CMOs) and orphan works. Not all of these areas of copyright will be utterly transformed by the blockchain; but they will all be affected in some way.

II. BLOCKCHAIN TECHNOLOGY

Blockchain is the technical protocol at the heart of Bitcoin.[2] However, it has also recently spurred examinations of how we might change the legal system in areas like land title registration, share registries, privacy, financial regulations, banking and payments, secured transactions, currency systems, and many, many others.[3] A blockchain is a form of "distributed ledger", and this term captures the essence of the technology – simply put, the blockchain is a technical protocol to create a secure, transparent ledger that reports transactions to everyone within a given blockchain's network.

The initial impetus for the blockchain came from the idea of a digital money system, independent of the state. Although the ideas underlying this kind of cyberlibertarianism have a far longer history than

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* Annabel Tresise: BIGS JD is a researcher at Swinburne Law School. Jake Goldenfein: BSc, LLB (Hons), GDLP, PhD is a lecturer at Swinburne Law School. Dan Hunter: BSc, LLB (Hons), LLM, PhD is the Foundation Dean of Swinburne Law School.

1 Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System", *Bitcoin* (1 November 2008) <http://www.bitcoin.org/bitcoin.pdf>.

2 As a matter of naming convention, the term "blockchain" can be used to refer to the "blockchain protocol", that is, the technical architecture/description that can be used to create a distributed ledger, or to a particular instance of this architecture, such as the blockchain implementation that underlies Bitcoin. In this article we will generally refer to the blockchain protocol as "*the* blockchain" and any given instance as "*a* blockchain". But where we do not, the context will make the usage clear.

3 See, eg, Jake Goldenfein and Dan Hunter, "Blockchains, Orphan Works, Public Domain" (2017) 41 *Columbia Journal of Law and Arts* 1; Josh Fairfield, "*BitProperty*" (2015) 88 *Southern California Law Review* 1; Primavera de Filippi, "The Interplay between Decentralization and Privacy: The Case of Blockchain Technologies" (2016) 7 *Journal of Peer Production* 1 <https://hal.archives-ouvertes.fr/hal-01382006>; Gareth W Peters and Efstathios Panayi, "Understanding Modern Banking Ledgers through Blockchain Technologies: Future of Transaction Processing and Smart Contracts on the Internet of Money" in Paolo Tasca, Tomaso Aste, Loriana Pelizzon and Nicolas Perony (eds), *Banking Beyond Banks and Money* (Springer, 2016) 239, 240–276.

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we can recount here,[4] the first truly workable cryptocurrency emerged in 2008 in the White Paper that described and defined Bitcoin.[5] Since then, interest in Bitcoin has come from two main fronts: those who (recently) made (and potentially lost) a fortune in cryptocurrency speculation as Korean investors drove up the price of Bitcoin and other cryptocurrencies like Litecoin and Ether, and those who saw a transformative role for the distributed ledger architecture of Bitcoin in arenas outside currency.[6]

Blockchain platforms can re-architect registry systems and guarantee their integrity without trusted intermediaries like governments and banks, creating a form of "trustless trust".[7] That trust is based on blockchain technology providing a way of guaranteeing that a record exists or existed on a ledger at a certain time. It does not matter what that record is – it may be a file, a piece of music, a transaction, a piece of digital art or an email. The majority of interest in blockchains concerns the storage of transaction records for digital tokens or cryptocurrencies, but the technology can effectively store any record in the same way. For example, with respect to intellectual property, a blockchain will not store the actual copyrighted material, but rather a cryptographic artefact that identifies that material as it existed at a particular point in time.

To add such a record to a blockchain, the intellectual content (or transaction record, or any other data) is first run through an algorithm to create a unique, encrypted string of data called a "hash". This hash uniquely identifies the record, and guarantees its integrity because there is no way that the record can be altered without changing the hash. Once a record has been hashed, it is then gathered together with a small number of other hashes of other entries made to the ledger that were encrypted around the same time. This collection of entries is called a "block". Each block is then itself turned into a hash, with every new block also referring to the hash of the previous block, creating a cryptographically connected chain of blocks. Any modification to an older block will sever the chain because the hash of that block will no longer be validly referenced in the subsequent blocks. This is why the protocol is called the "blockchain" – it is a chain of blocks.[8]

At its heart then, the blockchain is simply a ledger of transactions, much like an electronic version of a handwritten bank ledger. But the blockchain ledger is unusual and profound in at least two ways. First, the blockchain records *all* of the transactions that ever occurred within the network.[9] The technology of the blockchain is such that one party cannot make any transaction without the transaction being duly recorded in the authoritative ledger. Like the Domesday Book of William the Conqueror, the blockchain ledger tells the complete story of the division of property interests. Second, the blockchain ledger is public and promiscuous.[10] All blockchains are transparent to the members of the blockchain,

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[4] See, eg, Lucky Green, "Trusted Computing Platform Alliances: The Mother(board) of All Big Brothers", *Cypherpunks* (22 October 2017) <https://perma.cc/8T3A-PMLZ>; Steven Levy, *Crypto* (Penguin, 2001) for a popular account of cypherpunk history and ideology; Timothy May, "True Nyms and Crypto Anarchy" (1996) in Vernor Vinge and James Frenkel (eds), *True Names: And the Opening of the Cyberspace Frontier* (Tor Books, 2001).

[5] Nakamoto, n 1.

[6] Mark Staples, "Blockchain Is Useful for a Lot More than Just Bitcoin", *The Conversation* (10 May 2017) <https://theconversation.com/blockchain-is-useful-for-a-lot-more-than-just-bitcoin-58921>.

[7] Kevin Werbach, "Trust, But Verify: Why the Blockchain Needs Law" (2018) *Berkeley Technology Law Journal* Forthcoming, SSRN: <https://ssrn.com/abstract=2844409>or <http://dx.doi.org/10.2139/ssrn.2844409>.

[8] For detailed descriptions of blockchain technologies, see generally Diego Romano and Giovanni Schmid, "Beyond Bitcoin: A Critical Look at Blockchain-based Systems" (2017) 15 *Cryptography* 1; Michael Crosby, Nachiappan, Pradan Pattanayak et al, "Blockchain Technology: Beyond Bitcoin" (2016) 2 *Applied Innovation Review* <http://scet.berkeley.edu/wp-content/uploads/AIR-2016-Blockchain.pdf>; Don Tapscott and Alex Tapscott, *Blockchain Revolution: How the Technology behind Bitcoin and Cryptocurrency Is Changing the World* (Penguin, 2016).

[9] Although the introduction of "lightning networks" may change this in the context of payments.

[10] Public and private blockchains are sometimes termed "permissionless" and "permissioned" blockchains, respectively. Bitcoin and Ethereum are the best examples of permissionless/public blockchains, and in these implementations any computer may join or leave the blockchain at any time. Permissioned/private blockchains have generally been used for financial databases, for example in the back office clearing house system of the Australian Stock Exchange <https://www.asx.com.au/services/chess-replacement.htm>. Private, permissioned blockchains are at the core of most implementations of legal registers, see Nathan Lands, "How Will Binded Make Money", *Binded* <https://help.binded.com/about-binded/cost/how-will-binded-make-money>.

and once you become a member of a blockchain, you become privy to a complete copy of every transaction ever made on that blockchain. Members on a blockchain are identified with "addresses" rather than as specific persons. These "addresses" are the public side of a private/public cryptographic key pair (an address is a hash of the public key.) Knowing the private key allows individuals to link themselves to the address, and therefore perform transactions on the ledger on behalf of that address.

Blockchain platforms also allow us to automate transactions in ways that are both new and significant. Shortly before the White Paper that led to the creation of Bitcoin, Nick Szabo proposed a mechanism that he called a "smart contract", which was "a computerized transaction protocol that executes the terms of a contract".[11] While smart contracts do not necessarily, in themselves, represent legal contracts,[12] a smart contract *can* use computer code to represent an agreement. Unlike a regular contract however, smart contracts might automatically execute the terms of the agreement by transferring funds held in escrow or changing the state of registers or ledgers. As we discuss below, this gives rise to the possibility of authoritative, automated copyright licensing systems; but if poorly implemented may lead to unintended consequences, hackin,g and the loss of tens of millions of dollars.[13]

The significance of these technical features is profound. As the UK White Paper on blockchain uses in government noted:

> [D]istributed ledger technologies have the potential to help governments to collect taxes, deliver benefits, issue passports, record land registries, assure the supply chain of goods and generally ensure the integrity of government records and services.[14]

Any system of laws that relies on an authoritative register is susceptible to being transformed, and each week brings a new raft of announcements about the use of blockchains in title deed registration,[15] securities issuing,[16] and digital identity.[17] In the sections below we discuss how this type of distributed registration system is likely to alter copyright law and practice. We discuss a range of opportunities and challenges to the copyright system that the blockchain generates, starting with the possibility of using the ledger to create a copyright registration system.

III. REGISTRATION SYSTEMS

Copyright registration systems based on blockchain platforms are suited to overcome many issues associated with copyright ownership, proof of existence and user accessibility for the mass of digital works generated daily.

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[11] Nick Szabo, "Formalizing and Securing Relationships on Public Networks", *First Monday* (September, 1997) <http://firstmonday.org/article/view/548/469>; Nick Szabo, "Smart Contracts", *Phonetic Sciences, Amsterdam* (1994) <http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html>.

[12] Kevin Werbach and Nicolas Cornell, "Contracts Ex Machina" (2017) 67 *Duke Law Journal* 313.

[13] The most salient example here is the Distributed Autonomous Organization – the DAO – which attracted a huge amount of interest, and money – and then an equal amount of controversy and unhappiness when $50M was siphoned off the system by an unknown hacker. The most interesting, and troubling, aspect to the DAO hack was that it involved the perfectly legitimate use of the smart contracts within the DAO and thus, in some sense, there was no fraud perpetrated at all. See David Deigel, "Understanding the DAO Attack", *Coindesk* (27 June 2016) <https://www.coindesk.com/understanding-dao-hack-journalists/>.

[14] UK Government Chief Scientific Advisor, Government Office of Science, *Distributed Ledger Technology: Beyond Block Chain* (19 January 2016) 6 <https://www.gov.uk/government/publications/distributed-ledger-technology-blackett-review>.

[15] Jonathan Keane, "Sweden Moves to Next Stage with Blockchain Land Registry", *Coindesk* (30 March 2017) <https://www.coindesk.com/sweden-moves-next-stage-blockchain-land-registry/>.

[16] Taketoshi Mori, "Financial Technology: Blockchain and Securities Settlement" (2016) 8 *Journal of Securities Operations & Custody* 208, 208–227.

[17] Laura Shin, "The Identity Solution", *Forbes* (22 June 2017) <https://www.forbes.com/sites/laurashin/2017/06/22/the-identity-solution/#190aba6a72ed>.

Registration systems prove the existence of a work and the ownership of the person who created it by identifying this information within a publicly accessible register.[18] In areas of intellectual property such as patent, trade mark and industrial design systems, registration is a formal requirement: without registration, the right holders' intellectual property is not identified and the property is not protected. In copyright law, however, works enjoy protection from the date of their fixation without any formalities, and not because their creator has taken steps to register the work in a formal registration system: "if copyright is born with the work, then no further state action should be necessary to confer the right; the sole relevant act is the work's creation."[19] In fact, mandatory formalities are prohibited under Art 5(2) of the *Berne Convention for the Protection of Literary and Artistic Work*.[20] Despite the prohibition on mandatory formalities, some jurisdictions still require copyright registration to make certain rights available, and voluntary registration systems provide utility in a variety of areas, including determining the duration and expiry of a copyright term, performing a diligent search for an "orphan work", and searching commercial licensing terms.[21] Copyright registration systems are therefore useful mechanisms of economic co-ordination for both the rightsholder and the user, as the rightsholder can prove the existence of the work and their corresponding rights, while the user can access relevant information and rights associated with the work.

However, despite the benefits of registration systems, a 2010 WIPO survey of 80 countries with voluntary registration systems revealed that public searches are usually thwarted by search costs, administrative requirements and time delays,[22] thus not providing much utility for a potential user. Further, the varying degree of registration requirements in different countries is not conducive to the multi-jurisdictional nature of copyright infringement made possible by the internet. For example, in America, registration is not mandatory per se, but rather a requirement if a rightsholder wishes to enforce their rights.[23] Whereas Australia has no voluntary registration system at all. The explosion of digital content and the ease at which works can be shared across jurisdictions on the internet raises difficult questions of who owns what, from when and how to organise remuneration.[24] The complexity of ownership increases when we consider how many works are subject to copyright, how many people share ownership of the copyright, and how we apportion the relevant percentages of distributed ownership.[25] The copyright system is, as Molly Van Houweling describes it, three dimensional and "atomistic".[26] The inability to trace the work means a potential user of the work cannot reuse it, even if it was available for free use in the public domain.[27]

An easily accessible, public and international registration system could overcome these hurdles. There have been numerous attempts to establish such registration systems – by both governments, transnational NGOs and private players – but all of these have failed. Examples include the European Global Repertoire Database and the International Music Joint Venture (2000), both attempts backed by

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[18] Dev Saif Gangjee, "Copyright Formalities: A Return to Registration" in Rebecca Giblin and Kimberlee Weatherall (eds), *What If We Could Reimagine Copyright?* (ANU Press, 2017) 213, 219.

[19] Jane Ginsburg, "A Tale of Two Copyrights: Literary Property in Revolutionary France and America" (1990) 64 *Tulane Law Review* 991, 994.

[20] *The Berne Convention for the Protection of Literary and Artistic Works*, opened for signature 9 September 1886, 1161 UNTS 30 (entered into force 5 December 1887) Art 5(2).

[21] Graham Greenleaf and David Lindsay, *Public Rights: Copyrights' Public Domain* (CUP, forthcoming, 2018) 271.

[22] Greenleaf and Lindsay, n 21; WIPO, "Summary of the Responses to the Questionnaire for Survey on Copyright Registration and Deposit Systems: A Copyright Registration and Recordation", *World Intellectual Property Organization* (2010) <http://www.wipo.int/export/sites/www/copyright/en/registration/pdf/registration_summary_responses.pdf>.

[23] 17 USC §411 (1976).

[24] For a discussion on the "atomic" qualities of copyright, see generally, MS Van Houweling, "Author Autonomy and Atomism in Copyright Law" (2010) 96 *Virginia Law Review* 549, 553.

[25] Gangjee, n 18, 215 citing Van Houweling, n 24.

[26] Van Houweling, n 24.

[27] Gangjee, n 18, 216.

major CMOs to assist in the organisation of music rights and ownership. However, these attempts, and many others, have faltered due to a range of issues, including lack of confidence from the major financial players and wavering support by CMOs.

Registration systems based on the blockchain platform could overcome many of these difficulties. Using a blockchain platform, registration would be simple and based on a proof of existence model as briefly described above: all the rightsholder need do is encrypt their digital asset so it becomes a hash on the blockchain. The record could include details of the rightsholder or holders, the percentages of ownership and details directly relating to the creation of the work. If any issues arise in the future in which they need to prove the time and place of existence of their work, then this information would be available on the public ledger. An example of such an issue would be as evidence in litigation if the rightsholder wishes to prove their copyright against an unauthorised user. More complex versions of the blockchain could provide real-time tracking of the transactions of rights, and as to be discussed in Parts IV and V, a smart contract function can even facilitate licensing and permissions.

The successful application of a blockchain registry for copyright registration is possible if one considers the success of registration systems in other property and intellectual property areas. However, introducing copyright registries on blockchain platforms would raise questions of whether it should be managed at the international or domestic level, or perhaps even by a private player. This also raises questions about the type of blockchain platform or distributed ledger that would be most appropriate. Public blockchains like the Bitcoin or Ethereum blockchain use "mining" mechanisms to cryptographically verify the blocks. Every participant in the system competes to verify all the transactions and write the new block. The winner of that competition receives tokens as a reward for performing the verification. When those tokens have value, participants are incentivised to contribute computing power to that verification process. These "public" blockchains are accordingly governed through a combination of the technical systems, the core group of programmers that write them, and the behavioural economic forces that drive the miners and users. Such systems eliminate intermediaries more than, for instance, private blockchains that are not open to the public, and limit who can participate in the system, while maintaining a mining function. If the mining function is abandoned, then the system becomes a different type of distributed ledger than a blockchain, and is generally maintained by a single or small group of entities. This may be open to public participants, but cryptographic integrity of the system is not guaranteed by a mining mechanism. Nevertheless, such systems can still perform much of the disintermediated and automated transacting that blockchain platforms facilitate. It is also possible to have combinations of private and public systems, where the privately-operated system piggybacks off an existing public blockchain for cryptographic integrity. While we do not express a preference for what type of ledger would be most appropriate for intellectual property registration, various entities could fund, operate and govern such ledgers. Further, as discussed below, there are advantages to systems that use cryptocurrencies or tokens for the sake of licensing and digital rights mechanisms through smart contracts. However, building such a system still requires a concerted effort by interested parties.

On an international level, a WIPO controlled registry could be an easy solution to domestic registration systems, allowing users immediate access to rights information about a digital asset. However, unless WIPO has the capacity to resolve disputes on the blockchain – similar to its domain name arbitration process run by the WIPO Arbitration and Mediation Center[28]—then it is unlikely that it would be interested in bearing the cost of managing a registry which would provide mere proof of existence when rightsholders would still have to litigate in domestic jurisdictions. On a domestic level, a government-run registration system would need to be voluntary in order to not contravene the *Berne Convention*. In both these situations, the registration system may not be practicable, as the question of funding and resources would need to be raised: what is the utility for WIPO or a government body to fund and operate the registry if it is not a mandatory requirement to the function of copyright law? Without a change to Art 5(2) of the *Berne Convention* or the legal architecture surrounding it, a government or WIPO based approach seems impossible within the foreseeable future.

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[28] World Intellectual Property Organization, *Alternative Dispute Resolution* <http://www.wipo.int/amc/en/>.

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Private players, on the other hand, have started to explore using the blockchain platform for copyright registration and rights management.[29] A major benefit of a privately organised blockchain registry is that a company can create and maintain an international registration system. This would mean that a potential user could quickly and easily check the origin, rightsholder details, and available use of a work prior to using it, regardless of which jurisdiction the work originated. However, it is most unlikely that an Australian user will be interested in knowing the American origins of a song if they are unable to use it for their own purposes. Moreover, it is not commercially viable for any start-up to operate a blockchain registry if all they can do is provide information regarding the song. Accordingly, a blockchain registry is limited if it cannot provide a user with the ability to access the content they are searching for.

In light of these considerations, a private player would need to not just manage the registry, but also provide access to, or licensing of, the content to users. For example, a recent US based start-up, Binded,[30] offers a free blockchain registration ledger for copyright owners, and claims that in the future it will "make money by creating new opportunities"[31] for the copyright owner. It seems that this means that the company plans to license use of the works and may eventually take a finder's fee similar to Apple Appstore's 30% of the value.[32] Such a business model demonstrates the limited utility of mere proof-of-existence registration systems, and suggests that a blockchain registry would need to provide licensable content in order to achieve a meaningful penetration into the copyright system.

International, blockchain-based registration of copyright content is therefore unlikely to be implemented in the immediate future. Nonetheless, there will still be some changes created by the blockchain protocol, most likely pioneered by private players. As discussed in the sections below, proving existence via time-stamping registration is just the beginning of how blockchain could transform this area of law.

IV. DIGITAL RIGHTS MANAGEMENT

Blockchain platforms can be implemented to improve issues relating to DRM systems. DRM systems are technologies that are employed to protect against the infringement of copyrighted material in a digital format. Such material may be a video, song, book, or anything else that exists in digital form. DRM systems are usually varied and intertwined, and seek to secure digital content by controlling the digital distribution chain from the copyright owner to the user.[33] To achieve this, a DRM system usually contains an identifier and metadata that stipulates the identification of content, its provider, and the rules of access and usage for the user.[34] For example, the video and movie streaming provider Netflix allows users to stream videos online by providing them with a key to decrypt the film. In order to ensure you do not download, copy and share the film, Netflix must hide the key – either in a browser extension or downloaded app. Other examples of DRM systems include the technologies that enable you to play music you have licensed via Spotify or on Apple iTunes, or the coding in your DVD player that may or may not allow you to play legitimately-produced DVDs that you purchased abroad.[35]

In theory, DRM systems are designed to help copyright owners protect their digital assets by restricting potential duplication, distribution, and use from a range of people not authorised by the

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[29] Jessie Willms, "Is Blockchain-powered Copyright Protection Possible?", *Bitcoin Magazine* (9 August 2016) <https://perma.cc/9V88-K8ES>; "ASCAP, PRS and SACEM Join Forces for Blockchain Copyright System", *Music Business Worldwide* (9 April 2017) <https://perma.cc/Z7PG-8HJQ>.

[30] See Binded (2017) <https://binded.com/>.

[31] Lands, n 10.

[32] Lands, n 10.

[33] Zohar Efroni, *Access-right: The Future of Digital Copyright Law* (Oxford Scholarship Online, 2011) 193 <http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780199734078.001.0001/acprof-9780199734078>.

[34] Efroni, n 33.

[35] Nicholas Sheppard, "Digital Copyright Protection – Some Success, but Mostly Failure", *The Conversation* (12 August 2014) <https://theconversation.com/digital-copyright-protection-some-success-but-mostly-failure-30215>.

copyright holder. DRM systems are often perceived by users as pernicious and problematic, and represent one of the more controversial aspects of copyright law. They also frequently do not work as intended.[36] They are expensive and time consuming to develop and deploy, and often can be overcome by a single hacker. As a consequence, DRM systems often fail to maintain control of the digital asset and, for the large part, are vulnerable to hostile manipulations.[37] These concerns notwithstanding, the *Copyright Act* enshrines the centrality of DRM systems in protecting digital assets, including a rightsholder's ability to pursue civil remedies[38] and criminal penalties.[39]

How then might blockchain platforms be used for DRM, and what effect would this have on the copyright system? Blockchain technology affords a relatively simple mechanism to control use-rights and maintain copyright permissions as an alternative to relying on proprietary DRM systems. For instance, blockchain platforms could provide unlimited and uncontrolled use of a digital asset to a user while ensuring that the material cannot be copied. The blockchain itself would not hold the digital asset, due to size and current immaturity in processing capabilities,[40] but instead it would facilitate a smart contract that is encrypted with information regarding the rights and permissions of the digital asset. As noted above, a smart contract is not a legal contract, but a segment of programmed instructions on the blockchain that can automatically execute coded contractual terms and permissions. The smart contract can allocate the use of digital assets via cryptocurrency "tokens" – for example, bitcoins, ether, XRP, etc. – between users and copyright owners in a transparent and neutral way. This functionality is key for remuneration and payments.[41]

An example might make this clearer. Suppose you purchase an e-book from an online retailer who uses a blockchain-based DRM system. Your purchase transaction will be recorded on the blockchain in a record that contains all the information about your purchase and rights of access. When you wish to read the e-book, opening it on your device triggers communication with the distributed ledger that is the blockchain. The DRM system scans the record for the necessary permission and gives you access to the e-book. If you have purchased a limited-duration licence, the system can consult a trusted timeserver and compare the current time/date with the contract terms coded on the blockchain on a regular basis, and take away access once your lease is over.

The use of a blockchain platform can thus overcome many of the issues associated with DRM systems. First, it avoids the proprietary characteristic of most DRM systems. Purchasing a licence to listen to a song on Spotify does not allow a user to listen to it on iTunes or Tidal, and syncing various devices consistently leads to unhappiness. A neutral, non-proprietary blockchain-enabled DRM system can avoid many of these problems. Second, a smart contract allows rightsholders to maintain control over who has access to their product. With blockchain technology, the rightsholder has certainty that only the user has access, since the smart contract will be encoded in such a way that only the user's key will be provided with permission to use the copyrighted work. Similar to Bitcoin applications, the user will have a private and public key. The public key will be shown on the public ledger each time the user uses the product. Their private key is the basis of their contract with the rightsholder, and their key grants

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[36] Cory Doctorow, "DRM's Dead Canary: How We Just Lost the Web, What We Learned from It, and What We Need to Do Next", *Electronic Frontiers Association* (27 November 2017) <https://www.eff.org/deeplinks/2017/10/drms-dead-canary-how-we-just-lost-web-what-we-learned-it-and-what-we-need-do-next?page=4>.

[37] Efroni, n 33, 198; see also S Fujimura, H Watanabe, A Nakadaira et al, *BRIGHT: A Concept for a Decentralised Rights Management System Based on Blockchain, 2015 IEEE 5th International Conference on Consumer Electronics Berlin* (ICCE-Berlin).

[38] *Australian Copyright Act 1968* (Cth) ss 116A, 116B, 116C, 116AQ(1)(c); see also *World Intellectual Property Organization Copyright Treaty*, opened for signature 20 December 1996, 36 ILM 65 (entered into force 6 March 2002) Art 11.

[39] *Australian Copyright Act 1968* (Cth) ss 132APC, D, E.

[40] See Fujimura, Watanabe, Nakadaira et al, n 37; Alex Tran-Qui, "Smart Contracts & Digital Rights Management" (Speech delivered at the Blockchain Foundation Netherlands, Hogeschool Rotterdam, 23 June 2016); M Staples, S Chen, S Falamaki et al, "Risks and Opportunities for Systems Using Blockchain and Smart Contracts" (Data 61 CSIRO, May 2017) 6.

[41] Staples, Chen, Falamaki et al, n 40, 4.

them permission to use. Since only the user has access to their private key, and this is the ingredient to granting permissions, no permission could be granted to an unauthorised user.

The blockchain offers both the rightsholder and the user greater security. The decentralised system enhances transparency and heightens security against any hostile attackers. Further, the contract is recorded on the public ledger and so it is immutable. Rightsholders are assured of greater security against copyright infringers accessing their digital asset, and the user has comfort that a DRM system – which may be vulnerable to attack and which discloses personally-identifying information – will not be installed on their device.

Decentralised blockchain systems also allows for a potential reduction in service fees. DRM systems are costly and, for rightsholders, the cost of using DRM systems has to be balanced against the cost of attacks and technical issues. Cost and effort will be saved by the rightsholder as they will not have the responsibility of maintaining the blockchain[42] – once a user purchases the digital asset from the website, the smart contract is immediately implemented on the blockchain, and all other actions are automated from that point onwards.

The use of blockchain technology for DRM does raise questions about whether its implementation is consistent with the law. One potential conflict exists with the user's theoretical rights of property ownership, notably in the grant of limited licences and not outright sale.[43] Further, smart contracts do not necessarily encode the legislative bargain that finds expression in the fair dealing exceptions for the purposes of research or study,[44] criticism or review,[45] parody or satire,[46] reporting news,[47] by a legal professional providing advice,[48] or for the purposes of access by persons with a disability.[49] These problems are, however, common to all DRM systems, and – rightly or wrongly – have not been of great concern in recent years. Blockchain-based versions of DRM are unlikely to generate new problems in this regard.

Thus, using a blockchain platform as an alternative to DRM systems has the potential to overcome many of the technical and security problems experienced by rightsholders: increased security against hackers, and greater control over permissions and use. The user is, similarly, assured that hidden technologies are not installed on their devices.

V. AUTOMATED LICENSING SYSTEMS

If blockchain smart contracts develop as a widespread solution to the problems of proprietary DRM systems, then the traditional means of copyright licensing will change. While DRM systems deal with access and control of permissions, copyright licensing is about the exchange of permissions and remuneration. The introduction of smart contracts within the copyright system will likely create a stronger emphasis on licensing; indeed, licensing on blockchain platforms promises to revolutionise the creative industries because it can provide greater control over copyright content, lower transaction costs for artists, remove the middleman in licensing transactions, and generate immediate remuneration for artists.

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[42] Fujimura, Watanabe, Nakadaira et al, n 37, 345.

[43] Yee Fen Lim, "Digital Rights Management: Merging Contract, Copyright and Criminal Law" in Reihaneh Safavi-Naini and Moti Yung (eds), *Digital Rights Management: Technologies, Issues, Challenges and Systems (Lecture Notes in Computer Science)* (Springer, 2006) Vol 3919, 66–74.

[44] *Australian Copyright Act 1968* (Cth) ss 40(1), 103C(1).

[45] *Australian Copyright Act 1968* (Cth) ss 41, 103A.

[46] *Australian Copyright Act 1968* (Cth) ss 41A, 103AA.

[47] *Australian Copyright Act 1968* (Cth) ss 42, 103B.

[48] *Australian Copyright Act 1968* (Cth) ss 43(2), s 104(c).

[49] *Australian Copyright Act 1968* (Cth) s 113E.

Blockchain smart contracts can be implemented as a means of providing fair and fast remuneration to individual copyright holders, by allowing them to license directly with their users. We have already discussed how a smart contract arrangement can be set up with a rightsholder and their user – once the purchase of the digital asset is complete, information regarding the purchase is encrypted into a hash which is permanently embedded on the blockchain, allowing automatic use. The exchange for payment is the licence to use, as governed by the terms of the contract. In a blockchain-based licensing system the smart contract generates the direct payment and remuneration to the artist. The transaction would be simple as the information about the copyright owner would be recorded in the same hash that recorded the information about the user, their purchase, and their use rights.[50] Whether the copyright owner is remunerated for a single amount upon purchase, or each time the digital asset is used, and at what price, would be a commercial choice by the copyright owner. Any other terms – re-use or adaptation rights, rights determined by a range of other considerations, and so on – can be easily implemented using the blockchain and a system of smart contracts.

A smart contract system would also be able to facilitate much more complex transactions, encompassing multiple authors or multiple works. This would be a convenient management solution for works that are created via collaboration. For example, a film is developed by a producer/s, a director and by the inclusion of a cast and crew. Similarly, a song may have been written by A, performed by B and produced by C. All these people are involved in the creation of the work, meaning that all these people have interests in the copyright generated. A smart contract could automatically remunerate all the copyright owners their percentage of the copyright ownership, each and every single time the work is purchased or used.

One potential benefit from using the smart contract function for licensing is the technology's immutable nature.[51] Once the parties agree on the particular distribution of ownership percentages, these will be encrypted on the blockchain and cannot be tampered with. Thus, any potential future conflict or disagreements regarding royalty payments will be resolved and honoured as per the original agreements between the rightsholders. Time will tell whether this is a net benefit, as artists may wish for more flexibility to allow regular changes to the licensing terms. This is something that smart contracts can provide for, but not elegantly.

The use of smart contracts in automated licensing will, therefore, likely have a significant impact on different industries. The most beneficial consequence would be increased empowerment of the rightsholder to allow greater access to their licensing powers. Current systems of licensing are expensive, slow and problematic.[52] The direct and instantaneous distribution of payment from the user to the rightsholder should reduce the costs associated with collecting and managing statistics, maintaining databases and the distribution of royalty payments.[53]

We already have early indications of the changes that this type of licensing regime can implement; unsurprisingly, the first forays into blockchain licensing are in the music business.[54] The music industry is known for its poor money flows and traceability: it is estimated that 20%–50% of music payments do not make it to their rightful owners,[55] intermediaries are renowned for taking an unjustifiable amount of

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[50] Bill Rosenblatt, "Watermarking Technology and Blockchains in the Music Industry", *Digimarc* (2017) 13 <https://www.digimarc.com/docs/default-source/digimarc-resources/whitepaper-blockchain-in-music-industry.pdf?sfvrsn=2>.

[51] Trent McConaghy and David Holtzman, "Towards on Ownership Layer for the Internet", *Ascribe* (24 June 2015) <https://bravenewcoin.com/assets/Whitepapers/ascribe-whitepaper-20150624.pdf>.

[52] Lucie Guibault and Stef Van Gompel, "Collective Management in the European Union" in Daniel Gervais (ed), *Collective Management of Copyright and Related Rights* (Kluwer Law International, 2010); see also the discussion on collective management organizations, Part VI.

[53] Alexander Shelkovnikov, "Blockchain Applications in the Media Industry", *Deloitte LPP* (2016) <https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-blockchain-app-in-media.pdf>.

[54] See, eg, Rosenblatt, n 50, 15–17.

[55] Rethink Music initiative, "Fair Music: Transparency and Payment Flows in the Music Industry" (Report, Berklee College of Music's Institute for Creative Entrepreneurship, July 2015).

profit,[56] and the proliferation of streaming services has upended established verities about the viability of being a musician or recording artist.[57] Numerous start-ups have emerged, seeking to use the blockchain to solve these issues. An example of this is Ujo Music. Describing itself as a "global, open, decentralised, machine-readable licensing system" which uses a smart contract system based on the Ethereum blockchain.[58] A musician using the Ujo Music platform creates a user profile – similar to the profiles that are displayed on Spotify – and then uploads their music, which gives them control over distribution. The company describes the process as follows:

> Ethereum is utilized to build out flexible & modular licensing systems. Enabling automated payment to rights holders based on licenses they design themselves in our friendly and easy-to-use interface. It can be extended to incorporate a wide range of additional functionality: programmatic contracts, variable pricing, payment routing.[59]

Ujo Music has garnered significant press in the last year, and popular artists such as Imogen Heap have released albums on their blockchain. Other startups, such as Ascribe,[60] Bittunes[61] and Mycelia,[62] are using blockchain technology in various ways to seek to disrupt the music industry and, they say, empower rightsholders.

While the theoretical application of blockchain technologies to the music industry seems obvious, there are practical considerations of individual licensing via smart contracting which still demand answers. For example, is it really practicable, or likely, that users will ignore platforms like Spotify which stream more than a billion songs a day,[63] in order to contract individually with artists via a blockchain-based platform? To compete, the blockchain based systems will need to store and run millions, if not billions, of smart contracts, and will need to process them at speeds which are unfeasible using today's blockchain technology.[64] Other questions regarding security will need to be managed, especially as smart contracts are going to be tied to cryptocurrencies to clear the transactions. If there is a breach, what will be the adjudicative or administrative process to release or trace those funds?[65] Another consideration is whether users will want to obtain cryptocurrency in order to purchase the song or album. It will be interesting to monitor the success or failure of these startups over the next few years, but if they are successful then inevitably they will usurp traditional copyright licensing approaches.

VI. COLLECTIVE MANAGEMENT ORGANISATIONS

Current legal, economic and technological frameworks do not facilitate a practical or viable market for individual rightsholders to license their work, or monitor and enforce their rights, without the involvement of intermediaries.[66] Collective management of rights offers substantial economic benefits

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[56] David Gerard, "Why You Can't Put the Music Industry on a Blockchain", *HypeBot* (February 2017) <http://www.hypebot.com/hypebot/2017/08/why-you-cant-put-the-music-industry-on-a-blockchain-excerpt.html>.

[57] Gerard, n 56.

[58] Stuart Dredge, "Ujo Music on Blockchain: It's Such an Uphill Battle with Existing Companies", *Music Ally* (4 August 2017) <http://musically.com/2017/08/04/ujo-music-blockchain-uphill-battle-existing-companies/>.

[59] See Ujo Music (2017) <https://ujomusic.com/>.

[60] See Ascribe (2017) <https://www.ascribe.io/>.

[61] See Bittunes (2017) <http://www.bittunes.com/>.

[62] See Mycelia (2017) <http://myceliaformusic.org/>.

[63] Gerard, n 56, see also Stuart Dredge, "Spotify Now Processes 'Nearly 1bn Streams Every Day'", *Music Ally* (22 July 2015) <http://musically.com/2015/07/22/spotify-1bn-streams-every-day/>.

[64] See, eg, Rosenblatt, n 50, 17.

[65] "Law and Dispute Resolution on the Blockchain" (Roundtable discussion at Swinburne University of Technology, Hawthorn, 5 December 2017).

[66] See Australian Competition and Consumer Commission, "Copyright Licensing and Collecting Societies: A Guide to Copyright Licenses" (Draft, November 2006).

for both authors and users, notably by reducing transaction costs.[67] As a consequence, rightsholders are often encouraged, or required, to join CMOs that are relevant to their industry. These arrangements sometimes make CMOs an agent for the author, but often require an assignment of rights, making the CMO the copyright owner.

CMOs are collecting organisations that aggregate large catalogues of copyright works under their aegis, and then organise, grant, and enforce the licences on behalf of the individual rightsholder. The use of music for broadcast radio is a commonly cited example of a collectively-licensed use, where negotiating with individual rightsholders would be impractical. CMOs have greater bargaining power than individual rightsholders, they can locate a range of users more easily, and they generally have better resources than individual rightsholders in order to enforce rights.[68] These organisations were initially seen to offer a viable solution during a time when technological developments such as photocopiers and broadcasting devices led to widespread unlicensed reproductions of work,[69] with a consequential loss of control by individual rightsholders.[70] Nevertheless, CMOs have been criticised over the years for lack of transparency, time lags in payment of royalties/mandates, abuse of their monopoly positions, and inefficiency.[71] CMOs often provide "blanket licences" without representing all rightsholders of a particular class,[72] meaning they might be technically infringing.[73] In the context of orphan works, they have also been accused of operating under conditions of conflicted interest.[74]

Some even challenge the economic basis of allowing rights management under monopoly conditions by single entities – that is, the belief that CMOs achieve a "natural monopoly" where "the costs of production are such that it is less expensive for market demand to be met by one firm than by more than one".[75] CMOs can exploit monopolies against users that have only one supplier of licences for particular repertoires, and also against owners who have no alternative rights administration infrastructure available to exploit their works. There is now a substantial body of case law and scholarly commentary addressing the competition questions around particular practices of CMOs. Lucie Guibault and Stef van Gompel have demonstrated how often CMOs have been admonished for a range of problematic behaviour. This includes requiring authors to assign unduly broad categories of rights,[76] for discriminatory treatment of members in terms of income distribution,[77] denying membership to foreign

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[67] See Robert P Merges, "Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations" (1996) 84 *California Law Review* 1293.

[68] Severine Dusollier and Caroline Colin, "Peer-to-Peer File Sharing and Copyright: What Could Be the Role of Collective Management" (2011) 34 *Columbia Journal of Law and the Arts* 809, 817.

[69] Daniel J Gervais, *(Re)structuring Copyright* (Edward Elgar Publishing, 2017) 235.

[70] Kaya Koklu, "Individual Licensing of Copyrighted Works" in Kung-Chung Liu and Reto Hilty (eds), *Remuneration of Copyright Owners* (Springer, 2017) 177.

[71] See Gervais, n 69, Ch 11.

[72] See Daniel J Gervais, "Collective Management of Copyright and Neighbouring Rights in Canada: An International Perspective" (2002) 1 *Canadian Journal of Law and Technology* 21. Gervais discusses the various legal presumptions under which this reality is addressed.

[73] Guibault and Gompel, n 52.

[74] Stef Van Gompel, "The Orphan Works Chimera and How to Defeat It: A View from Across the Atlantic" (2012) 27 *Berkeley Technology Law Journal* 1347, 1363.

[75] Ariel Katz, "The Potential Demise of Another Natural Monopoly: Rethinking the Collective Administration of Performing Rights" (2005) 1 *Journal of Competition Law and Economics* 541. Katz claims, for instance, that there are other levels of intermediation available (ie publishers) that could make rights management feasible without monopolies, and that individual licensing would not be possible (ie purchasing music is generally an individual level transaction).

[76] Guibault and Gompel, n 52, "Collective Management in the European Union"; see *BRT v SABAM* (1974) ECR 51; Commission Decision of 06.08.2002 in case COMP/C2/37.219 Banghalter/Homem Christo (Daft Punk) v SACEM, 6 January 2010 concerning authors that wanted to maintain rights to distribute on the internet.

[77] *Commission Decision 71/224/EEC of 2 June 1971 Relating to a Proceeding under Article 86 of the EEC Treaty (IV/26 760 – GEMA)* [1971] OJ L 134/15.

authors and access to foreign users,[78] for charging excessive fees to users that wish to license primarily foreign works,[79] and for refusing to license only part of their repertoire.[80]

The result has been varying degrees of regulatory supervision, with many jurisdictions attempting to prevent market abuse through unilateral establishment of fees and tariffs under competition laws.[81] Many of these issues have also been regulated through judicial decisions and specific statutes, as well as "soft-law" approaches like recommendations or codes of conduct. Nonetheless, multiple issues with CMOs remain, and some argue "the collective management of rights … is in a state of chaos".[82]

The issues with CMOs have become numerous enough that bodies around the world are discussing how new technologies might enable fairer and more transparent systems of remuneration.[83] Blockchain platforms afford one technological pathway for augmenting or usurping the intermediary function of CMOs. Being both network and database technologies at the same time,[84] blockchain platforms enable the replication of CMO functions, bringing together users with works, but featuring drastically reduced transaction costs. Blockchain platforms could thus be used as infrastructure for rights "clearinghouses" that provide access to rightsholder information, while also automating licensing through smart contracts where rightsholders have control over licensing conditions. This promises to afford a transparent value chain for works.[85] Blockchain platforms could also assist with the orphan works problem, discussed below, and eliminate the necessity of CMO participation in "extended collective licensing" – one of the standard mechanisms proposed to deal with the orphan works problem. Further, under present conditions, CMOs are constantly litigating against each other to prevent multi-jurisdictional licences. However, blockchain platforms could eliminate the need for online content providers to acquire a licence from the relevant CMO in every jurisdiction.[86]

A blockchain based technical ecosystem could therefore co-ordinate registration, licensing and DRM functions in a manner sufficient to unseat the monopoly position of CMOs. The one-stop shop function for licensing, seen as economically imperative by bodies like the European Commission,[87] could be instead performed by a technical architecture. CMOs are entrenched economic actors however, and challenging their institutional role requires substantial incentivisation. Copyright owners need a reason to participate in creating a repertoire that can generate the economies of scale and network effects necessary for new copyright approaches. Blockchain platforms do carry their own incentives system however. As noted above, blockchain "mining" mechanisms reward actors protecting the security and integrity of the system with tokens. Rightsholders could also be rewarded with tokens for supplying works into a licensing architecture that could be exchanged for other currencies, or, depending on the

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[78] *Phil Collins and Patricia Im- und Export v Imtrat and EMI Electrola* (C-92/92, C-326/92) (1993) I ECR 5145.

[79] *Ministère public v Tournier* (1989) ECR 252.

[80] *Ministère public v Tournier* (1989) ECR 252.

[81] Adolph Dietz, "Legal Regulation of Collective Management of Copyright (Collecting Societies Law) in Western and Eastern Europe" (2002) 49 *Journal of the Copyright Society of the USA* 897. This sector specific competition approach is taken in the United Kingdom, whereas the United States has no systematic regulation of collecting societies, with anti-trust regulation left to general legislation. On the other hand, many continental European countries have much more rigorous controls on CMOs, covering issues such as authorisations to establish a CMO, how tariffs are set, how much bureaucratic supervision applies, how royalties are distributed.

[82] Guibault and Gompel, n 52, 166.

[83] This was of particular focus at the 2015 annual conference of the *Association Littéraire et Artistique Internationale.* ALAI is the world's first CMO founded in 1878 and is now a key body for exploring international issues in copyright; see Koklu, n 70, 178; see also Ariel Katz, "The Potential Decline of Another Natural Monopoly: New Technologies and the Administration of Performing Rights" (2006) 2 *Journal of Competition Law and Economics* 245.

[84] Vinay Gupta, "The Promise of Blockchain Is a World Without Middlemen", *Harvard Business Review*, 6 March 2017 <https://hbr.org/2017/03/the-promise-of-blockchain-is-a-world-without-middlemen>.

[85] Marcus O'Dair and Zuleika Beaven, "The Networked Record Industry: How Blockchain Technology Could Transform the Record Industry" (2017) 26 *Strategic Chance* 471.

[86] See Guibault and Gompel, n 52, noting that the system of reciprocal international licences is in turmoil.

[87] Gervais, n 72, 37.

structure of the system, represent rights to participate in system governance (i.e. voting). As an alternative to individual or private licensing systems, CMOs could be rebuilt on blockchains as "distributed autonomous organisations",[88] operating through interacting smart contract ecologies.

VII. Orphan Works

The final change to copyright law that the blockchain promises is in the area of orphan works. Orphan works are, of course, works which are still ostensibly in copyright, but for which no author can be found. In a recently published article, we have examined the way in which the blockchain could be used to track orphan work searches and then automatically render certain works into orphanhood, for all to use.[89] Although we do not wish to rehearse the entire article here, in the interests of giving a full account of copyright and the blockchain we provide a brief summary in this section.

To solve the orphan works problem, we propose a system that has three components, based around a blockchain-based registry system. Although a mandatory register of copyright owners is an impossible and illegal proposition, we propose using a blockchain to create a register of attempts to look for rightsholders. Because the *Berne Convention* and *GATT TRIPS* agreements prohibit mandatory copyright formalities that might generate a registry of rightsholders, most orphan works clearance mechanisms are anchored around a good-faith diligent search for an owner. Unfortunately, a diligent search for a rightsholder is expensive – search costs are sufficient to prevent many uses of orphan works, especially large-scale uses by cultural institutions.[90] The first component of our proposal is therefore an artificial intelligence system to perform a diligent search for a rightsholder. There has already been some discussion, and experimental implementation of, diligent search expert systems in Europe. And while those deployments of automation are a substantial step towards making orphan works available, we suggest that the process could be dramatically improved with one additional mechanism: a dynamic, immutable, auditable record of those searches.

The second component of our proposal is, therefore, a blockchain register where every search for a work's owner can be recorded. That register of searches has the potential to bring evidential significance to an automated system for diligent search, rather than it being exclusively a tool of institutional risk management. Think of this as a ledger where every possible orphan work has a page, and on that page is recorded each attempt by a would-be-user of that work to find the owner. For each orphan work there may be zero, one, two, or a million searches recorded, and every time someone looks for the owner of the work the search is collected and recorded. Of course, these searches are all coded on the blockchain, for all to see and use. Over time the number of searches will increase, and the ledger will become more and more authoritative.

The third component is a legal mechanism that delivers works into "orphanhood", and affords a right to use those works after a search for a rightsholder is deemed "diligent". In our article, we proposed that any user of an orphan work be assured they were not violating copyright if they had performed a diligent search for the work's owner. We offered a range of legal mechanisms by which one could assess what amounted to a diligent search, without wishing to specify which one was necessarily best.

Our conclusion in that article – and our suggestion here – is that blockchain platforms offers real prospects for solving the orphan works problem, in ways not available in more traditional registry structures. Whereas existing orphan works registries provide entries for works already deemed orphaned, the blockchain-based system we proposed would not merely record administratively-verified orphan works for the purpose of avoiding search duplication, but rather would be part of the mechanism that delivers a work into orphan status. We believe that the logics of co-ordination and consensus building associated with blockchain are highly useful not only to enable the verification of diligent search, but

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[88] These are described in Melanie Swan, *Blockchain: Blueprint for a New Economy* (O'Reily, 2015).

[89] Goldenfein and Hunter, n 3.

[90] Anna Vuopala, "Assessment of the Orphan Works Issue and Costs for Rights Clearance", *European Commission* (May 2010) <http://cultivate-cier.nl/wp-content/uploads/2012/03/vuopala_report.pdf>.

also to create an automated system that can issue and register rights to use an orphan work. And it would do so without the profiteering that has been associated with private copyright management.[91]

VIII. CONCLUSION

There has been argument in favour of digital systems that are useful for managing copyright works and rights for some time, and research and development of complex "electronic copyright management systems" has been an ongoing commercial imperative. These are combinations of repertoire databases, automated licensing engines, and usage monitoring with spiders looking for unauthorised copies of works.[92] Despite the potential for lowering transaction costs these systems still require an intermediary. Clearing houses still generally broker between CMOs and users, and the relationship between the intermediary CMO and the rightsholder remains vexed. Because they can operate as an "institutional technology",[93] blockchain platforms are able to perform those automated licensing and enforcement functions, as well as the organisational functions of a CMO. Blockchain platforms therefore present the possibility of rightsholders becoming the intermediary themselves, or otherwise disintermediating the relationship between rightsholder and user. The blockchain protocol also operates across jurisdictions, eliminating the territorial complexity, and absurdity, of national collective licensing systems and reciprocal relationships. They can also be linked to real-time content distribution networks, automated licensing agents, and open DRM systems that can automate licensing conditions and interact with user identities.

New legal architectures will still be necessary for administering these technical systems. There will almost certainly be a need to connect the technical infrastructure of the blockchain to the decisions from dispute resolution bodies: for instance, there are likely to be disputes over who owns what rights, or whether an automated licence performed as specified. It may also be necessary to translate legislative pronouncements, for instance concerning copyright exceptions, into smart contract systems (or distributed autonomous organisations). Smart contracts also cannot be edited or deleted beyond the parameters of their technical code.[94] Building in the necessary adaptability for legal governance is not simple, especially when specific territorial legal considerations materialise in an otherwise universal system.

It is true that entirely do-it-yourself success via blockchain licensing has generally remained elusive for individual creators;[95] but it is not only individuals who could use blockchain licensing systems. Publishers may be a more prominent user class than individuals as the transaction costs of using the system will only be beneficial at a certain point in the "long tail" economics of copyright works. There are also issues around verifying information and data integrity that indicate private blockchain might be a better approach, which would require the introduction of new intermediaries to govern the technical infrastructures.[96]

All of these issues will need resolution as we seek to connect the legal system of copyright to the technical system of the blockchain. Although it is unclear how these issues will be resolved, it is certain that, in the next decade, the blockchain protocol will have a significant effect on the development of the copyright system, and on the industries that are dependent on it.

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[91] See, eg, Jonathan Band and Brandon Butler, "Some Cautionary Tales about Collective Licensing" (2013) 21 *Michigan State International Law Review* 689.

[92] Gervais, n 72, 36–37.

[93] Sinclair Davidson, Primavera de Filippi and Jason Potts, "Blockchains and the Economic Institutions of Capitalism" (2018) *Journal of Institutional Economics* 1.

[94] At least without forking the code of the smart contracts, see Curtis Yarvin, "The DAO as a Lesson in Decentralized Governance", *Urbit*, 24 June 2016.

[95] O'Dair and Beaven, n 85, 472.

[96] O'Dair and Beaven, n 85, 476.