

Music On The Blockchain

Blockchain For Creative Industries Research Cluster
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Blockchain for Creative Industries (BCI) is an interdisciplinary research cluster at Middlesex University, which draws together researchers from Media, Performing Arts and Computer Science to explore applications of blockchain technology in the creative industries. Our research – on business models, creative identity, copyright, digital rights and digital forensics – informs undergraduate ‘live projects’ as well as postgraduate research. We are part of the academic working group for the Open Music Initiative.

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Foreword

Much has been made of the massive opportunity for artists in the digital economy but that potential has been tempered by stories of revenue streams that are too complex to understand, old-world structures within the music industry that are not fit for the digital age, a lack of good data and a decrease in remuneration for the majority of artists.

It has been said many times that if anyone were to design a music industry for the present, let alone the future, it might be very different from the historic one that young artists today have inherited. Yet credible strategies to modernise have so far proved elusive.

Distributed Ledger Technology (DLT), or 'blockchain', has started to receive increasing media attention and investment from several sectors including governments, financial services and the creative industries. The potential application in relation to music is of particular interest, as it appears to offer solutions to problems artists have highlighted for decades – around transparency, the sharing of value and the relationships with intermediaries that sit between the artist and fan, the central and most important relationship in music.

If blockchain technology can help the commercial and contractual relationships in music keep pace with technology and the communication between artists and fans then it could be truly revolutionary.

Critics of blockchain technology state that claims made about it are overstated and that it will be years, even in the best case scenario, before we see some of the benefits that many artists hope for. Through the debate, there clearly needs to be some objective and rational analysis to cut through the hype of a utopian vision and help us understand the reality of the current landscape, the potential for the future and what the next steps might be to bridge the gap. This report is a valuable contribution to that endeavour and I hope it can help inform the debate and take us all forwards.

If blockchain technology is going to be the future, we need to dig in and make it happen.

Nick Mason
Pink Floyd

Summary

Naughton (2016) suggests that blockchain technology could be 'the most important IT invention of our age'; Mougayar (2016) that it is 'at the same level as the World Wide Web in terms of importance' (p19).

Both in the media and at industry events, there has been an explosion of interest in recent months in the potential impact of blockchain technology on the music industries, in particular those associated with recorded music. Yet while the debate between 'for' and 'against' camps has at times seemed black and white, it is important to remember that the blockchain is a technology rather than a particular product, and its applications are already diverse. What is called for is a critical, analytical overview.

In this report, the Blockchain for Creative Industries cluster at Middlesex University highlight four areas in which blockchain technology does appear to have transformative potential for recorded music:

- 1 As a networked database for music copyright information
- 2 Facilitating fast, frictionless royalty payments
- 3 Offering transparency through the value chain
- 4 Providing access to alternative sources of capital

We also question other claims for blockchain technology:

- » That it would give artists increased control over pricing and terms of use
- » That it would necessarily be used to create a 'fair trade' music ecosystem
- » That it is likely to bring about the demise of record labels and performance rights organisations

Finally, we set out the significant barriers to adoption:

- » Issues with cryptocurrencies
- » Impact of governance and regulation on the integrity of the data
- » Difficulty of reaching critical mass

We conclude by setting out our agenda for future research.

Introduction

The music industries are worth an estimated \$45 billion globally, of which the record industry – those aspects associated with recorded music – is responsible for approximately \$15 billion (Rethink Music 2015). 2015 marked an overall increase in income from recorded music of 3.2%, yet this can be seen as a cause for optimism only in the context of two decades of apparently inexorable decline (IFPI 2016). Though the era of legal downloads and, more recently, streaming may in some respects seem an improvement on the initial ‘piracy’ era of digital consumption (Watson 2015), the shift to a model based on access rather than ownership has brought with it significant challenges.

In this report, Middlesex University’s Blockchain for Creative Industries (BCI) research cluster take stock of the recent explosion of interest in blockchain technology, seen by some as a solution to challenges faced by the record industry. New organisations exploring the potential of blockchain technology for recorded music include Mycelia, Dot Blockchain Music, Ujo Music, Peertracks, Bittunes, Aurovine and Blokur. We propose four areas in which we believe blockchain technology does indeed have transformative potential, as well as outlining additional claims that have been made for blockchain technology. We also outline barriers to, and possible downsides of, adoption, and conclude by setting out an agenda for future research.

Our aim is to provide answers to three main questions:

- 1 What is blockchain technology?
- 2 How might it transform the record industry?
- 3 What are the main challenges to adoption?

What Is Blockchain Technology?

Blockchain technology emerged as the foundation for the cryptocurrency, bitcoin, and the associated payment system, Bitcoin. It was first discussed in a 2008 paper written by Satoshi Nakamoto¹ and implemented early the following year. While Bitcoin was ingenious in a number of respects, many now believe that Nakamoto's most important innovation was not bitcoin itself but its underlying blockchain technology. This allowed payments made on its network to be conducted peer-to-peer, without the need for a third party to verify the authenticity of the transaction.

At root, the blockchain is a ledger, but one whose distributed 'mesh' structure is markedly different to the 'star' or 'hub and spoke' structure of centralised and even decentralised systems (Baran 1964). It has two major features that make it highly attractive as a store of data. Firstly, data written to it is immutable and therefore provides an auditable record of events that cannot be modified. Secondly, an exact copy is maintained in a large number of independent locations: there is no central point of failure.

Blockchain technology allows payments to be peer-to-peer, without a third party

Some now regard the use of bitcoins to purchase goods – a pizza in the landmark first commercial transaction in 2010, or drugs on the notorious 'dark web' marketplace Silk Road, shut down by the FBI in 2013 – as a mere first step. 'Meta coins' have extended the functionality of the Bitcoin blockchain, while 'alt coins' run on their own blockchains entirely. Ethereum, for instance, can be considered a 'second generation' blockchain, one that is particularly suitable for 'smart contracts': contractual agreements implemented via software, a notion first proposed by Szabo (1997).

'Blockchain', then, refers to a technology rather than a particular product, and the applications of this technology are diverse. Blockchains already vary in incentive and consensus method (proof of work versus proof of stake, for instance). There is also an important distinction between permissioned and permissionless blockchains, and between public and private². Permissioned blockchains differ markedly from the Bitcoin model, for instance, in that they

Cryptocurrency

A digital currency whose security is guaranteed through the use of cryptography

Transaction

The transfer of coins from an address (or addresses) to another address (or addresses). An address is the public representation of the public and private key pairs that are used to store and transfer coins. It is used to send and receive funds

Meta coin

A coin created on top of the Bitcoin blockchain but with additional functionality that allows a small amount of bitcoin to represent another asset

Alt coin

A cryptocurrency other than bitcoin

Ethereum

A blockchain that runs smart contracts using its own cryptocurrency, ether

Smart contract

A contractual agreement built on computer protocols, whose terms can be executed automatically

Proof of work

A method of achieving network consensus, whereby the ability to mine coins is dependent on the computing power of the miner

Proof of stake

An alternative consensus mechanism to proof of work, whereby the number of coins that can be mined is dependent on the number already possessed

1. The name is widely considered to be a pseudonym.

2. Public blockchains are usually considered synonymous with permissionless blockchains but they can also be permissioned (BitFury Group 2016); private blockchains, meanwhile, can *only* be permissioned.

are open only to authorised participants, thereby potentially removing such familiar aspects as proof-of-work and miner's fees, yet they still offer some of the same improvements in terms of efficiency.

Mougayar (2016) states that blockchain technology is as important as the World Wide Web, 'and arguably might give us back the Internet, in the way it was supposed to be: more decentralised, more open, more secure, more private, more equitable, and more accessible' (pxix). The UK government is among those to endorse the possibilities the technology offers (HM Treasury 2015, Waplor 2016) while MEPs have also been positive (Von Weizsäcker 2016). The World Economic Forum (2015) predicts that we could store 10% of global GDP on blockchains by 2025 (p7).

It has been suggested that blockchain technology is as important as the World Wide Web

Banks too have shown considerable interest in blockchain technology, with an associated explosion in financial technology: so-called 'fintech'. While the main impetus is in commercial banking, both the European Central Bank (2015) and the Bank of England (Ali et al 2014) have been cautiously supportive. This is a surprising shift for a technology that was until relatively recently primarily associated with the 'dark web' and anti-authoritarian 'cypherpunks': activists who advocate anonymous transactions and the use of cryptography to achieve privacy in an electronic age (Hughes 1993).

Permissioned blockchain

A blockchain whose use is restricted to known, vetted participants

Permissionless blockchain

A blockchain that is accessible to anyone who wishes to use it

Public blockchain

A blockchain that grants read access and ability to create transactions to all users

Private blockchain

A blockchain that limits read access to particular users

Mining

Best thought of as nodes or bookkeepers, miners compete to solve a mathematical puzzle that requires the consumption of computing power (see 'proof of work'). Once the puzzle is solved, the new block of transactions is accepted by the network and committed to the blockchain. The miner is rewarded with newly generated coins

How Might It Transform The Record Industry?

Claims in the media for blockchain technology as a solution to many of the challenges facing recorded music have been bold. It has been suggested that the blockchain could 'revolutionise' the music industry (Wallach, 2014; Perez, 2015). Bartlett (2015) hailed the British singer, songwriter and producer Imogen Heap as a possible 'saviour of the music industry' for her Mycelia concept, while Gansky (2016) suggests that Mycelia 'will revolutionise the way music gets played and how artists get paid'. Gottfried (2015) goes as far as to suggest that the blockchain alone 'can help solve virtually all of the challenges the music industry currently faces'.

In terms of its effect on the record industry, BCI see the potential of blockchain technology most clearly in four areas:

- 1 A networked database for music copyright information
- 2 Fast, frictionless royalty payments
- 3 Transparency through the value chain
- 4 Access to alternative sources of capital

Taken together, we believe these changes have the potential to create what – with reference to Yochai Benkler (2006) – we call the *networked record industry*.

1 A Networked Database For Music Copyright Information

Any piece of recorded music contains at least two copyrights: one for the sound recording itself, relating to the performer and the record label, and one for underlying words and music, relating to the songwriter or composer and the music publisher. These could be stored on the blockchain, via a cryptographic hash. Improvements in authorship and attribution alone, however, would not overcome the fact that there is no single database that documents ownership of all song and recording copyrights. Instead, there are numerous databases, none entirely comprehensive; information can vary between one database and another, with no central authority to settle conflicts. Each individual database must be contacted in order to correct any errors.

Blockchain technology is potentially transformative in functioning as both database and network (Gupta 2016). It allows information to sit on a

Hash

A process that converts data into a unique output of a fixed length to produce a digital fingerprint

distributed ledger rather than in silos. This would mean that information on the blockchain would be updated instantly and automatically; the same information would also be available to all users rather than stored in discrete databases.

Metadata embedded into every piece of recorded music could include terms of use and contact details for the copyright holders, making it far easier to locate the owners of a piece of recorded music and to obtain a license to use it. Benji Rogers, of the Dot Blockchain Music initiative, is working on a 'wrapper' or 'container' that would house MP3 or WAV files and contain information as to who should be paid and how they can be contacted. Others envisage the inclusion of more information: for Mycelia, Imogen Heap envisages including key, tempo, lyrics, instruments, the location in which a piece of music was written, even the type coffee she was drinking as she wrote it. The potential for sponsorship is clear.

The blockchain functions as both database and network, allowing information to sit on a distributed ledger rather than in silos

Conceivably, the gradual placing of copyright data on the blockchain could ultimately lead to the creation of one, comprehensive copyright database for music. While the Global Repertoire Database, a high-profile attempt to achieve a broadly similar result, suffered an equally high-profile collapse in 2014, blockchain technology could by contrast allow the process to occur incrementally.

Global Repertoire Database

An attempt by music publishers to create a central database of owners, beneficiaries and administrators of lyrical and musical copyright

The notion of a networked database for music copyright information is contentious, however. Many cite the failure of the Global Repertoire Database, as well as broadly similar attempts such as the International Music Joint Venture and the International Music Registry, as evidence of the impossibility of the task. The question of who would enter the data is key, as is the question of how the data would be verified: there are legitimate concerns around 'dirty data', with many repeating the adage: 'garbage in, garbage out'. Other issues include the sheer volume of data that would need to be stored, and the difficulty of resolving any conflicts over data.

In discussion of the role blockchain technology could play for recorded music, there is not always a clear distinction between songwriting and

sound recording rights. It is also the case, as Silver (2016) points out, that a session player doesn't necessarily know whether he ended up on a final mix (p45); and that entering data would be an additional burden for musicians (or, indeed, their managers). It is also the case that credits and splits may not be known at the point of recording, instead sometimes being negotiated after the event. Silver also points out that, while the Dot Blockchain Music proposal for Minimum Viable Data is attractive, it neglects 'the fundamental challenge with which the collecting societies grapple': essentially that complete ownership information is highly complex and often in flux (p36). It is particularly in flux, it seems, for hit recordings: charges of plagiarism have dogged such recent hits as 'Blurred Lines' by Robin Thicke and Pharrell Williams, 'Stay With Me' by Sam Smith, and Mark Ronson's 'Uptown Funk'.

The question of who would enter the data is key, as is the question of how the data would be verified

It is also unclear whether a cryptographic hash stored on the blockchain would in itself prevent copying. To do so would probably require something akin to Digital Rights Management (DRM), which was hugely unpopular when introduced in the mid-2000s. There are further logistical questions too, since even a microscopic edit of the same track, or minute alteration in tempo, would create a different hash. It is also unclear how samples would be identified.

2 Fast, Frictionless Micropayments

Royalty payments, for both the sound recording and the underlying words and music, are often slow, taking months or even years to reach the bank accounts of rights holders. Given that fans can listen to tracks at the click of a mouse, this seems archaic. 'Friction' is an issue too since, by the time the money reaches rights holders, more than one performance rights organisation, or PRO, may have deducted administrative fees (Rethink Music 2015, p20).

Blockchain technology has the potential to change this situation in various ways. Firstly, the low transaction costs of cryptocurrencies, which have a large range of denomination, typically to eight decimal places, make micropayments feasible. This is particularly important given the small size of typical payments in the streaming era. It would also allow content creators to

receive 'tips', even in very small sums. Tapscott and Tapscott (2016) suggest that the blockchain could also allow for the 'micrometering' of streamed content such as videos: thousandths of a penny for milliseconds of video. It remains uncertain, however, whether consumers will pay for streams, which are currently more typically monetised through subscription or advertising models.

The low transaction costs of cryptocurrencies facilitate micropayments. They also allow content creators to receive tips, even in very small sums

Secondly, smart contracts, implemented via software, could allow music royalties to be administered almost instantaneously. Rather than passing through intermediaries, revenue from a stream or download could be distributed automatically between rights holders, according to agreed 'splits', as soon as a track is downloaded or streamed.

As well as improving cash-flow for artists, smart contracts could have a significant effect on counterparty risk within the sector. The record industry can be characterised as a web, connecting numerous small/medium enterprises (SMEs) with other SMEs and micro-businesses, and even the three so-called 'major' labels, through sometimes complex licensing arrangements. Since relationships are often carved out by territory for periods of several years and subject to accounting periods that might at best be six months apart, SMEs and micro-businesses may be holding sums for onward payment for substantial periods, leaving the money vulnerable to seizure in the case of business failure. The demise of distributor Pinnacle in 2008 is a reminder of the reliance of independent labels, in particular, on this global network of contractual obligations and their exposure when businesses in those networks fail. Smart contracts would appear to eliminate this aspect of counterparty risk completely.

It is true that much of the debate regarding the speed of royalty payments seems to overlook the fact that artists tend to be paid in advances: a record label or publisher pays money to the artist and then keep the artist's royalties until it has 'recouped', or made its money back. Yet while the speed of accounting is not important for an artist yet to recoup, it would have an immediate effect on artists who do not receive large advances or given a non-recoupable advance. Since remuneration from public performance rights, normally administered by performance rights organisations, are inalienable

and therefore not available to count against recoupment, the effect of introducing blockchain technology could also have an instant effect on income relating to performing rights from the song copyright (via PRS For Music, in the case of the UK) and equitable remuneration on performance rights income from the recording copyright (via PPL in the UK).

3 Transparency Through The Value Chain

There is a lack of transparency in the value chain for recorded music. ‘Significant funds are often paid to the wrong party’, while ‘large pools of royalty revenue end up outside the artist’s reach in a so-called “black box” – where rightful owners of royalty revenue cannot be accurately identified because of a lack of an industry-wide system for tying usage to ownership’ (Rethink Music 2015, pp 3-4). And since the specific details of many streaming deals are hidden behind non-disclosure agreements, it is difficult for artists and songwriters (or their managers) to assess whether labels, publishers or collective management organisations are processing payments efficiently (Cooke 2015).

Perhaps the most ingenious aspect of Bitcoin was that it produced a practical working solution³ to the so-called Byzantine Generals Problem (Lampert et al 1982), essentially the problem of exchanging information over an unreliable and potentially compromised network. Nakamoto’s solution used a ‘proof of work’ algorithm (Back 2002) to achieve consensus without, crucially, requiring a central trusted authority or intermediary to verify the transaction. This could radically transform a culture of ‘black boxes’ and non-disclosure agreements, bringing transparency throughout the value chain.

Revenue from a stream or download could be distributed automatically between rights holders as soon as a track is downloaded or streamed

For Mycelia, Imogen Heap also envisages increased transparency between artist and fan. For her track ‘Tiny Human’, intended as a test case for releasing music using blockchain technology, Heap posted her own income, together with the income earned by her fellow musicians and other contributors

PRS For Music

A collecting society for songwriters, composers and music publishers. PRS (Performing Right Society) For Music collects license fees from anyone that uses music for business benefit and then pays royalties to its members

PPL

A collecting society for record companies and performers. PPL (Phonographic Performance Ltd) licenses recorded music played in public or broadcast on the radio or TV and then distributes fees to its members

Byzantine Generals Problem

Imagine several divisions of the Byzantine army camped outside an enemy city, each division commanded by a general who may or may not be a traitor. Communicating only via messenger, how can they guarantee that all loyal generals decide upon the same plan of action – and that a small number of traitors cannot cause the loyal generals to adopt a bad plan?

3. It is still technically possible to carry out a ‘51% attack’ on the network.

such as the mastering engineer, on the Ujo Music website. (That these sums are small should not be taken as evidence that blockchain technology has nothing to offer recorded music; to purchase the track from Ujo required the possession of ether, which, particularly in the autumn of 2015, reduced the market dramatically. It can be understood, rather, as an attempt to provide proof of concept.) On the Mycelia model, this transfer of information between artist and fan could be two-way; artists and their managers would also be able to gain access to data on those listening to their tracks at home or playing them on radio stations on the other side of the world.

Not all feel comfortable with such transparency. From the perspective of a label or publisher, some information could clearly be commercially sensitive; adoption would require, for instance, a belief that increased transparency would make companies more attractive to artists or, indeed, users. For different reasons, fans too may be unwilling to share data. Even for artists, transparency can bring challenges, as is clear from issues experienced during some crowdfunding campaigns (Beaven 2015). While less established artists might wish to be perceived as earning more than they actually are, major stars might wish to downplay their revenue, fearing that disclosure would make fans less willing to purchase their work.

Blockchain technology could radically transform a culture of 'black boxes' and non-disclosure agreements, bringing transparency throughout the value chain

There are, however, various proposals for utilising blockchain technology in the context of recorded music and they differ in the level of transparency they propose: on Dot Blockchain Music, for instance, anything beyond the Minimum Viable Data would be optional. It is certainly possible for artists and managers to be able to view the full value chain without making that same information available to all users.

4 Access To Alternative Sources Of Capital

Seed funding – often a crucial step between start-up and venture capital investment – is a major challenge in the record industry. Blockchain technology could help in three ways.

Ether

The cryptocurrency used on the Ethereum blockchain

Seed funding

Relatively small investment required to start a business, typically from friends, family or angel investors

Venture capital

More substantial funds required for a business, typically from venture capitalists

Firstly, despite some growth in alternative funding models such as Seed Enterprise Investment Schemes (SEIS) and crowdfunding platforms, access to capital for artists attempting to operate without a record label remains limited. This is in part because of the difficulty of understanding a clear pathway to profitability for some artists and of effectively assessing, and therefore pricing, capital. The transparency inherent in delivery of music via the blockchain could improve investor ability to monitor activity and investment outcomes, facilitating the modelling of likely returns and potentially affecting the pricing of capital.

Seed Enterprise Investment Schemes

Designed to help small, emerging companies raise equity finance by offering tax relief to investors who purchase shares in those companies

Blockchain technology could have a significant effect on crowdfunding, with artists issuing their own shares or tokens and smart contracts guaranteeing that pledge contributions would be returned were funding targets not met

Secondly, blockchain technology could bring about the emergence of ‘artist accelerators’ along the lines of technology start-ups. The possibility for fully automated monitoring of artists throughout their careers, via smart contracts, could make this ‘accelerator’ model relevant to artists, opening up the sector to new sources of capital seeking high-risk and highly scalable businesses for seed or venture capital. The opportunity to ‘hot house’ a group of emerging artists, offering access to resources, mentoring, facilities and networking in exchange for a small stake in their future sound recording income⁴ might become a viable business model for portfolio investors.

Accelerator

A kind of ‘incubator’ for tech start-ups, typically lasting three months, in which mentorship and other support is provided in return for equity

Finally, blockchain technology could have a significant effect on crowdfunding, with artists issuing their own shares or tokens and smart contracts guaranteeing that pledge contributions would be returned were funding targets not met.

Other Advantages Claimed On Behalf Of Blockchain Technology

BCI regard the prospect of a networked database of music copyright information, near-instant micropayments, transparency through the value chain and access to alternative sources of capital as the four key potential benefits of blockchain technology for the record industry, though even these are not

4. This seems more likely than songwriting income, due to copyright law.

without their challenges. Some have claimed additional benefits, which we address here.

Artistic Control Over Pricing And Terms Of Use

Howard (2015) envisages artists using blockchain technology to break out of the blanket licensing system and licence their works individually at prices of their own choosing. Since it could diminish their important capacity for blanket licensing, however, widespread withdrawal from PROs seems unlikely.

Widespread withdrawal from performance rights organisations seems unlikely, and flexible pricing presents challenges

Although artists can already set their own prices for music sold via their own websites, they cannot do so on most digital service providers. Some have suggested that artists could use smart contracts to establish the pricing of tracks, although flexible pricing would present challenges, for instance in terms of chart eligibility.

'Fair Trade' Music

Some have suggested that blockchain technology can bring about a 'fair' or 'fair trade' music ecosystem⁵. The potential benefits of blockchain technology – a networked database of music copyright information; faster, frictionless, royalty payments; transparency through the value chain; access to alternative sources of capital – could indeed offer artists and songwriters a greater share of value. It is also true that distributed networks can allow autonomous agents to freely determine their behaviour and linkages without having to pass through intermediary 'hubs' (Bauwens 2005).

Yet it is not clear that all parties understand 'fairness' or 'fair trade' in the same way. Neither is it clear that blockchain technology is intrinsically more 'fair'. Private, permissioned blockchains, for instance, might have a number

5. The notion that blockchain technology can give us 'fair' or 'fair trade' music has been proposed by Imogen Heap and Benji Rogers, as well as Stem, a start-up exploring the potential of blockchain technology for tracking revenue streams from digital service providers; Aurovine, a platform for listening to and sharing music via the blockchain; and the music streaming platform Resonate.

of advantages but ‘fairness’ would not necessarily be one of them. O’Dwyer (2014) states that even Bitcoin, often presented as politically radical, is in fact driven by a strong neoliberal agenda. Although there is no suggestion of this happening so far, peer-to-peer projects that provide distributed file storage – such as IPFS⁶, which facilitates Dot Blockchain Music – also appear to have the ability to facilitate a new music ‘piracy’ that would be extremely difficult to shut down.

Another issue is that it is uncertain to what extent users would respond to the notion of ‘fair trade’ music; their support would be important in encouraging adoption.

Cutting Out The Middleman

The ingenuity of Bitcoin lies in ‘allowing any two willing parties to transact directly with each other without the need for a trusted third party’ (Nakamoto 2008, p1). Some have suggested that blockchain technology could remove such third parties from the record industry. PwC (2014), for instance, present the technology in terms of disintermediation: providing opportunity for filmmakers, musicians, artists, authors and other content creators to more easily sell their work to fans worldwide, bypassing country-based currencies, payment networks, gateways and distribution platforms (p6).

It is not clear that all parties understand ‘fairness’ or ‘fair trade’ in the same way, nor that blockchain technology is intrinsically more ‘fair’

In practice, it is highly probable that any intermediaries that add value will remain, though percentage ‘splits’ may alter in the favour of artists and songwriters. Music publishers, for instance, might concentrate on data verification and the resolution of disputes; even if their administrative function is replaced by blockchain technology, their role in negotiating payments is likely to continue. Perhaps most significantly, royalty payments could be split almost instantly according to agreed percentages and paid directly to artists and songwriters; though third parties could still take a cut, they might occupy a different position in the value chain.

6. Other examples would be Storj and Madsafe.

What Are The Main Challenges To Adoption?

Certainly, a number of issues with using blockchain technology in the context of recorded music remain unresolved. We outline the most pertinent below.

Issues With The Cryptocurrencies

Hileman (2013) points out that alternative currencies often survive for only brief periods, although even in 2013 he acknowledged that bitcoin possessed radical characteristics. In 2016, it has been joined by other successful cryptocurrencies including ether, the currency used by Ethereum. That said, a number of issues remain, from the legal and regulatory (Guadamuz and Marsden 2015) to the environmental (Tapscott and Tapscott 2016). Scalability also remains a big question (Peters and Panayyi 2015).

Widespread adoption may be dependent on blockchain technology becoming 'invisible', affecting the back-end of music transactions rather than the user experience

Even if the association of blockchain technology with the 'dark web' (Walport 2016) is reducing, the fact that some platforms require payment in a given cryptocurrency is limiting adoption, as is the fact that platforms tend not to be particularly user-friendly. Of particular note here is the management and retention of private keys (Eskandari et al 2015), required to transmit ownership of a bitcoin or associated asset. Unlike a public key, which can be shared with other users, private keys must be kept secret; as a long string of apparently arbitrary letters and numbers, however, they are not easily memorable. It is recommended that users create back-ups of their wallet and keys, with the most secure option being offline or 'cold storage' – including, ironically, a printed 'paper wallet' stored in a safe. More widespread adoption may be dependent on blockchain technology becoming 'invisible', affecting the back-end of music transactions rather than the user experience.

In the context of recorded music, it is not yet certain which blockchain-based platform(s), if any, will achieve pre-eminence. While Ujo uses Ethereum, Peertracks employs MUSE; Bittunes and Dot Blockchain Music use the Bitcoin blockchain but representatives of both organisations have already posited a possible shift to other blockchains in the future. Aurovine use

Private key

A means of digitally signing transactions. Randomly generated, it must be kept secret as private keys facilitate the spending of coins stored in the associated address

Wallet

Software that holds addresses and their associated keys, and which provides the ability to send and receive coins

yet another currency, the bespoke token Audiocoin. The advantages and disadvantages of such an approach require further exploration, although the use of a bespoke token would appear likely to limit adoption and, arguably, innovation.

Although Silver (2016) states that different blockchains for different artists would be a 'nightmare' (p59), there may be some potential for plurality. Yet the possibility of a single, comprehensive copyright database clearly hinges upon the compatibility of any blockchains storing such data, something on which the company Hyperledger is currently working. The need for standardisation in data collection and reconciliation is clear.

Governance, Regulation And Integrity Of The Data

Governance and regulation could have consequences for the integrity of the data, given the obvious danger that erroneous information is entered, accidentally or otherwise, onto an immutable ledger. Corrections to such information would be possible – they too would be stored on the ledger – but the vital issue of how disputes would be resolved remains unclear. Claimants would, presumably, still need to use the courts; until the first test cases, it is difficult to predict how they will be received. In reality, most disputes would probably never reach the courts: at present, disputes are more typically discussed between publishers or artists, with some input from collection societies.

Governance and regulation could have consequences for the integrity of the data, given the obvious danger of entering erroneous information onto an immutable ledger

The question of governance and regulation relates, to an extent, to how these organisations are financed. The two most popular blockchains, Bitcoin and Ethereum, operate under open source licenses, and are permissionless, which provides them with a greater independence and seems to fit with the sentiment of Heap and Rogers: both Mycelia and Dot Blockchain Music are conceived as not-for-profit organisations. Yet for-profit organisations can hardly be expected to ignore this field. Though such organisations may still use open source blockchains, it is also very possible that powerful corporations will set up private, permissioned blockchains, as has happened in

banking with the R3 group, a consortium of over 50 institutions exploring the use of blockchain technology for global financial markets. This would affect the ability of newcomers to gain access to the network.

Reaching Critical Mass

Silver (2016) suggests that Peertracks and Bittunes, which he sees as representing new business models based on the band equity and super-distribution offered by blockchain technology, will struggle to achieve critical mass. However much they may celebrate it as a sign of their independence, he argues, their separation from the major label system is a fundamental weakness (pp30-32). The same argument could perhaps be made about Aurovine. At the same time, it is important to note that these platforms are much more advanced than the more ambitious Mycelia project, with Bittunes, for instance, already claiming users in 70 countries. It is also true that the 'long tail' market may become increasingly significant, given that recent technological advances have given widespread access to the means of recording and digitally distributing music.

Blockchain technology is perceived by some in the industry as a threat, and its introduction is likely to be resisted by incumbents

If it is relatively easy to at least imagine how blockchain technology might be employed by an emerging artist yet to sign a record or publishing deal, for instance on a platform such as Bittunes⁷, it is much harder to see how it would be employed in the context of back catalogue owned by major labels.

At present, though its potential for disintermediation may have been exaggerated, blockchain technology is perceived by some in the industry as a threat. As such, its introduction is likely to be resisted by incumbents. This could represent a missed opportunity. The media has tended to focus on permissionless blockchains, and the Mycelia and Dot Blockchain Music models proposed by Imogen Heap and Benji Rogers respectively dominate

7. Bittunes declare on their website that they will never work with major labels; they are looking to work with small indie labels 'but only if their artists' fundamental power is maintained'. Accessed 16.06.16: <http://bittunes.co.uk/about-bittunes/>

discussion within the industry. In fact there is potential for plurality, and for permissioned blockchains to co-exist alongside permissionless networks. As Silver (2016) points out, permissioned blockchains might be more appropriate for collection societies (p55) and major labels (p3). Since such networks still offer many of the efficiencies of distributed systems, they could offer financial benefit to all stakeholders.

Adoption by large corporations will depend on a clear value proposition: as a means of dealing with the volume of data from on-demand streaming, for instance, or a way to monetise derivative works and user-generated content. To achieve critical mass may also require not only the support of distributors but the involvement of high-profile artists. Benji Rogers sees an alternative route to adoption, via the predicted explosion in virtual and augmented reality and a related spike in demand for music (Mas 2016). Yet persuading virtual and augmented reality companies, let alone digital service providers more broadly, to use only the .BC format proposed by Dot Blockchain Music will be challenging.

Virtual reality

The user is entirely immersed in a three-dimensional, computer-generated world

Augmented reality

The user continues to experience real life but in 'enhanced' form, for instance through the superimposition of graphics or text

Conclusion

There has been considerable hype around blockchain technology in recent months, and some claims have at the very least been premature. Several of the organisations mentioned in this report are already operational, at least in beta form; as we go to press, Dot Blockchain Music are predicting that they will have a minimum viable product within weeks. Mycelia, by contrast, is still very much a work in progress.

Yet if some claims for the potential impact of blockchain technology on recorded music are inflated, there are also potential uses that have been relatively overlooked. There would appear to be considerable potential for smart ticketing, for instance, at the point blockchain technology converges with the Internet of Things. The company Ascribe, meanwhile, is exploring the creation of digital limited editions for visual images; there are clear possibilities for collectors' editions and box-sets of recorded music. Thirdly, the streaming platform Resonate are proposing to use blockchain technology to establish themselves as a co-operative that extends beyond national borders, providing, for instance, visible proof of membership, anonymous voting records and a store of founding by-laws as well as any amendments and alterations. Blockchain technology could also facilitate the transfer of assets, including intellectual property; Colu, one of the companies developing such services, claim that a secondary market of music rights will flourish as a result. Finally, there are significant licensing implications, with smart contracts enabling a peer-to-peer market for sync licenses as well as automatic agreements between artists and potential remixers – something explored by Imogen Heap on 'Tiny Human'.

Internet of Things

Communication between machines via the Internet

If some claims for the potential impact of blockchain technology on recorded music are inflated, other potential uses may have been overlooked

There is a danger that the discussion about the potential impact of blockchain technology on the record industry becomes entirely about a universally accessible, entirely transparent database of all music copyright information. In fact, what the technology offers is far from one-size-fits-all. There could be multiple blockchains, permissioned as well as permissionless, private as well as public, and there are multiple use cases. The use of blockchain technology envisaged by Imogen Heap for the artist-centred Mycelia project is different to the use of the same technology by Bittunes, where it is employed primarily to broaden participation – and where operating 'outside the music industry'

is celebrated. Silver (2016) sees Ujo as 'the closest prototype to something even recognisable to the mainstream' but there have been recent changes, with founder Phil Barry leaving to set up another music start-up, Blokur. There are also hybrid platforms such as OCL, or One-Click License, which combines blockchain and centralised technologies. Dot Blockchain Music and Mycelia, unlike the other organisations mentioned, are not platforms at all.

The potential of blockchain technology is only just starting to be explored. There will be new opportunities and, no doubt, new challenges

What is clear is that the potential of blockchain technology is only just starting to be explored. As it develops, it is likely to go beyond simply solving existing problems to create entirely new opportunities (Mougayar 2016). There will no doubt be new challenges too. At the time of writing, a new project called the The DAO – or Decentralised Autonomous Organisation – has been attracting considerable publicity. The structure and behaviour of the company is written into a smart contract built on the Ethereum blockchain, with participants receiving tokens that determine their influence on the organisation's direction: they are, in essence, shareholders. The response to the recent crowdfunding campaign has been remarkable, raising, in ether, a sum equivalent to more than \$150 million. At the same time, the high-profile hack suffered by The DAO – with the equivalent of \$50 million apparently being stolen – is a reminder of the uncertainty and volatility of what is still a nascent field. An equivalent for the record industry, allowing users to participate via smart contracts, is conceivable, although it would presumably share the risks, as well as the potential benefits, exposed by the DAO experiment.

There is also, in some areas of the record industry, a tendency to discuss blockchain technology as though it is a concern only for music. In fact, use cases are already emerging in other creative industries – including film, fashion, journalism, games, fashion and art – as well as in fields from online gambling to the diamond trade, and from banking to the storage of citizenship records.

For all the barriers to (and even potential disadvantages of) adoption, blockchain technology does present an 'extraordinary array of opportunities' (Walport 2016, p10). It could bring about 'major changes in the way in which the economy and society itself is organised and governed' (Godsiff 2016,

The DAO

A new type of self-governing organisation that leverages smart contracts on the Ethereum blockchain. In return for their early support, participants receive DAO tokens that allow them to vote on important decisions

p52). Predictions of overnight adoption for recorded music are clearly too optimistic; Silver (2016) predicts that mainstream adoption of blockchain technology might take 10 or 15 years. Consultant Mark Mulligan envisages that, in five years, a 'parallel alternative music industry' of artists without record deals or signed to independent labels might be using blockchain technology in sufficient numbers to begin to affect the major labels – but only in the most optimistic scenario (Music Ally 2016).

According to one prediction, mainstream adoption of blockchain technology might take 10 or 15 years

Particularly in terms of storing music copyright data, fast and frictionless royalty payments, transparency through the value chain and access to new sources of capital, blockchain technology does seem potentially transformative. Whether a shift to a *networked record industry* actually comes to pass, of course, is another question entirely. Certainly there is a need for further research into the possible benefits of blockchain technology for the record industry, in particular to explore the extent to which blockchain technology can co-exist with current contractual and copyright systems. Equally, possible barriers to, and disadvantages of, adoption must be explored in greater detail. More broadly, research needs to be extended to potential applications of the technology in those music industries not directly related to recorded music – and, indeed, in other creative industries entirely. This will provide the agenda for our own future research.

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