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Blockchain Copyright Exchange – A Prototype

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ABSTRACT

The copyright market for creative works such as music and movies traditionally involves a complex web of licensing transactions and exorbitant transaction costs. Out of every dollar that consumers pay, an artist who writes, performs, and produces her own work may receive less than fifteen cents while the rest are diverted to cover the costs of financing new production, marketing new works, and distributing royalties. Although artists are typically scheduled to receive royalties on a quarterly basis, a payment may lag as far as two years after users paid. Furthermore, if a collecting society is unable to identify the rightful owner for a royalty payment, it routinely allocates the royalty among its existing members.

This Article proposes a blockchain copyright exchange ("BCE") that dramatically improves efficiency and accuracy

in copyright transactions by hardcoding thousands of copyright rules and license terms in blockchain-based smart contracts. First, BCE allows artists to earn a royalty per stream potentially sixteen times larger than Spotify offers and eighty times larger than YouTube offers. Artists receive payments at a speed millions of times faster, in a matter of seconds instead of months, with zero administrative charges and zero dollars falling through the cracks. Second, BCE allows artists to launch crowdfunding campaigns inviting fans to securely finance creative works in return for a share of copyright ownership in the form of a non-fungible token ("NFT") or a fungible token ("FT"). It significantly diversifies the investment risks for artists and labels alike. Third, BCE cultivates a healthy ecosystem among artists and users by mobilizing users to mine BCE tokens through distribution and promotion of licensed works. These powerful incentives, together with BCE's innovative enforcement mechanisms, may effectively eliminate the breeding ground for copyright piracy.

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INTRODUCTION

Assume you want to remit $100 to your cousin in another city. You go to a bank to process the remittance. The bank tells you it needs to charge 85% of the amount as an administrative fee, which would leave $15 for your cousin. Assume you love your cousin so much that you decide to bite the bullet and accept the administrative fee. The bank then indicates that it will take at least three months, but up to a couple of years, for the money to arrive. By the way, if the bank is somehow unable to locate your cousin, it will simply give the money to other clients of the bank. Do you have any doubt about whether a bank like this, with such exorbitant costs and inferior services, would survive a single day in an ordinary market?

However, this is the everyday reality for artists in copyright industries. First, for every dollar that consumers pay for creative works, artists often receive less than fifteen cents, with the rest diverted to cover administrative costs.[1] Second, labels, publishers, and collecting societies are usually scheduled to report accountings of copyright royalties on a quarterly basis. In practice, it is not uncommon for royalty payments to be further delayed for a couple of years.[2] Third, it appears that 20 to 50 percent of royalty

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1. *See infra* Figure 13.

2. *See also* Imogen Heap, *Blockchain Could Help Musicians Make Money Again*, HARV. BUS. REV. (June 5, 2017), https://hbr.org/2017/06/blockchain-could-

revenues never reach their rightful owners and fall into a black box instead. [3] If the royalties collected remain unclaimed for a certain amount of time (say three years), a collecting society is legally permitted to use the unallocated amount to defray administrative costs and support collective-purpose projects for existing members. [4] In the digital age where users may gain immediate access to any creative work with a click on the mouse, it seems absurd that it takes months or even years, if ever, for intermediaries to distribute royalty revenues to rightful owners.[5]

The astonishing inefficiency in copyright industries is a byproduct of complicated legal and economic structures, which dictate that artists have to go through a web of hundreds, even thousands of copyright transactions to license creative works and collect royalties. [6] Exorbitant transaction costs, in the forms of administrative bureaucracy

help-musicians-make-money-again.

3. RETHINK MUSIC, FAIR MUSIC: TRANSPARENCY AND PAYMENT FLOWS IN THE MUSIC INDUSTRY 26 (2015).

4. *See, e.g.*, Jane C. Ginsburg, *Reproduction of Protected Works for University Research or Teaching*, 39 J. COPYRIGHT SOC'Y U.S.A. 181, 195 n.43 (1992) ("Music performance right collecting societies such as CISAC have a long tradition of deducting up to ten percent of their revenue for various collective purposes."); Thomas Riis & Jens Schovsbo, *Extended Collective Licenses and the Nordic Experience: It's a Hybrid but Is It a Volvo or a Lemon?*, 33 COLUM. J.L. & ARTS 471, 492 (2010) ("[T]he practice is widespread and generally accepted due to the prevalence of the practice (at least in continental Europe)."); Ferdinand Melichar, *Deductions Made by Collecting Societies for Social and Cultural Purposes in the Light of International Copyright Law*, 22 INT'L REV. INDUS. PROP. & COPYRIGHT L. 47, 49 (1991). Similarly, Spotify divided any funds left over from the pending and unmatched funding pools among participating publishers based on their market share on Spotify during the royalty period. *See* Ed Christman, *Spotify and Publishing Group Reach $30 Million Settlement Agreement Over Unpaid Royalties*, BILLBOARD (Mar. 17, 2016), https://www.billboard.com/articles /business/7263747/spotify-nmpa-publishing-30-million-settlement-unpaid-royalties.

5. *See generally* BRUCE A. LEHMAN & RONALD H. BROWN, INTELLECTUAL PROPERTY AND THE NATIONAL INFORMATION INFRASTRUCTURE: THE REPORT OF THE WORKING GROUP ON INTELLECTUAL PROPERTY RIGHTS 116 (1995) (analyzing digital technology and copyright law).

6. *See* Jiarui Liu, *Copyright Reform and Copyright Market: A Cross-Pacific Perspective*, 31 BERKELEY TECH. L.J. 1461, 1464–65 (2016).

and operating expenses, gobble the majority of royalty revenues from existing services, cause substantial delays in royalty distribution, and impede accuracy in identifying rightful owners.

This Article proposes a blockchain copyright exchange ("BCE") to untangle the web of copyright transactions and unlock the digital potential for artists, by hardcoding thousands of copyright rules, license terms, and money flows through smart contracts.[7] BCE may dramatically improve upon mainstream online services like Spotify and YouTube at least in the aspects of royalty collection and distribution.

First, BCE enlarges the total pie of copyright royalties by restoring the market value of a stream to $0.01, almost three times as valuable as a Spotify stream ($0.00397) and fourteen times as valuable as a YouTube stream ($0.00074).[8] By minimizing the transaction costs involved in copyright licensing, BCE dramatically increases artists' share in the royalty pie from 15 to 100 percent. As a result, BCE allows artists to earn per stream revenue up to sixteen times larger than Spotify offers and eighty times larger than YouTube offers.

Second, BCE smart contracts automatically enforce the rights and obligations under copyright license contracts whenever a user intends to enjoy a creative work in the BCE community. After the user gains access to the work of her choice, BCE generates and distributes 100% of the royalty revenue per instruction by the copyright owner in a matter of seconds instead of months. Further, BCE may directly split the reward pro rata to enable multiple copyright owners including artists, labels, and publishers to receive their respective shares simultaneously.

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7. For general introductions of smart contracts and their legal implications, see, for example, Kevin Werbach & Nicolas Cornell, *Contracts* Ex Machina, 67 DUKE L.J. 313, 319 (2017); Jeremy M. Sklaroff, *Smart Contracts and the Cost of Inflexibility*, 166 U. PA. L. REV. 263, 266–67 (2017); Max Raskin, *The Law and Legality of Smart Contracts*, 1 GEO. L. TECH. REV. 305, 311 (2017).

8. *See infra* note 66 and accompanying text.

Third, BCE smart contracts are essentially immune from any external influence ex post as they are self-executing on an immutable blockchain in accordance with predetermined contractual terms. This cryptographic robustness minimizes the risk of a breach of contract or of fiduciary duty, e.g., an agent sitting on or misappropriating collected royalties. No one has any ability or incentive to create a black box of unidentified royalties, because every dollar goes directly to copyright owners in the BCE ecosystem.

BCE develops a variety of innovative tools based on the blockchain technology to prevent copyright disputes and combat online infringements.[9] Most importantly, the BCE ecosystem cultivates healthy socioeconomic conditions in which all users, including artists and fans, are motivated to benefit one another, rather than fighting one another over copyright piracy. First, while artists receive equitable financial rewards in proportion to the values of their creative contributions, BCE keeps access to creative works essentially free to average consumers. Second, fans may share in a creative work's commercial success by acquiring a portion of copyright ownership in the work in the form of a non-fungible token ("NFT") or a fungible token ("FT") and therefore receiving a percentage of its revenue flows. The copyright crowdfunding created at BCE, featuring zero transaction fees and improved security, is superior to traditional equity or reward crowdfunding.[10] Third, fans may mine BCE tokens by distributing, promoting, and voting for new creative works. Unlike existing services such as Spotify,[11] the BCE ecosystem squarely aligns the financial

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9. *See infra* Part V.

10. For traditional crowdfunding, see generally INDIEGOGO, www.indiegogo.com (last visited June 27, 2021); KICKSTARTER, www.kickstarter.com (last visited June 27, 2021).

11. For legal disputes between artists and Spotify, see, for example, Sasha Bogursky, *Taylor Swift, Garth Brooks and Other Artists Lead the Fight Against Spotify*, FOX NEWS (Jan. 13, 2017), http://www.foxnews.com/entertainment /2014/11/19/taylor-swift-garth-brooks-artists-lead-fight-against-spotify/; Stuart Dredge, *Thom Yorke Explains Why He Hates Spotify*, BUS. INSIDER (Oct. 7, 2013,

incentives between artists and fans, so that the more fans support artists, the more artists excel in the market, and the more fans benefit themselves financially.

Part I starts with an overview of copyright industries. It shows how rampant copyright piracy profoundly transforms business models and affects artist revenue streams. Part II presents detailed analyses on the level of complexity in copyright licensing structures. Taking download and stream as examples, it further explains how complex copyright transactions incur substantial transaction costs and diminish creative incentives. Part III illustrates how BCE substantially increases incentives for artists by restoring the market value of creative works and automatizing copyright transactions through smart contracts. BCE allows artists to receive reasonable royalties in an amount dozens of times larger and at a speed millions of times faster than existing services offer. Part IV reveals how the BCE ecosystem motivates fans to actively participate in the financing, distribution, and promotion of new creative works. In return for their benevolence, fans may receive meaningful financial rewards through various forms of BCE token mining. Part V introduces blockchain-based mechanisms that BCE designs to improve copyright enforcement, e.g., copyright priority, dispute resolution, and automated investigation. It emphasizes that BCE is tackling the piracy problem not only with a stick, but also with a carrot by providing powerful incentives for users to move away from piracy and do the right thing. Part VI briefly lays out the technological architecture for the BCE ecosystem.

7:03 AM), http://www.businessinsider.com/thom-yorke-explains-why-he-hates-spotify-2013-10.

I.   Copyright Industry Landscape

A. *Industry Overview*

Copyright industries, including music, movie, and publishing, have been undergoing a dramatic transformation in recent years, while competing with widespread pirated and free content on the internet. We use music as an example to illustrate the current landscape in copyright industries, and the analyses below apply equally to movies and literature for the most part. The music industry has experienced a significant slump in music sales, which declined over 40% between 1999 ($25.2 billion) and 2014 ($14.2 billion).[12] Although digital sales have rapidly grown to supersede physical sales, digital sales are far from sufficient to offset the overall decline. For example, digital sales reached $9.4 billion in 2017 (Figure 1), accounting for 54% of total music sales.[13] Of digital sales, streaming made up 70% and download was responsible for the rest (Figure 2).[14]

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12. *See* IFPI, Global Music Report 2018, at 11 (2018).

13. *Id.*

14. *Id.*

FIGURE 1.   Global Recorded Music Industry Revenues
1999-2017($ Billions)

■ Physical   ■ Digital (non-streaming) ■ Streaming

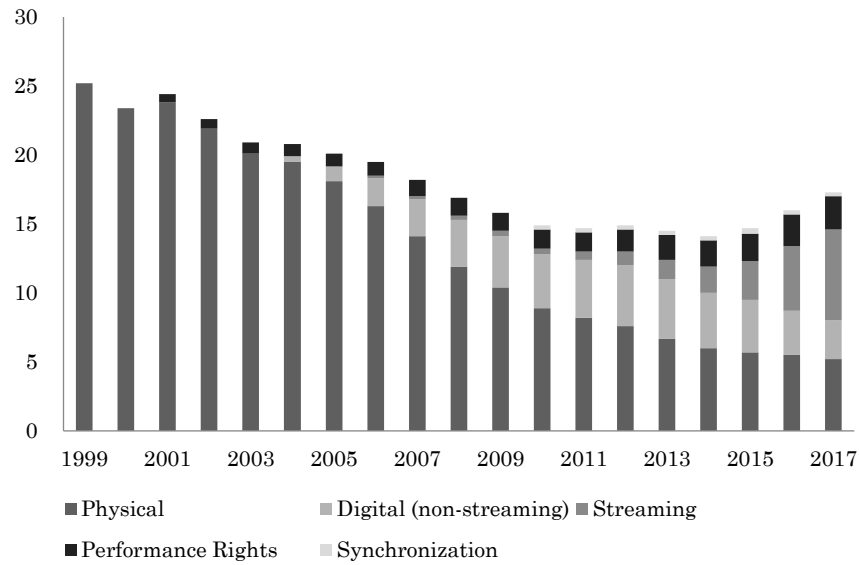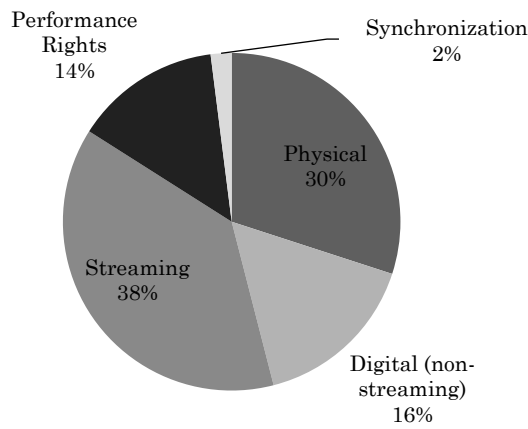■ Performance Rights   ■ Synchronization

FIGURE 2.   Global Recorded Music Revenues by
Segment 2017

In response to the inherent uncertainty of public taste in
entertainment products, labels traditionally invest in a large
portfolio of varied creative productions in the hope of cross-

subsidizing less popular ones with hit sales.[15] By contrast, copyright piracy naturally tends to focus on bestsellers, which undermines the revenue streams on which copyright owners build sustainable business models. In recent years, labels have started to further diversify their investment portfolios in the wake of increased risks in copyright markets.[16] Labels are expanding their roles in a value chain beyond production, promotion, and distribution of creative works and reshaping their business models to be more and more like talent management agencies that handle and share revenues for all aspects of an artist's entertainment-related businesses, including record sales, publishing, touring, merchandising, sponsorship, fan clubs, official websites, and television and film appearances.[17] These all-encompassing deals are often called the "360-degree" model, by which artists essentially sign over the entirety of their careers during the contractual term.[18]

"360-degree" deals result in several unsettling phenomena in the industry: First, labels prefer to sign new

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15. *See* Paul Goldstein, *Copyright*, L. & CONTEMP. PROBS., Spring 1992, at 83; Barry W. Tyerman, *The Economic Rationale for Copyright Protection for Published Books: A Reply to Professor Breyer*, 18 UCLA L. REV. 1100, 1121 (1971) (discussing cross-subsidization in books).

16. Traditionally, an artist would sign three kinds of contracts—an album contract, an agent contract, and a copyright contract—with three different entities. A record company would be responsible for production, promotion, and distribution of her albums. A talent agent would be responsible for managing performances, sponsorship, and advertisement. A music publisher would be responsible for handling copyright issues. Nowadays, a "360-degree" deal would typically incorporate all three of these contracts.

17. *See* PETER TSCHMUCK, CREATIVITY AND INNOVATION IN THE MUSIC INDUSTRY 194 (2d ed. 2012); Phil Gallo, *Madonna, Live Nation Make Music*, VARIETY (Oct. 10, 2007, 5:14 PM), https://variety.com/2007/music/markets-festivals/madonna-live-nation-make-music-1117973815/; Rosie Swash, *Jay-Z to Sign Deal with Live Nation*, THE GUARDIAN (Apr. 3, 2008, 11:53 AM), http://www.guardian.co.uk/music/2008/apr/03/jayz.urban.

18. For the media usage of the term "360-degree" deals, see, for example, *Music Firms Tune into New Deals*, BBC NEWS (June 30, 2008, 1:14 AM), http://news.bbc.co.uk/2/hi/business/7480183.stm.

artists at a young age and for an extended period of time.[19] Alternative revenue streams—such as touring, advertising, and merchandizing—in most cases entail long-term investment in cultivating artists' reputations and influencing peripheral markets. A long-term contract would help recoup the heavy initial investment in young artists, who have less bargaining power than established artists in deal negotiations.

Second, although one may presume that digital technologies have empowered artists with more autonomy, labels have actually become even closer to wielding "360-degree" control over an artist's creative process and even her personal life to maintain her commercial value in advertising and merchandizing markets. Not only must her works convey the same messages as the products promote, but the public image of the artist must also be consistent with mainstream tastes.

Third, when labels search for new artists, they increasingly emphasize non-musical characteristics, such as attractive appearance and positive public image, again to accommodate the need for alternative revenue streams. If an artist has no potential to tour and spin off into ancillary forms of revenue such as advertising opportunities, labels may eventually pass up an otherwise unparalleled creative talent.

B. *Artist Revenue Streams*

Consistent with the overall trend in copyright industries, the importance of copyright royalties has declined as a source of income for individual artists because users are increasingly exposed to pirated and free content online. Artists have to look at other ways to make a living. Figure 3 and Figure 4 illustrate the relative magnitude of various

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19. Jiarui Liu, *Copyright for Blockheads: An Empirical Study of Market Incentive and Intrinsic Motivation*, 38 COLUM. J.L. & ARTS 467, 472 (2015).

revenue streams as a percentage of the total income for artists in the United States [20] and in China. [21] Several similarities exist between the diagrams from the two largest economies in the world: First, artist revenue streams are highly diversified. Second, copyright royalties are not among the top three artist revenue streams; rather, performance currently generates the largest revenue. Third, merchandizing has yet to develop into a meaningful source of income for individual artists.

FIGURE 3.   Sources of Income for Artists (United States)

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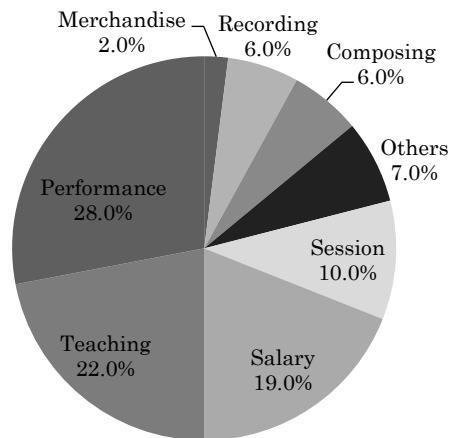
20. *See* Peter DiCola, *Money from Music: Survey Evidence on Musicians' Revenue and Lessons About Copyright Incentives*, 55 ARIZ. L. REV. 301, 352 fig.2 (2013); *see generally Artist Revenue Streams*, FUTURE OF MUSIC COAL. (Oct. 10, 2010), http://futureofmusic.org/article/research/artist-revenue-streams.

21. *See* Liu, *supra* note 19, at 545 fig.23.

FIGURE 4.   Sources of Income for Artists (China)
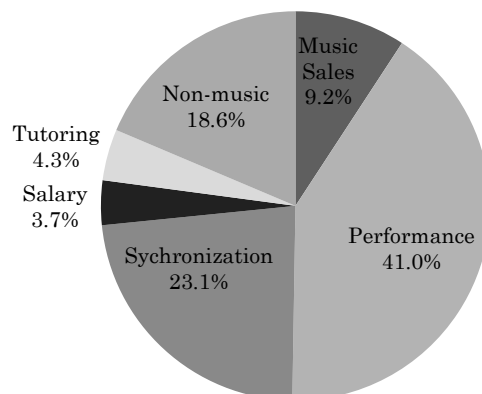
II.   COPYRIGHT LICENSING STRUCTURE

Not only are new digital technologies transforming the business models in copyright industries, but they are also dramatically increasing the level of complexity in copyright licensing structures.[22] The following Part provides a basic framework of copyright ownership under current legal regimes. It further explains how complicated licensing structures incur substantial transaction costs and diminish creative incentives for authors.

A. *Copyright Ownership*

Taking the music industry as an example, every piece of recorded music usually encompasses two distinct works of authorship:[23] (1) a musical work, which is the underlying composition created by the songwriter or composer, including any accompanying lyrics created by the lyricist; and (2) a sound recording, which is the audio performance of the

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22. *See* Liu, *supra* note 6.

23. *See* 17 U.S.C. §§ 101–102.

musical work that has been fixed in a tangible medium of expression. Therefore, online distribution of any recorded music, e.g., a song, inevitably involves copyright licenses for both the musical work and the sound recording. If musical works and sound recordings are created by different authors, they are often owned and licensed by different parties (Figure 5).

FIGURE 5. Music Copyright Ownership
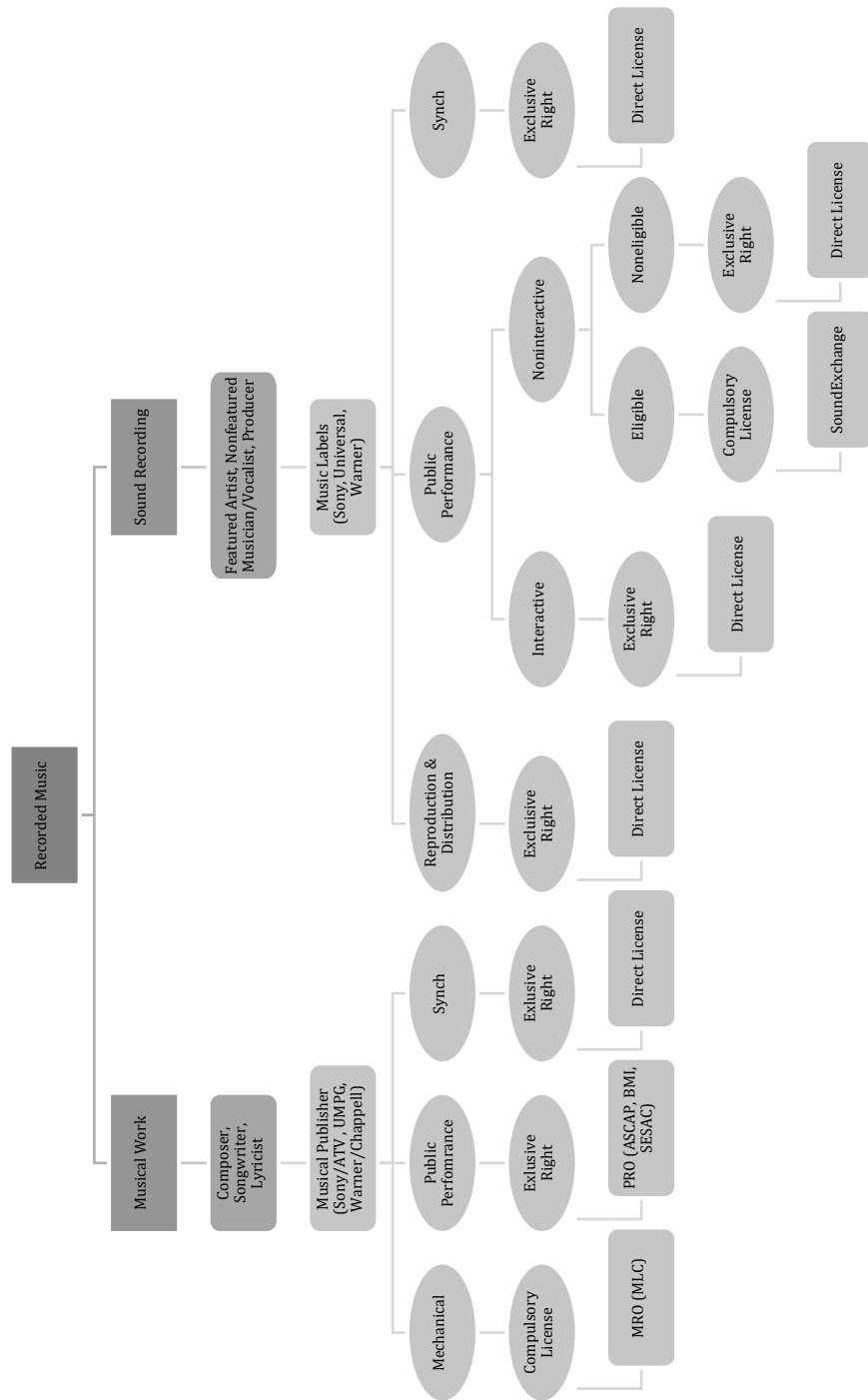
1. Musical Works

The copyright in a musical work naturally vests *ab initio* in its songwriter, composer, and lyricist.[24]

Any of the above authors may transfer a portion (traditionally 50%) or the entirety of her copyright to a music publisher in exchange for the following services: (1) the publisher may pay an advance to the musician against future royalties to finance the musician's writing projects; (2) the publisher licenses and promotes the musical work to potential users; and (3) the publisher distributes copyright royalties to the musician after deducting the publisher's share.[25] In the cases where a musical work involves multiple musicians, each having her own publisher and contractual terms, it is technically difficult to precisely calculate and distribute license royalties among right holders. Three major firms, Sony/ATV Music Publishing ("Sony/ATV"), Universal Music Publishing Group ("UMPG"), and Warner/Chappell Music respectively control 25%, 21%, and 11.6% of the music publishing market.[26] Because digital technology has lowered both market entry barriers to music production and distribution costs, the majors are faced with increasing competition from thousands of independent music publishers including Kobalt Music Group and BMG Chrysalis, which have in the aggregate grown from 31.6% of the market in 2007 to 42.3% of the market in 2019.[27]

Copyright law grants authors and other copyright owners a bundle of exclusive rights to control certain exploitations of their works, of which the most economically important ones encompass the rights to reproduce,

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24. *See* 17 U.S.C. § 201(a).

25. *See* Donald S. Passman, All You Need to Know About the Music Business 219–20 (8th ed. 2013).

26. *Revenue Market Share of the Largest Music Publishers Worldwide from 2007 to 2019*, Statista (Jan. 8, 2021), https://www.statista.com/statistics/272520/market-share-of-the-largest-music-publishers-worldwide/.

27. *Id.*

distribute, and publicly perform copyrighted works. [28] Authors and other copyright owners of musical works traditionally exploit different exclusive rights through different licensing mechanisms.

First, copyright owners have the right to license reproduction and distribution of their musical works in phonorecords, i.e., material objects in which sound recordings are fixed.[29] A phonorecord can be a vinyl LP, CD or MP3 file. Such rights are often collectively called mechanical rights. [30] While mechanical rights in musical works are subject to a compulsory license under copyright law, users often choose instead to obtain voluntary mechanical licenses through mechanical rights organizations ("MRO") such as the Harry Fox Agency ("HFA").[31] Pursuant to the Music Modernization Act of 2018, the U.S. Copyright Office established The Mechanical Licensing Collective ("MLC"), which began administering blanket mechanical licenses to eligible streaming and download services (digital service providers or DSPs) in the United States in January 2021.[32]

Second, musicians and publishers usually grant a performing rights organization ("PRO") a nonexclusive right to license the public performance right in their musical works. [33] The PRO may offer a blanket license to users

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28. 17 U.S.C. § 106.

29. *See* 17 U.S.C. § 115.

30. *See* AL KOHN & BOB KOHN, KOHN ON MUSIC LICENSING 367–68 (4th ed. 2010).

31. *Music Licensing Reform: Hearing Before the Subcomm. on Intellectual Property of the Comm. on the Judiciary*, 109th Cong. 109 (2005) (statement of Marybeth Peters, Register of Copyrights) (indicating "the use of the [compulsory] license appears to have again became almost non-existent; up to this day, the Copyright Office receives very few notices of intention") (S. Hearing 109–1021).

32. *About Us*, THE MECH. LICENSING COLLECTIVE, https://www.themlc.com /our-story (last visited June 28, 2021).

33. *See* U.S. COPYRIGHT OFF., COPYRIGHT AND THE MUSIC MARKETPLACE 20 (2015), http://copyright.gov/policy/musiclicensingstudy/copyright-and-the-music-marketplace.pdf.

including websites, television and radio stations, nightclubs, concert halls, restaurants, and retailers to publicly perform all the musical works in its repertoire. In exchange, the users pay royalties calculated on the basis of their business scales and the importance of musical works to their operations. The PRO typically divides the royalties 50/50 between musicians and publishers, regardless of their co-ownership shares, after deducing an administrative fee. Three principal PROs, ASCAP, BMI, and SESAC, in aggregate account for 95% of the licensing market for musical public performance in the United States.[34]

Third, if a user intends to incorporate a musical work in an audiovisual work, such as a movie, television program, or videogame, she would be required to obtain a synchronization license directly from copyright owners. [35] There is neither compulsory licensing nor collective management organizations with respect to the synchronization right.

2. Sound Recordings

The copyright in a sound recording vests *ab initio* in its creators, including featured artists (e.g., lead singers), nonfeatured musicians (e.g., session players), nonfeatured vocalists (e.g., background singers), sound engineers, and producers.[36]

However, the above authors conventionally assign all their copyrights in a sound recording to the music label that is responsible for financing, marketing, and/or distributing the sound recording. In exchange, featured artists receive

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34. *See* Diane Bartz, *U.S. Justice Department to Review 1941 ASCAP, BMI Consent Decrees*, REUTERS (June 5, 2019, 3:25 PM), https://www.reuters.com/article/us-usa-antitrust-ascap-bmi/u-s-justice-department-to-review-1941-ascap-bmi-consent-decrees-idUSKCN1T62GP; Chris Versace, *The Future of Streaming Music Rests With Congress*, FOX NEWS (Jan. 10, 2016), https://www.foxbusiness.com/features/the-future-of-streaming-music-rests-with-congress.

35. *See* U.S. COPYRIGHT OFF., *supra* note 33, at 55.

36. *See* 17 U.S.C. § 201(a).

advances and royalties in accordance with their contracts with the music label; nonfeatured artists and sound engineers are usually paid at an hourly rate; and producers may be compensated by either a lump-sum fee or by a share out of featured artists' royalties.[37] The recording sector has a market structure similar to the publishing sector. There are three major labels, Universal Music Group ("UMG"), Sony Music Entertainment, Inc. ("SME"), and Warner Music Group ("WMG"), that respectively hold 31%, 21%, and 18% market shares.[38] Hundreds of independent labels and artists combined account for 30% of record industry revenues.[39] Further, major music labels and major music publishers are subject to common corporate ownership. UMPG is owned by UMG, the Sony Corporation owns SME and half of Sony/ATV, and Warner/Chappell Music is a division of WMG.[40]

The copyright owners of sound recordings, e.g. music labels, directly license their reproduction and public distribution rights without the assistance of a collective rights organization or compulsory license.[41] Many online services, including ringtone, download, and interactive streaming services, inevitably involve reproduction and public distribution of sound recordings. They generally need to obtain copyright licenses from music labels.

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37. U.S. COPYRIGHT OFF., *supra* note 33, at 21–22.

38. *See* Mark Mulligan, *2018 Global Label Market Share: Stream Engine*, MIDIA (Mar. 13, 2019), https://www.midiaresearch.com/blog/2018-global-label-market-share-stream-engine.

39. *See id.*

40. *See* Sebastian Torrelio, *Jody Gerson Appointed Chairman and CEO of Universal Music Publishing Group*, VARIETY (Aug. 1, 2014, 2:13 PM), http://variety.com/2014/biz/news/jody-gerson-appointed-chairman-and-ceo-of-universal-music-publishing-group-1201273829; *Sony Group Corp (ADR)*, REUTERS, https://www.reuters.com/companies/SONY.N (last visited Sept. 3, 2021); *What We Do*, WARNER CHAPPELL MUSIC, https://www.warnerchappell.com /what-we-do/ (last visited June 27, 2021).

41. Limited exceptions exist in the context of noninteractive streaming services that qualify for a compulsory license. *See* 7 U.S.C. §§ 112, 114.

Copyright owners enjoy a public performance right for sound recordings, but it is limited to digital audio transmission under the U.S. Copyright Act.[42] Copyright owners follow different licensing schemes depending on the technical nature of digital audio transmission. For instance, interactive services, such as Spotify, Apple Music, and Amazon Music, allow consumers to access sound recordings from a place and at a time individually chosen by consumers. Copyright owners directly license the public performance by interactive services through market negotiation.[43]

By contrast, noninteractive services, such as Pandora, iHeartRadio, and Sirius XM, typically stream sound recordings in accordance with a schedule predetermined unilaterally by these services. Noninteractive services basically fall into three categories depending on their license schemes:[44] (1) nonsubscription broadcast transmissions, made by a FCC-licensed terrestrial broadcast station, are exempt from any copyright license; (2) noninteractive services other than nonsubscription broadcast may be subject to a compulsory license that allows them to publicly perform sound recordings, on the condition that the services satisfy certain statutory requirements ("compliant noninteractive transmissions") and pay statutory royalties;[45] and (3) all the other noninteractive services that do not fully satisfy the statutory requirements are deprived of the compulsory license ("noncompliant noninteractive transmissions"), and instead need to obtain licenses directly from copyright owners.

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42. 17 U.S.C. § 106.

43. *See* Cong. Rsch. Serv., Copyright Licensing in Music Distribution, Reproduction, and Public Performance 12 (2015), https://crsreports.congress.gov/product/pdf/RL/RL33631.

44. 17 U.S.C. § 114(d).

45. For example, such statutory requirements include prohibition of publishing an advance program schedule or otherwise identifying in advance when a specific song, album or artist will be played, and limitation of the number of tracks from a single album or by a particular artist that may be played during three hours. 17 U.S.C. § 114(j)(13).

SoundExchange, a collective management organization established by RIAA in 2000, is in charge of collecting statutory royalties from noninteractive services and, after deducting an administrative fee, distributing the reminders to copyright owners (50%), featured artists (45%), nonfeatured musicians (2.5%), and nonfeatured vocalists (2.5%).[46]

Furthermore, copyright owners directly license the synchronization right to incorporate sound recordings in a movie, television program, or videogame, without going through any collective management organization.[47]

B. *Copyright License*

The following subsections present case studies of the two major methods of content transmission on the internet, including download (Figure 6) and streaming (Figure 7), to illustrate how complex ownership structures may create exorbitant transaction costs for copyright licensing and royalty distribution.

1. Download

Online download services like iTunes transmit digital copies of copyrighted works to end users without simultaneously playing the same works to users. Nonetheless, once the transmission is complete, users typically possess permanent copies in their devices and may play back the copies whenever they want regardless of any internet connection.

First, download constitutes reproduction and distribution of the sound recording. Therefore, the service needs to obtain a direct license from the music label, which may demand payment of royalties set through market negotiation. The music label subsequently transfers a

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46. *See* 37 C.F.R. § 380.11 (2014).

47. *See* U.S. COPYRIGHT OFF., *supra* note 33, at 55–56.

portion (usually 10%-50%) of the royalties to the relevant artists in accordance with their contracts.

Second, download involves reproduction and distribution of the musical work embedded in the sound recording, typically in the form of digital phonorecord delivery ("DPD").[48] A DPD is subject to a compulsory mechanical license, for which the Copyright Royalty Board ("CRB") is responsible for setting statutory royalty rates in lieu of market negotiation.[49] Online services often obtain the mechanical license through an MRO (e.g., MLC), which charges 11.5% of the royalty revenue as its administrative fee for distributing the royalties (9.1 cents per copy) to the music publisher.[50] Again, the music publisher splits the amount (usually 50%) with the composers.

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48. *See* 17 U.S.C. § 115(a).

49. *See* 17 U.S.C. §§ 801–805; Copyright Royalty and Distribution Reform Act of 2004, Pub. L. No. 108-419, 118 Stat. 2341.

50. *FAQs*, THE HARRY FOX AGENCY, https://www.harryfox.com/#/faq (last visited June 27, 2021); *see generally* Adjustment of Determination of Compulsory License Rates for Mechanical and Digital Phonorecords, 78 Fed. Reg. 67,938, 67,939 (Nov. 13, 2013) (to amend 37 C.F.R. pt. 385).

FIGURE 6.   Copyright License Structure for Download
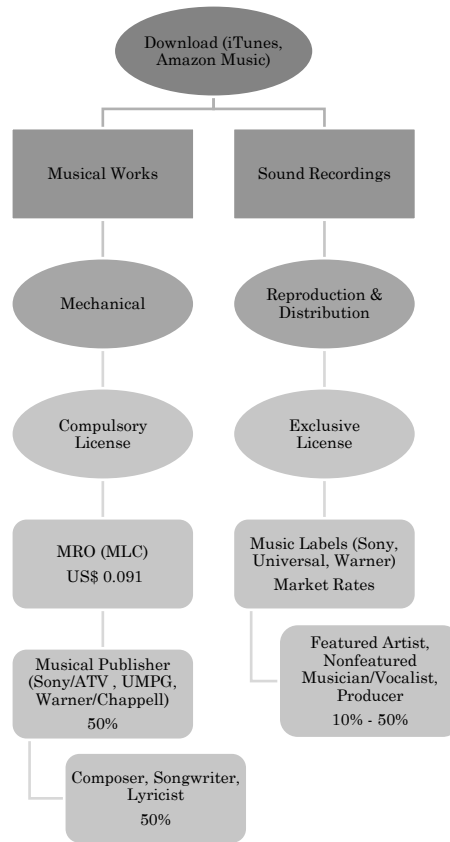
2. Streaming

As digital streaming services like Spotify transmit digital copies of copyrighted works to end users, they automatically trigger media players to perform the same works to users. During the course of transmission, the recipient devices only temporarily store segments of the transmitted works in random access memory ("RAM"),[51] and constantly rewrite the segments that have been played. At the end of the transmission, users are usually unable to retain permanent copies in their devices for further

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51. MAI Sys. Corp. v. Peak Comput., Inc., 991 F.2d 511, 519 (9th Cir. 1993).

playbacks, unless they are equipped with special decryption tools. Therefore, streaming normally requires continuous connection to the internet and to the streaming services if users want to play the works for multiple times.

Streaming services may be interactive (e.g., on-demand services), which allow users to choose works to be performed, or non-interactive (e.g., internet radios), which perform works according to a predetermined schedule. [52] Spotify contains both components in its offerings (Figure 7).

First, an interactive stream constitutes reproduction, distribution, and digital public performance of the sound recording streamed. It requires a direct license from the music label.[53] The music label in turn transfers a portion (usually 10%-50%) of the royalties to the relevant artists in accordance with their contracts.

Second, an interactive stream involves a public performance of the musical work underlying the sound recording. The streaming service usually needs to obtain a license from the relevant PRO. ASCAP, BMI, and SESAC each provide blanket licenses tailored for streaming services at a royalty rate of approximately 6% of their total revenues.[54] The royalty rates offered by ASCAP and BMI are subject to rate-setting proceedings by the rate courts at the United States District Court for the Southern District of New York. [55] After taking approximately 11.5% of the royalty revenue as its administrative fee, the PRO transfers the remainder to the music publisher, who then splits the amount (usually 50%) with the relevant composers in

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52. 17 U.S.C. § 114(j)(7).

53. *See* 17 U.S.C. § 114(a).

54. *See U.S. Music Streaming Royalties Explained*, MANATT, https://www .manatt.com/Manatt/media/Media/PDF/US-Streaming-Royalties-Explained.pdf (last visited June 27, 2021).

55. *See* Orrin G. Hatch–Bob Goodlatte Music Modernization Act, Pub. L. No. 115-264, 132 Stat. 3676 (2018).

accordance with their contracts.[56]

Third, an interactive stream entails reproduction and distribution of the musical work in DPD. Accordingly, the streaming service needs to obtain a mechanical license through the MRO, which transfers the royalties (i.e., at least 10.5% of the service revenue minus the performance royalties) to the music publisher after withholding 11.5% as its administrative fee.[57] The music publisher then splits the amount (usually 50%) with the composers in accordance with their contracts.

A noninteractive stream results in a dramatically different licensing structure from an interactive stream. First, while a noninteractive stream clearly constitutes digital public performance of the sound recording streamed, it may be subject to a compulsory license if it satisfies the legal requirements for compliant noninteractive transmission.[58] SoundExchange is in charge of collecting statutory royalties for compliant noninteractive transmission. After deducting approximately 6% as its administrative fee, SoundExchange distributes the remaining royalties in accordance with the statutory scheme, among music labels (50%), featured artists (45%), nonfeatured musicians (2.5%), and nonfeatured vocalists (2.5%).[59]

Second, a noninteractive stream that does not qualify for

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56. *See BMI Tops $900 Million Mark in Revenues*, BMI (Aug. 25, 2008), http://www.bmi.com/news/entry/bmi_tops_900_million_mark_in_revenues; *Frequently Asked Questions*, ASCAP, http://www.ascap.com/licensing /licensingfaq.aspx#general (last visited June 27, 2021).

57. *See* Nina Ulloa, *Exclusive: HFA Raising Its Commission to 11.5 Percent…*, DIGIT. MUSIC NEWS (Jan. 20, 2015), https://www.digitalmusicnews.com/2015/01 /20/hfa-raising-commission-11-5-percent/.

58. *See* 17 U.S.C. § 114(d)(2) (detailing the legal requirements for compliant noninteractive transmission).

59. *See* SOUNDEXCHANGE, SOUNDEXCHANGE ANNUAL REPORT FOR 2017 PROVIDED PURSUANT TO 37 C.F.R. § 370.5(C), at 2–3 (2017), https://www .soundexchange.com/wp-content/uploads/2016/09/2017-SoundExchange-Fiscal-Report-FINAL-Post-Audit-SXI-Only.pdf.

compliant noninteractive transmission requires a direct license from the music label, rather than the compulsory license. [60] Similarly, the music label transfers a portion (usually 10%-50%) of the royalties to the artists in accordance with their contracts.

Third, while a noninteractive stream does not constitute reproduction and distribution of the musical work in DPD, it involves a public performance of the musical work embedded in the sound recording. As a result, the service does not need any clearance for a mechanical license, but it is required to obtain a license from the relevant PRO at a royalty rate of approximately 6% of its total revenues.[61] Similarly, the PRO distributes the royalties to the music publisher after deducting approximately 11.5% as its administrative fee.[62] The music publisher in turn splits the amount (usually 50%) with the composers in accordance with their contracts.

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60. *See Licensing 101*, SOUNDEXCHANGE, https://www.soundexchange.com/service-provider/licensing-101/ (last visited June 27, 2021).

61. *See* Manatt, *supra* note 54.

62. *See supra* note 56 and accompanying text.

FIGURE 7.   Copyright License Structure of Streaming
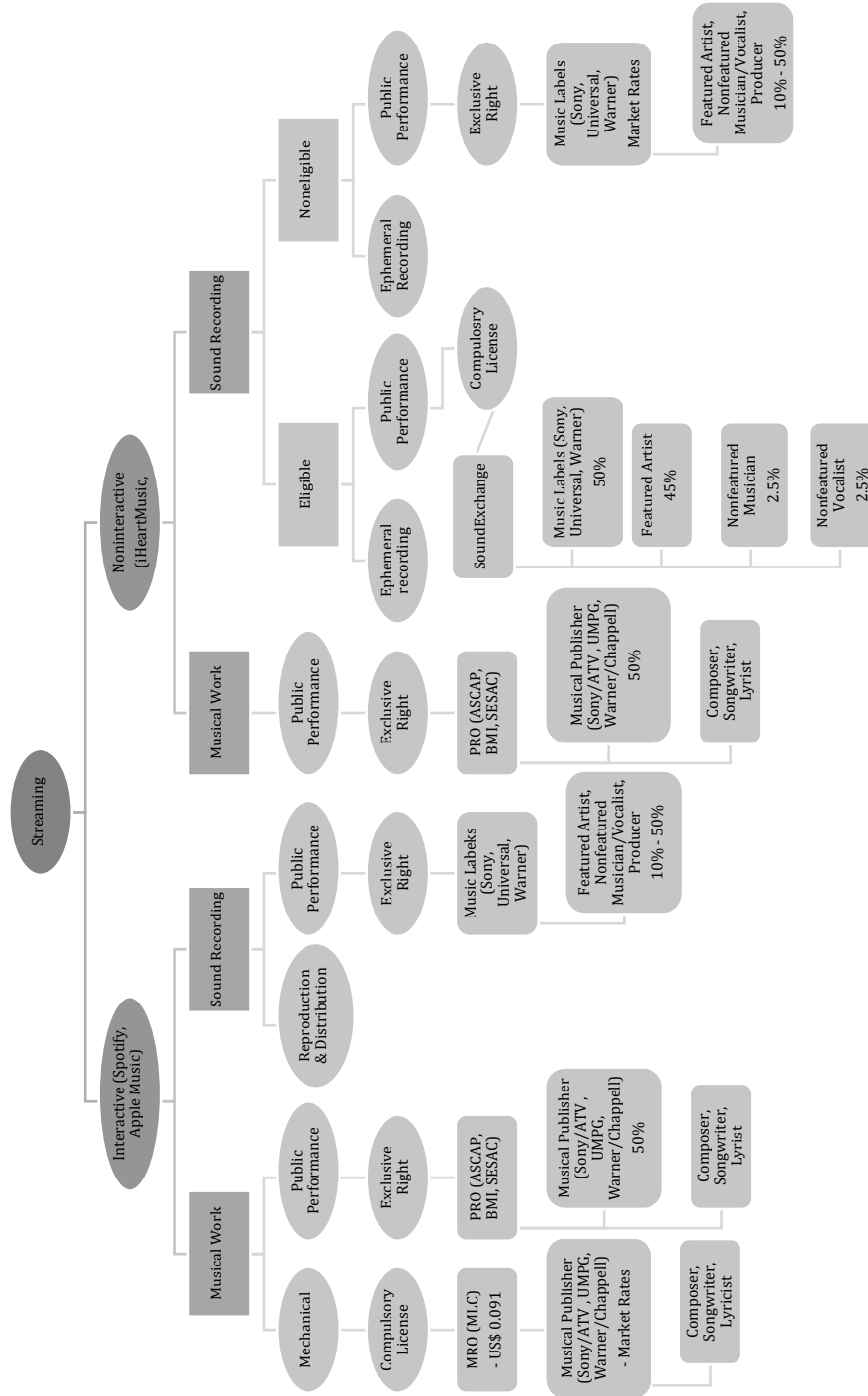
III. How BCE Increases Incentives for Creativity

BCE enlarges the total pie of copyright royalties by restoring the market value of a BCE stream and by minimizing the transaction costs involved in copyright licensing. As a result, BCE allows artists to earn per stream revenue up to sixteen times larger than Spotify offers and eighty times larger than YouTube offers.

A. *Restoring Market Value of Creative Works*

Mainstream streaming services like Spotify and YouTube have been significantly devaluing creative works in the marketplace. When Apple initially launched the iTunes store in 2003, it set the price per track at $0.99. [63] Accordingly, an album was priced at $9.90 assuming ten tracks in an album. After retaining 30% as its service fee, the iTunes store distributed 70% (i.e., $0.69 per tack) to copyright owners.[64] In recent years, the growth of streaming services has crowded out the market share of download services due to their pricing advantages, particularly with regard to their free tiers.[65] The public quickly realized that the success of streaming services was at the expense of declining copyright royalties. As Figure 8 indicates, Spotify and YouTube respectively generated $0.00397 and $ 0.00074 per stream in 2017.[66] In other words, it takes 2,494 streams at Spotify and 13,379 streams at YouTube to earn a payment equivalent to one download of an album in value.

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63. *See* Austin Carr, *Apple's 30% Fee, an Industry Standard, Is Showing Cracks*, Bloomberg (May 3, 2021, 6:45 AM), https://www.bloomberg.com /news/newsletters/2021-05-03/apple-s-30-fee-an-industry-standard-is-showing-cracks.

64. *Id.*

65. *See* IFPI, *supra* note 12, at 6.

66. *2017 Streaming Price Bible! Spotify per Stream Rates Drop 9%, Apple Music Gains Marketshare of Both Plays and Overall Revenue*, The Trichordist (Jan. 15, 2018), https://thetrichordist.com/2018/01/15/2017-streaming-price-bible-spotify-per-stream-rates-drop-9-apple-music-gains-marketshare-of-both-plays-and-overall-revenue/.

FIGURE 8. Copyright Royalties from Streaming Services (2017)

	DSP / STORE	PER STREAM	Streams Quantity % of Total	Streams Amount % of Total	Streams Per Song	Streams Per Album	Marketshare Streams	Marketshare Amount
1	Spotify	$0.00397	47.78%	51.51%	154	1,535	47.78%	51.51%
2	Apple iTunes	$0.00783	10.48%	22.29%	78	778	10.48%	22.29%
3	Pandora	$0.00134	21.56%	7.86%	454	4,538	21.56%	7.86%
4	Google	$0.00611	2.41%	4.00%	100	996	2.41%	4.00%
5	Amazon	$0.00740	1.89%	3.80%	82	823	1.89%	3.80%
6	Deezer	$0.00624	1.91%	3.24%	98	976	1.91%	3.24%
7	Tidal	$0.01284	0.50%	1.76%	47	474	0.50%	1.76%
8	Rhapsody	$0.01682	0.38%	1.75%	36	362	0.38%	1.75%
9	YouTube	$0.00074	8.38%	1.70%	818	8,181	8.38%	1.70%
10	Xbox Music	$0.02730	0.09%	0.65%	22	223	0.09%	0.65%
11	Telecom Italia	$0.01410	0.06%	0.24%	43	432	95.38%	98.57%
12	24-7 Entertainment	$0.01461	0.05%	0.20%	42	417		
13	UMA	$0.00022	2.71%	0.16%	2,831	28,311		
14	Yandex LLC	$0.00039	1.38%	0.15%	1,555	15,551		
15	Qobuz	$0.03816	0.01%	0.14%	16	160		
16	KKBOX	$0.00369	0.12%	0.12%	165	1,652		
17	Peloton	$0.04785	0.01%	0.08%	13	127		
18	iHeartRadio	$0.01318	0.02%	0.06%	46	462		
19	Zed	$0.04576	0.00%	0.06%	13	133		
20	Saavn	$0.00160	0.09%	0.04%	381	3,807		
21	NMusic	$0.00873	0.02%	0.04%	70	697		
22	Slacker	$0.00502	0.02%	0.03%	121	1,213		
23	Cricket	$0.00927	0.01%	0.03%	66	657		
24	Touchtunes	$0.01409	0.00%	0.02%	43	432		
25	Akazoo	$0.53026	0.00%	0.01%	1	11		
26	Turkcell	$0.00462	0.01%	0.01%	132	1,318		
27	Naxos	$0.05200	0.00%	0.01%	12	117		
28	PlayNetwork	$0.00042	0.10%	0.01%	1,443	14,426		
29	iMusica	$0.02314	0.00%	0.01%	26	263		
30	AWA	$0.00894	0.00%	0.01%	68	681		
			100.00%	100.00%				

To put this into perspective, the US national minimum wage currently sits at $1,160 per month (e.g., the wage for a full-time job flipping burgers at a fast-food chain).[67] Figure 9 illustrates the number of downloads or streams a copyright owner needs to sell in order to earn the minimum wage, assuming she receives 70% of all sales revenues.

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67. *See Minimum Wage*, U.S. Dep't of Labor, https://www.dol.gov/general /topic/wages/minimumwage (last visited June 27, 2021).

FIGURE 9.   Number of Plays to Reach the Minimum Wage (2017)

Minimum Wage ($1,160) from Creative Works		
	Per Month	**Per Year**
iTunes	167 album downloads	2004 album downloads
Spotify	292,191 streams	3.5 million streams
YouTube	1,567,568 streams	18.8 million streams

Even assuming a fan downloads only one album per year, an artist simply needs 2,004 fans to get the minimum wage, and a bit over 10,000 fans to live a decent life. By contrast, how likely is it for an artist to earn the minimum wage by annually achieving 3.5 million streams at Spotify or 18.8 million streams at YouTube? Apparently very unrealistic, except for a small group of superstars.[68] It suggests that middle-class artists who used to earn a living by a limited number of album sales only a decade ago would be reduced to part-time hobbyists until they were able to gain a superstar-level astronomical number of plays through streaming services.

Although iTunes and Spotify both distribute 70% of their gross revenues to copyright owners,[69] they drastically differ in pricing models: iTunes is an à-la-carte store selling creative works for per-unit prices while Spotify offers a "buffet" by charging every subscriber a flat fee (i.e., $9.99 per month) no matter how much content she consumes. The buffet approach allows royalty revenues to grow only with an

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68. *See Selling Out: How Much Do Music Artists Earn Online – 2015 Remix*, INFORMATION IS BEAUTIFUL, https://informationisbeautiful.net/visualizations/how -much-do-music-artists-earn-online-2015-remix/ (last visited June 27, 2021) (indicating that only 1.5% of Spotify users and 0.5% of Youtube users hit minimum wage level streams).

69. *See, e.g.*, Randall Roberts, *Does Spotify Pay Artists a Fair Rate? Here's What Musicians, Managers and Apple Music Have to Say*, L.A. TIMES (Apr. 19, 2021, 6:00 AM), https://www.latimes.com/entertainment-arts/music/story/2021-04-19/spotify-artists-royalty-rate-apple-music.

increase in subscriptions, not necessarily with an increase in the quantity of works offered. If the increase in subscriptions lags behind the increase in the total number of songs, the royalty income per stream would actually decrease over time. This appears to be exactly what happened to Spotify, which managed to increase the number of paying subscribers by 600% from 10 million in 2014 to 60 million in 2017;[70] during the same period of time, its per-stream rate actually dropped by 23.8% from $0.00521 to $0.00397.[71]

Figure 10 similarly illustrates the declining trend in Spotify royalties per stream during the period between 2011 and 2015.[72]

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70. *See, e.g.*, *Number of Spotify Premium Subscribers Worldwide from 1st Quarter 2015 to 1st Quarter 2021*, STATISTA (June 4, 2021), https://www.statista .com/statistics/244995/number-of-paying-spotify-subscribers/; Paul Sawers, *Spotify's Path to 50 Million Paying Subscribers*, VENTUREBEAT (Mar. 3, 2017, 5:38 AM), https://venturebeat.com/2017/03/03/spotifys-path-to-50-million-paying-subscribers/.

71. *See* THE TRICHORDIST, *supra* note 66; *see also Streaming Price Index Updated 2014 : Per Stream Pay Rates*, THE TRICHORDIST (Feb. 20, 2014), https://thetrichordist.com/2014/02/20/streaming-price-index-updated-2014-per-stream-pay-rates/.

72. *If Only Artists and Managers Had Listened To Us : Spotify Per Stream Rates Keep Dropping*, THE TRICHORDIST (May 18, 2017), https://thetrichordist .com/2017/05/18/if-only-artists-and-managers-had-listened-to-us-spotify-per-stream-rates-keep-dropping/.

FIGURE 10. Spotify Copyright Royalties per Stream (2011-2015)

Annotations in figure:
- March 2014 .00533
- May 2015 .00408
- It has been over a year since the monthly average per stream rate has been above .00500
- Series1

Date	Per Stream
Jun-11	$0.00722
Jul-11	$0.00585
Aug-11	$0.00597
Sep-11	$0.00556
Oct-11	$0.00516
Nov-11	$0.00486
Dec-11	$0.00437
Jan-12	$0.00464
Feb-12	$0.00504
Mar-12	$0.00485
Apr-12	$0.00478
May-12	$0.00451
Jun-12	$0.00516
Jul-12	$0.00510
Aug-12	$0.00527
Sep-12	$0.00502
Oct-12	$0.00495
Nov-12	$0.00511
Dec-12	$0.00519
Jan-13	$0.00515
Feb-13	$0.00501
Mar-13	$0.00473
Apr-13	$0.00506
May-13	$0.00487
Jun-13	$0.00538
Jul-13	$0.00555
Aug-13	$0.00558
Sep-13	$0.00620
Oct-13	$0.00577
Nov-13	$0.00598
Dec-13	$0.00584
Jan-14	$0.00524
Feb-14	$0.00562
Mar-14	$0.00533
Apr-14	$0.00495
May-14	$0.00436
Jun-14	$0.00460
Jul-14	$0.00437
Aug-14	$0.00417
Sep-14	$0.00396
Oct-14	$0.00380
Nov-14	$0.00379
Dec-14	$0.00357
Jan-15	$0.00376
Feb-15	$0.00417
Mar-15	$0.00378
Apr-15	$0.00407
May-15	$0.00408
	$0.00479

BCE chooses not to follow the subscription models popular among mainstream streaming services, given their unintended effect of devaluing creative works. Instead, BCE strives to return to the à-la-carte model for artists while maintaining access to content essentially free to average consumers.[73] For instance, BCE uniformly emits BCE tokens in the value of $0.01 per stream, almost three times as valuable as a Spotify stream ($0.00397) and fourteen times as valuable as a YouTube stream ($0.00074).[74]

More importantly, BCE rejuvenates consumer demands for a BCE download, which is consistently valued at $1, i.e., 100 times a BCE stream. A download is tied to BCE token mining in the forms of marketing and distributing creative works. By doing so, not only does a download bring strong royalty revenues to artists, but it also generates financial returns to miners who contribute valuable attention, processing power, and storage space.

B. *Minimizing Transaction Costs*

As much as the $0.00397 per stream that Spotify allocates to the pool of copyright royalties undervalues creativity, it is virtually impossible for the artists who produced the relevant works to receive the entirety of that $0.00397.[75] In practice, the legal and economic structures in copyright industries dictate that artists have to go through a complex web of hundreds, even thousands of copyright contracts to license creative works and collect royalties.[76] Exorbitant transaction costs, in the forms of administrative fees and operating expenses, gobble the majority of royalty

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73. BCE implements an innovative freemium model in which users who access works for free may still generate values for authors.

74. *See* THE TRICHORDIST, *supra* note 66.

75. These analyses apply equally to other content services such as Apple and YouTube.

76. *See generally* Peter Tschmuck, *Copyright, Contracts, and Music Production*, 12 INFO. COMMC'N & SOC'Y 251 (2009).

revenues from online services. Figure 11 illustrates the flows of copyright licenses and royalties in a single song "Uptown Funk."[77]

FIGURE 11. Copyright Topography of Uptown Funk
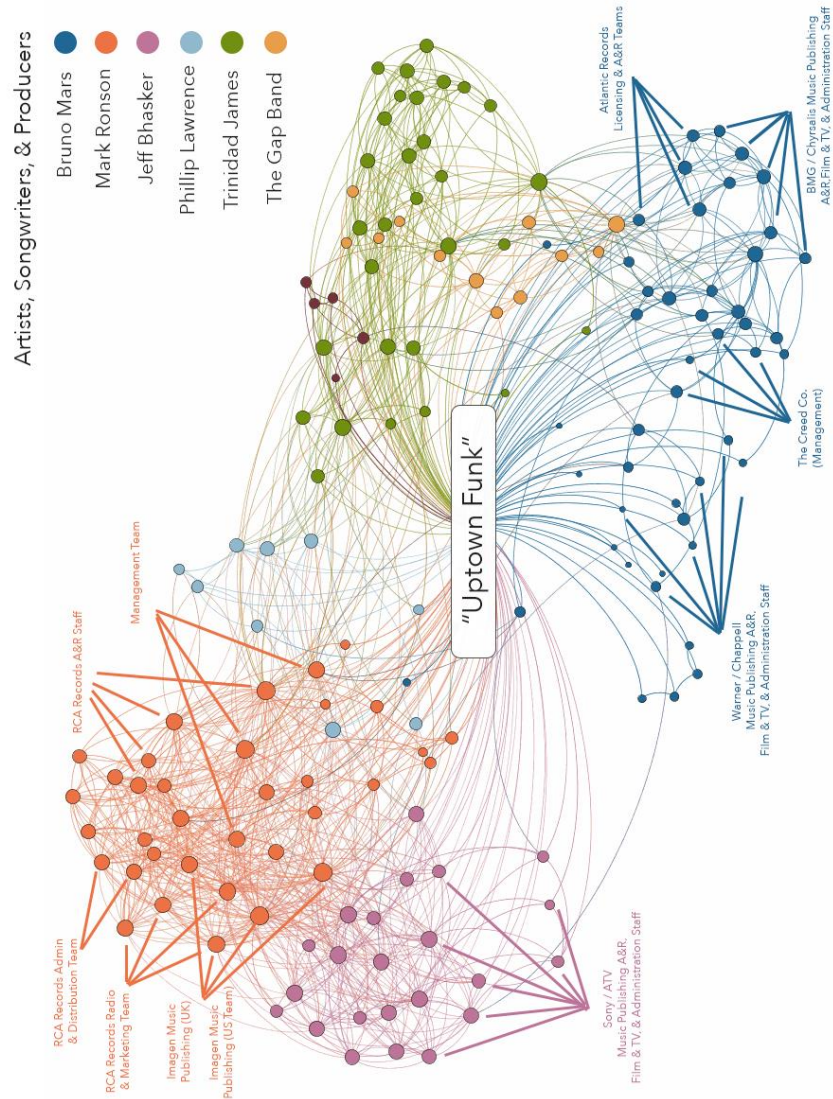
77. Jesse Feister, *The Music Data Debacle: Natural Workflows Can Power a Faster, Smarter Music Industry*, MEDIUM (Mar. 16, 2016), https://medium.com /@flashfeister/the-music-data-debacle-you-re-already-fixing-it-482ee18cfead.

For instance, we may assume the best-case scenario where an artist writes, performs, and produces her works all by herself, which suggests she is likely to be the initial owner of 100% copyrights in her sound recordings and musical compositions. The key question is what percentage of royalty revenues the all-around artist may receive from online services, after deducting all the costs involved in financing, marketing, and distributing her works and in collecting and allocating copyright royalties.
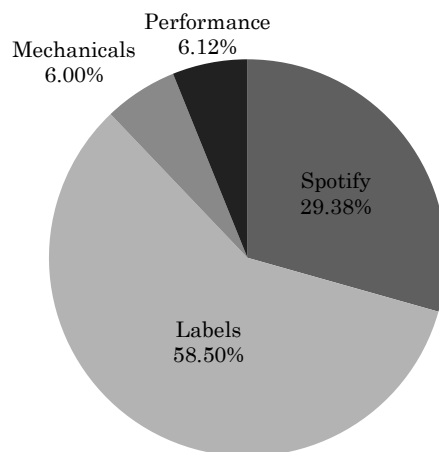
For every dollar Spotify receives from its users, it typically withholds 29.3 cents for itself, distributes 58.5 cents to music labels, 6 cents to MROs (e.g., MLC), and 6.12 cents to PROs (e.g., ASCAP, BMI, and SESAC).[78]

FIGURE 12. Interactive Streaming Service Revenue Distribution

If the artist has signed a recording contract with a major label and a publishing contract with a major publisher, the label transfers approximately 16% of royalty revenues for sound recordings (i.e., 9.36 cents) to the signed artist.[79]

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78. *See* Manatt, *supra* note 54.

79. *Id.* We use middle-class artists as the benchmark.

MROs and PROs are responsible for collecting royalties for music compositions and respectively charge 11.5% as their administrative fees. [80] Afterwards, they distribute the remainder to the writer and the publisher typically by splitting the amount 50/50, resulting in 5.37 cents for each.[81] Therefore, for every dollar consumers pay Spotify for content, the signed artist may receive only 14.73 cents (Figure 13).

FIGURE 13. Artist/Writer Revenues from Interactive Streaming (Major Labels)

Sound Recordings	Mechanicals	Performances
Label's Share **58.5 × (1 − 16%) = 49.14**	Collecting Society 6 × 11.5%= 0.69	Collecting Society 6.12 × 11.5% = 0.7
Artist's Share **58.5 × 16% = 9.36**	Publisher's Share (6 − 0.69) × 50% = 2.66	Publisher's Share (6.12 − 0.7) × 50% = 2.71
	Writer's Share **(6 − 0.69) × 50% = 2.66**	**Writer's Share** **(6.12 − 0.7) × 50% = 2.71**
Total = 9.36 + 2.66 + 2.71 = 14.73[82]		

If the artist has signed a record deal with an independent label and an administrative agreement with a publisher, the label normally splits its royalty revenues 50/50 with the independent artist,[83] who therefore receives 29.25 cents for sound recordings. Again, MROs and PROs respectively charge 11.5% as their administrative fees. [84] Of the remaining funds, the publisher typically withholds 10% as its administrative fee, and remits 90%, i.e., 9.66 cents, to the writer.[85] Therefore, for every dollar consumers pay Spotify

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80. *See supra* notes 50, 56 and accompanying text.

81. *See* Todd Brabec & Jeff Brabec, *Songwriter and Music Publisher Agreements*, ASCAP, https://www.ascap.com/help/music-business-101/200809 (last visited June 27, 2021).

82. Traditional download services generated a similar share for major artists/writers: (70 − 9.1) × 16% + 9.1 × (1 − 11.5%) × 50% = 13.77.

83. Manatt, *supra* note 54.

84. *See supra* notes 50, 56 and accompanying text.

85. *See* Brabec & Brabec, *supra* note 81.

for content, the independent artist may only receive 38.91 cents (Figure 14).

FIGURE 14. Artist/Writer Revenues from Interactive Streaming (Independent Labels)

Sound Recordings	Mechanicals	Performances
Label's Share $58.5 \times (1 - 50\%) = 49.14$	Collecting Society $6 \times 11.5\% = 0.69$	Collecting Society $6.12 \times 11.5\% = 0.7$
Artist's Share $\mathbf{58.5 \times 50\% = 29.25}$	Publisher's Share $(6 - 0.69) \times 10\% = 0.53$	Publisher's Share $(6.12 - 0.7) \times 10\% = 0.54$
	Writer's Share $\mathbf{(6 - 0.69) \times 90\% = 4.78}$	**Writer's Share** $\mathbf{(6.12 - 0.7) \times 90\% = 4.88}$
Total = 29.25 + 4.78 + 4.88 = 38.91[86]		

If the artist handles recording and publishing all by herself, she may receive 90% of the royalty revenues for sound recordings after paying approximately 10% commission to online distributors (e.g., CD Baby). [87] Meanwhile, she may receive both the writer's and publisher's shares of the remaining royalties for musical compositions after MROs and PROs deduct their administrative fees. Therefore, for every dollar consumers pay Spotify for content, the DIY artist may receive 63.38 cents (Figure 15).

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86. Traditional download services generated a similar share for independent artists/writers: $(70 - 9.1) \times 50\% + 9.1 \times (1 - 11.5\%) \times 90\% = 37.70$.

87. *See CD Baby or TuneCore*, CD BABY, https://cdbaby.com/cdbaby-vs-tunecore.aspx (last visited June 27, 2021).

FIGURE 15. Artist/Writer Revenues from Interactive
 Streaming (Independent Artists)

Sound Recordings	Mechanicals	Performances
Distributor's Share **58.5 × (1 − 90%) = 5.85**	Collecting Society 6 × 11.5%= 0.69	Collecting Society 6.12 × 11.5% = 0.7
Artist's Share **58.5 × 90% = 52.65**	**Writer's Share** **(6 − 0.69) × 100% = 5.31**	**Writer's Share** **(6.12 − 0.7) × 100% = 5.42**
Total = 52.65 + 5.31 + 5.42 = 63.38[88]		

Labels, publishers, and collecting societies conventionally report accountings of copyright royalties on a quarterly basis.[89] As a result of the complexity in licensing structures, they are sometimes unable to quickly identify and locate all relevant copyright owners. In practice, it is not uncommon for royalty payments to be delayed by a couple of years. A Grammy Award winning artist once lamented that "creatives in the music industry—such as songwriters, producers and musicians—. . . are the first to put in any of the work, and the last to ever see any profit."[90]

In accordance with a report released by the Berklee College of Music, 20 to 50 percent of royalty revenues never reached their rightful owners and fell into a black box instead.[91] One of the major reasons appears to be that collecting societies that work with online services may have enough incentives to collect royalties but not enough to locate their copyright owners and distribute royalties. For one thing, if the money collected is negligible and hardly covers searching costs, a collecting society would naturally be

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88. Traditional download services generated a similar share for DYI artists/writers: (70 − 9.1) × 90% + 9.1 × (1 − 11.5%) × 100% = 62.86.

89. *See, e.g.*, Lydia Pallas Loren, *Untangling the Web of Music Copyrights*, 53 CASE W. RSRV. L. REV. 673, 682 n.38 (2003).

90. Heap, *supra* note 2. The statement is more relevant to independent artists than signed artists who may receive advances from labels before production starts.

91. *See* RETHINK MUSIC, *supra* note 3, at 16, 26.

unwilling to search for copyright owners. For another thing, if the royalties are substantial, a collecting society could arguably have even less incentive to locate recipients: If the royalties collected remain unclaimed for a certain amount of time (say three years), a collecting society would be legally permitted to use the unallocated amount to defray administrative costs, [92] and support collective-purpose projects for existing members in the form of awards or stipends.[93] Such a windfall suggests that collecting societies may financially benefit by sitting on the royalties collected for unidentified copyright owners.

To sum up, current licensing models of online content services incur extensive transaction costs, cause substantial delays in royalty distribution, and lack accuracy in identifying rightful owners.

In the early digital age, legal scholars popularized the buzz phrase "code is law," which suggests that computer code may increasingly supersede law as a predominant force regulating human behaviors in cyberspace.[94] However, the experiences of online services such as Spotify and YouTube reveal that technological innovation alone, disconnected from legal and social norms, would not spontaneously promote justice, fairness, and social welfare. The advent of the blockchain technology reminds us that computer code may also be implemented to automatically enforce legal rules and contractual terms. To this extent, law is code.

In particular, blockchain-based smart contracts have a key advantage. Traditionally, laws and contracts are enforced ex post through the judicial system. Taking copyright infringement as an example, anybody technically

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92. *See, e.g.*, *General FAQs*, SOUNDEXCHANGE, https://www.soundexchange.com/about/general-faqs/ (last visited June 27, 2021).

93. *See* Ginsburg, *supra* note 4; Riis & Schovsbo, *supra* note 4; Melichar, *supra* note 4.

94. *See, e.g.*, Lawrence Lessig, *Code Is Law*, HARV. MAG. (Jan. 1, 2000), https://www.harvardmagazine.com/2000/01/code-is-law-html.

has the liberty to distribute a movie online no matter whether she obtains a license or pays a royalty. Only if she does so without a proper license would a court intervene and impose injunctive relief and monetary damages. [95] By contrast, smart contracts enforce legal and contractual obligations ex ante by technological means rather than the threat of legal sanctions. When a user is playing a movie, smart contracts would automatically conclude a license contract and remit a payment to the copyright owner. As a result, it would technologically be more difficult and less efficient for average users to violate the law than to follow the law. By discouraging and preventing illegal behaviors in the first place, smart contracts avoid the substantial social costs involved in legal proceedings comprised of lawyers, police officers, and judges.[96]

BCE is exactly such a legal and technological ecosystem that enlists the blockchain technology to hardcode thousands of copyright rules, license agreements, and money flows through smart contracts. BCE has at least three advantages over mainstream streaming services in terms of royalty collection and distribution.

First, BCE may eliminate the transaction costs that artists have to assume in traditional methods of copyright licenses. Therefore, artists wield 100% control over all the royalties paid for their works, as opposed to the 14.73% traditionally available after deducting transaction costs for financing, marketing, and licensing.[97]

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95. *See* 17 U.S.C. § 501(a).

96. Taking traffic law as another example, a person is normally free to drive at whatever speed she wants. A court would not intervene and impose a fine until she is caught exceeding the speed limit. However, we may sometimes need to prevent people from driving too fast by architectural means, e.g., building speed bumps. Notably, technological measures improving law enforcement may sometimes impede "efficient breaches" where the social benefit of breaching the law overrides the social costs. For example, one may have to exceed a speed limit to save others.

97. *See supra* Figure 14.

Second, while users may immediately access any creative work on mainstream online services with a click on the mouse, it seems absurd that it takes months or even years for these services to distribute royalty revenues to rightful copyright owners, if ever. By contrast, whenever a user streams or downloads a creative work in the BCE community, smart contracts automatically enforce copyright licenses without any human intervention. Within a matter of seconds, BCE generates BCE tokens worth $0.01 per stream or $1 per download and distributes 100% of the revenue per instruction by relevant copyright owners on the blockchain. Furthermore, BCE may directly split the reward pro rata among the copyright owners. For example, each member in a four-piece band may simultaneously receive twenty-five cents out of every dollar received if so agreed.

Third, as BCE smart contracts are self-executing on an immutable blockchain in accordance with predetermined contractual terms, they are essentially immune from any external influence ex post. This cryptographic robustness minimizes the risk of a breach of contract or fiduciary duty, e.g., an agent sitting on or misappropriating collected royalties. Nobody has any incentive or ability to create a black box of unidentified royalties, as every dollar goes directly to copyright owners in the BCE community.

IV. How Blockchain Rewards User Contribution

BCE cultivates a healthy ecosystem in which all users, including artists and fans, are motivated to benefit one another by actively participating in the BCE community: Artists receive various forms of financial rewards in proportion to the values of their creative contribution. Fans may share in the commercial success by acquiring a portion of copyright ownership in a creative work and therefore receiving a percentage of revenue flows. Additionally, fans may mine BCE tokens by hosting, promoting, and voting for creative works. In a nutshell, the BCE ecosystem squarely aligns the pecuniary incentives between artists and fans, to

the extent that the more fans support artists, the more artists excel in the market, and the more fans may benefit themselves financially.

A. *Diversifying Investment Risks*

It is not uncommon to hear the complaint that labels exploit artists in record deals by taking the lion's share of copyright royalties, often in the range of 80 to 90 percent.[98] Nonetheless, this practice has been rational and justifiable in the face of significant investment risks in copyright industries. The basic functions of major labels in a value chain conventionally revolve around financing and coordinating production, promotion, and distribution of creative works. According to a recent study, labels invest a total of $4.5 billion annually in artists and repertoire and marketing, accounting for 27% of their total revenues.[99] A major label typically spends between $0.5 million to $2 million upfront in discovering, developing, and promoting an emerging artist in the U.S. Market.[100] Figure 16 breaks down the investment:

FIGURE 16. Typical Investment in New Artists

Typical Investment in a New Artist	
Advance	$50,000-$350,000
Recording	$150,000-$500,000
Video production	$50,000-$300,000
Tour Support	$50,000-$150,000
Marketing and Promotion	$200,000-$700,000
Total	$500,000-$2,000,000

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98. *See, e.g.*, David Lowery, *Meet the New Boss, Worse Than the Old Boss?*, THE TRICHORDIST (Apr. 15, 2012), https://thetrichordist.com/2012/04/15/meet-the-new-boss-worse-than-the-old-boss-full-post/.

99. IFPI, *Investing in Music: The Value of Record Companies*, RIAA (2016),

https://www.riaa.com/wp-content/uploads/2017/01/ifpi-iim-report-2016.pdf.

100. *Id.*

As indicated above, an artist typically signs a recording contract with a major label in exchange for its upfront investment. The recording contract usually allocates 10 to 50 percent of copyright royalties to the artist while the label retains the remainder. More importantly, it allows the label to use the artist's share to fully recoup its investment in the advance (often including recording and music video) before it actually starts to transfer any royalty to the artist.[101] For example, a recording contract requires the label to give the artist an advance of $100,000 and allocate 10% of copyright royalties to the artist; additionally, the artist must pay back the $100,000 advance out of her 10% share. As a result, if an album is priced at $10 per copy, the artist needs to sell at least 100,000 copies before she sees a penny of copyright royalty, while the label receives $1 million royalties and makes a $900,000 profit.

Meanwhile, there is a high degree of uncertainty in consumer preferences inherent in the market of creative works. Some labels estimated that only one or two out of ten albums may achieve commercial success, while the rest are unable to recoup their own costs.[102] In response to the investment risks, traditional labels operate a lot like venture capitalists to the extent that they invest in a large portfolio of varied creative works in the hope of cross-subsidizing less popular works with the lucrative revenues from bestsellers.[103] In other words, the share of copyright royalties from a successful project has to be large enough to cover the costs of up to ten projects in order for a label to retain its financial soundness and long-run sustainability. Therefore, the $900,000 markup from one project is essentially a breakeven point in light of the whole portfolio of ten projects invested.

BCE enables artists and labels to diversify investment

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101. Notably, the recoupment usually doesn't cover marketing and promotion.

102. *See* Liu, *supra* note 19, at 493.

103. *See supra* note 15 and accompanying text.

risks by inviting their fanbases to invest in future or existing works. In exchange, the fans turn into sponsors who are entitled to a percentage of royalty revenues derived from these works. The blockchain-based crowdfunding may benefit all the parties involved. First, artists do not have to relinquish copyright ownership in their creative works in order to obtain financing. Instead, they may wield stronger control over their works and enjoy increased shares of copyright royalties. Second, labels take less financial risk during the creative process. Therefore, they may better focus their attention on developing new artists, producing and marketing new works. Third, fans may share in the market success of creative works of their choices as sponsors. The high transparency and low transaction costs on the blockchain ensure that a sponsor receives a substantial stream of royalty revenues as a result of superior taste and vision. It brings immense satisfaction both financially and emotionally.

The crowdfunding procedures in the BCE community consist mainly of the following steps. First, a publisher such as an artist or label, who first brings her work into the BCE community, may offer a percentage of copyright ownership in her work in the form of NFT or FT for the crowdfunding purpose. The crowdfunding option is not applicable if she is not a publisher who first brings her work into the BCE community. In these cases, BCE only allows a single party to take over the entire portion offered through sales or auction to avoid excessive fragmentation in copyright ownership.[104] Publishers may launch crowdfunding campaigns both within the BCE community and through other channels including

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104. Over-fragmentation may lead to the holdout problem. *See, e.g.*, Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1107 (1972). Similar issues are sometimes called the tragedy of "anticommons." *See* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 623–24 (1998); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research,* 280 SCIENCE 698, 698 (1998).

social media by means of embedded widgets.

Second, all members in the BCE community are invited to bid for sponsorship of any works offered. For each work, BCE implements a combination of advanced auction tactics including English auction and Vickrey auction to make sure that the new work receives sufficient funding. [105] For example, we may designate the highest bidder as the winner, who however needs to pay the amount offered by the second highest bidder. BCE allows a maximum of five hundred sponsors, who are generally the top five hundred bidders. The others do not have to return empty-handed. Instead, they may choose to use a portion (e.g., $1) out of their initial bids to purchase a presale copy enabling them to eventually mine BCE tokens at an accelerated rate (e.g., 30% faster than a normal rate).

Third, during and immediately after the bidding process, all the funding would be temporarily stored in an escrow account on the BCE blockchain. A publisher may propose a numerical threshold for crowdfunding. If the total amount falls short of reaching the threshold during a set period of time, all the funding would be automatically returned to the original bidders. If the threshold is reached and the work has been published before crowdfunding, BCE smart contracts will release the funding to the publisher and simultaneously transfer the shares of copyright royalties pro rata to the winning bidders. If a work otherwise has yet to be produced, BCE smart contracts would first release 35% of the total funds to the publisher to cover the production costs. BCE would release the remaining 65% after the work is published and more than 50% shares of the winning bidders approve of the published work.

Fourth, the winning bidders split the percentage of copyright royalties offered pro rata according to their respective amounts. If there is only one winner, such as in

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105. *See generally* VIJAY KRISHNA, AUCTION THEORY 91–101, 178–79 (2d ed. 2010) (discussing the English and Vickrey auctions).

the case of less than 30% offered, she would receive the whole share. BCE smart contracts in turn distribute all royalty revenues in the BCE community to artists, labels, and sponsors in proportion to their respective shares.

Fifth, those who acquire through crowdfunding shares of copyright ownership in any works are free to transfer their shares in the secondary market. Nevertheless, BCE smart contracts allow a publisher or any other owner to set the duration of a transfer up to thirty-five years so that the transferred ownership will revert to herself after a certain number of years at her discretion. As a result, if a user acquires 30% ownership in a work for three years, after a year, she would be able to transfer only the remaining two years of ownership.

Crowdfunding business models, such as Kickstarter and RocketHub, actually predated the blockchain technology. However, the blockchain technology dramatically minimizes the financial risks and costs involved in large-scale crowdfunding transactions. First, typical crowdfunding services have to charge around 5% as administrative fees or payment processing fees. [106] The blockchain technology enables BCE to avoid a centralized credit card system and reduce the relevant fees to zero.

Second, BCE smart contracts have incorporated applicable copyright and corporation rules in major legal jurisdictions to fulfill the ultimate vision of "law is code." Therefore, BCE offers a crowdfunding platform with an unprecedented level of legal compliance. For example, while certain countries impose complex legal requirements on equity crowdfunding,[107] BCE instead designs a new model of

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106. *See, e.g.*, *Fees for the United States*, KICKSTARTER, https://www.kickstarter .com/help/fees (last visited June 27, 2021).

107. *See, e.g.*, SEC, *The Laws That Govern the Securities Industry*, INVESTOR.GOV, https://www.investor.gov/introduction-investing/investing-basics /role-sec/laws-govern-securities-industry (last visited June 27, 2021).

crowdfunding relying on copyright divisibility.[108] A copyright owner may transfer her entitlement to a work to multiple users without the typical legal hurdles in the equity and securities markets. Copyright crowdfunding among numerous users has been legally possible but economically unrealistic until the blockchain technology diminished the transaction costs in complex copyright licensing.

Third, BCE smart contracts minimize the risks of funding misappropriation. The accumulated funding would be stored in blockchain-based escrow accounts out of reach to artists until artists have delivered the promised works approved by the majority of the winning bidders. Subsequently, remittance of funding and transfer of copyright ownership are both self-executing, immune from any human intervention.

Fourth, the current U.S. Copyright Act of 1976 allows authors the possibility of terminating copyright assignment or license agreements after thirty-five years.[109] However, the notification formalities required to trigger the termination are so complicated as to make termination virtually impossible in practice. [110] BCE smart contracts use automation to greatly simplify termination formalities and make the legal benefit accessible to authors.

Fifth, BCE copyright crowdfunding provides investors with a stable stream of revenues. Conventional crowdfunding models either grant equity in a startup that produces minimal dividends and is difficult to cash out, or give away rewards of value no more than a souvenir or a product presale.[111] By contrast, BCE copyright crowdfunding

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108. *See generally* 17 U.S.C. § 201(d)(1)–(2) (codifying the divisibility of copyright).

109. 17 U.S.C. § 203(3).

110. *See, e.g.*, Burroughs v. Metro-Goldwyn-Mayer, Inc., 683 F.2d 610, 618–19 (2d Cir. 1982); Milne *ex rel.* Coyne v. Stephen Slesinger, Inc., 430 F.3d 1036 (9th Cir. 2005); Penguin Group (USA) Inc. v. Steinbeck, 537 F.3d 193 (2d Cir. 2008).

111. Carol Benovic & Sid Orlando, *Need Some Reward Ideas? Here Are 96 of Them*, KICKSTARTER (Apr. 16, 2015), https://www.kickstarter.com/blog/need-

results in a continuous and automated distribution of substantial royalty revenues to all sponsors.

We may readily extend the models of copyright crowdfunding and copyright mining to live performance either online or offline. Traditionally, a touring artist often takes an educated guess on which cities may have a good turnout for her concerts. Once she starts to sell concert tickets through ticketing agencies like Ticketmaster, it may turn out that some cities do not have audiences large enough to justify the costs of performing a concert. In these cases, the artist has to cancel the dates, refund all the tickets sold, and pay ticketing agencies for their administrative fees nonetheless. Copyright crowdfunding may provide a solution to such an information asymmetry. First, the touring artists or other event organizers may publish an upcoming event in the BCE community. Organizers may offer 30% or more of ownership and revenues for crowdfunding. Additionally, they may offer ticket presales to the general public. Second, if organizers have not secured a hosting venue yet, they may offer a percentage (e.g., 10%) of ownership and revenues to a potential host. Third, BCE may generate a specific hyperlink to ticket sales for each ticketholder, who is then able to mine BCE tokens (e.g., 20%) by promoting and distributing the hyperlink to other potential audiences on various social media. Fourth, all the payments are tentatively stored in an escrow account on the BCE blockchain. Organizers may set a threshold for each city. If the sales do not reach the threshold, all the payments would be refunded automatically. If the sales reach the threshold, BCE smart contracts would directly distribute the revenues to relevant copyright owners, hosts, and promoters. Fifth, the tickets sold may be freely transferred within the BCE community ahead of time. If the resale generates a premium, the original ticketholder needs to share 30% with the organizers. Sixth, BCE will release the tickets in the form of a barcode an hour

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some-reward-ideas-here-are-96-of-them (providing a list of potential rewards to give to Kickstarter campaign investors).

prior to the event in order to prevent ticket forgery.

B. *Democratizing Talent Discovery*

Marketing is usually the largest operating cost for a major label, which may spend between $200,000 and $700,000 in order to effectively promote an emerging artist to the general audience.[112] In total, major labels annually invest $1.7 billion, i.e., around 10% of their total revenues, in marketing and promotion.[113] Independent labels and individual artists rarely have the financial resources necessary to launch extensive marketing campaigns, e.g., in the form of payola to radio and television stations.[114] Therefore, the utmost question for many emerging and alternative artists is how to engage fans around the world in the absence of substantial funding. BCE provides artists and labels with innovative mining mechanisms to mobilize their fanbases to promote creative works through the viral effects of crowdsourcing and social media. BCE users may take at least three measures to mine BCE tokens on the basis of their respective contributions to the marketing and distribution of creative works.

1. Mining by Hosting

Once a user downloads a copy of a work, she may serve as a "hosting miner" by setting her copy as a "node" that supplies feeds to other users who stream or download the same work.[115] All the hosting miners whose nodes facilitate a stream or download would jointly be entitled to an additional 10% of the BCE tokens allocated to its copyright

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112. *See* IFPI, *supra* note 100.

113. *Id.*

114. *But see* R. H. Coase, *Payola in Radio and Television Broadcasting*, 22 J.L. & ECON. 269, 315 (1979).

115. Mining by hosting depends essentially on a protocol like InterPlanetary File System (IPFS). For the IPFS open-source information, see *IPFS Powers the Distributed Web*, GITHUB, https://github.com/ipfs/ipfs (last visited June 27, 2021).

owners. This mining approach would be particularly attractive for users having excess processing power or bandwidth.

2. Mining by Linking

A user who downloads a copy of a work may obtain from BCE a widget that uniquely associates with the particular user and embeds a hyperlink to the particular work. She may distribute the widget, e.g., as part of a commentary or playlist, within the BCE community and through social media such as Facebook, Twitter, and WeChat. If another user downloads or streams a work through her widget, she would be entitled to an additional 20% of the BCE tokens allocated to its copyright owners for serving as a "linking miner."

3. Mining by Voting

The third channel of mining BCE tokens invites users to act as "voting miners" who influence the rankings of all the works published in the BCE community. The voting system is set up in response to the fact that the emission of new BCE tokens in proportion to the number of streams and downloads may not fully reflect how much weight consumers allocate to each work if each stream or download is uniformly priced at $0.01 or $1. Traditionally, a seller often engages in price discrimination strategies to gauge the maximum amount that a buyer is willing to hand over to procure a product or service, which is also referred to as "willingness to pay" ("WTP").[116] Accordingly, we may calculate the total market value of a work by multiplying its market width,

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116. For detailed discussions of price discrimination, see generally Mark Armstrong, *Recent Developments in the Economics of Price Discrimination*, *in* 2 ADVANCES IN ECONOMICS AND ECONOMETRICS: THEORY AND APPLICATIONS 97 (Richard Blundell, Whitney K. Newey & Torsten Persson eds., 2006); Lars A. Stole, *Price Discrimination and Competition*, *in* 3 HANDBOOK OF INDUSTRIAL ORGANIZATION 2221 (Mark Armstrong & Robert H. Porter eds., 2007); Hal R. Varian, *Price Discrimination*, *in* 1 HANDBOOK OF INDUSTRIAL ORGANIZATION 597 (Richard Schmalensee & Robert D. Willig eds., 1989).

defined as the total number of users who consume the work, with its market depth, defined as the average WTP that each user allocates to the work.

BCE implements an innovative voting and ranking system in the blockchain context to gather WTP information beyond the number of streams and downloads. BCE releases a series of weekly charts that rank the most valuable works (e.g., Top 100) in different genres.[117] The ranking methodologies depend on a combination of the following three elements: First, the total value of streams and downloads during a week accounts for 35% of the ranking score allocated to a work in all the relevant charts. Second, a user may vote for or against any work with regard to any weekly chart in which it may potentially appear.[118] Each vote is weighted by the BCE tokens that the voter has spent to back her vote. The total weighted value of both positive and negative votes accounts for 35% of the ranking score. We may disregard top 1% of positive and negative votes to minimize the risks of voting manipulation. Third, a qualified artist may opt to vote for or against any work as a critic, rather than as a user. A critic vote would not cost any BCE tokens and therefore would not be weighted.[119] The total value of positive and negative critic votes accounts for 30% of the ranking score in all the relevant charts.

All the works are ranked in the weekly charts according to their ranking scores.[120] If a work has moved upwards in a

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117. All the works may fall into one of the three categories: music, video, and literature. A work may be listed only in one category. Each category has a unified chart and five genre charts. A work may fall into a unified chart and one of the genre charts within a category.

118. This means a user may vote for the same work multiple times in different charts, with different directions and different BCE tokens.

119. We may select as critics all artists who meet the threshold of works published (e.g., 10) and/or streams and downloads (e.g., $100). Alternatively, we may select top 100 artists or randomly select 100 critics from the artists who meet the threshold.

120. If multiple works happen to have the same ranking score, the tiebreaker would be the total value of streams and downloads, then the total weighted value

chart, the BCE tokens from the positive voters would not change hands, and the BCE tokens from the negative voters would be divided between the relevant artists (35%), the positive voters (35%), and the positive critics (30%). [121] Similarly, if a work has moved downwards, the BCE tokens from the negative voters would not change hands, and the BCE tokens from the positive voters would be divided between the relevant artists (35%), the negative voters (35%), and the negative critics (30%). If a work has stayed put, the tiebreaker would be the change in the total value of streams and downloads, then the change in the total weighted value of votes, and then the change in the total value of critic votes.

V.   How BCE Improves Copyright Enforcement

BCE develops a variety of innovative tools based on the blockchain technology to prevent copyright disputes, combat online infringements, and cultivate socioeconomic conditions against copyright piracy. First, the BCE blockchain produces immutable hashes of copyright ownership information to establish copyright priority and facilitate copyright registration; second, BCE streamlines the procedures for third parties to obtain copyright licenses for user generated content and other derivative works; third, BCE reshapes notice-and-takedown procedures to resolve copyright disputes in a cost-effective way, improving upon the existing system under the U.S. Copyright Act; [122] fourth, BCE automates searching and detection of online infringements through a blockchain-based search engine and bounty system; fifth, and most importantly, BCE is tackling the piracy problem not only with a stick, but also with a carrot

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of votes, and then the total value of critic votes.

121. The rewards for the positive voters are distributed in proportion to their investments of BCE tokens. The rewards for the positive critics are divided equally.

122. *See generally* 17 U.S.C. § 512 (setting forth the notice and takedown system for copyrighted material online).

by providing powerful incentives for users to move away from copyright piracy and do the right thing: it is highly convenient and mostly free for average users to enjoy licensed creative works in the BCE community. Furthermore, BCE users are motivated to actively sponsor, distribute, and promote new creative works taking comfort in the fact that BCE aspires to reward their benevolence financially through the mining of BCE tokens and confer 100% of the royalty revenues on artists.

A. *Copyright Priority*

Copyright ownership information is readily accessible, transparent, and immutable on the BCE blockchain. Once an artist publishes her work in the BCE community, BCE automatically generates a series of hashes through a Merkle tree consisting of its digital fingerprint and copyright ownership information, such as who are copyright owners, how copyright royalties are to be split, and how long copyrights last. The BCE blockchain stores these hashes with a timestamp as *prima facie* evidence of copyright ownership. The blockchain record documenting a work published by a particular author at a particular time is useful to obtain a registration at the Copyright Office and to prove legal standing in copyright litigation.[123] A publisher has the option to proceed with the official copyright registration automated through the BCE blockchain, preferably within three months of publication.[124]

In the meantime, the blockchain record establishes a copyright priority in the BCE community. When another user intends to publish a new work subsequently, BCE will scan the new work looking for a match between its digital

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123. *See* 17 U.S.C. § 401(b)–(c).

124. When registration is made within three months after publication of a work, a copyright owner is eligible for statutory damages, attorneys' fees, and costs. *See* U.S. COPYRIGHT OFF., CIRCULAR 1 COPYRIGHT BASICS 5 (2021), https://www.copyright.gov/circs/circ01.pdf.

fingerprint and that of any preexisting work. BCE would automatically block the new work if a match is found, unless the original owner has approved the new work through the procedures set forth in Section V.B.[125]

Even if a new work is blocked, it may not necessarily mean that it infringes upon the copyrights in any preexisting work. In reality, it could be the other way around where the preexisting work had copied the new one. An aggrieved artist may file a notification to resolve the dispute following the procedures set forth in Section V.C.[126] Alternatively, she may directly file a lawsuit in court. In this case, she has to overcome by preponderance of the evidence the blockchain record that a court may accord the weight of *prima facie* evidence.

B. *Approval Mechanism*

If a user publishes a new work that incorporates an original work, BCE requires her to send an application to its original owner in the BCE community or otherwise obtain a license. Within ten days of receipt of the application, the original owner may request BCE to take down the published work. Upon receipt of the request, BCE would promptly remove the published work and forfeit all the revenues derived from the same. If the original owner does not respond to an application during the ten-day period, she still has the right to request a takedown afterwards. However, all the revenues incurred before the takedown would be allocated exclusively to the publisher.

Alternatively, the original owner may approve publication of the new work unconditionally, or on the condition that she receives a percentage or entirety of royalty revenues derived from the new work. BCE would promptly forward the approval to the publisher. In the case of a

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125. *See infra* Section V.B.

126. *See infra* Section V.C.

conditional approval, if the publisher chooses to reject it within ten days of receipt of the approval, BCE would remove the published work and forfeit all the revenues; if the publisher agrees with or does not respond to the conditional approval within ten days of receipt, BCE would proceed to distribute revenues in accordance with the proposed condition.

The approval mechanism is particularly useful for user general content ("UGC") such as a smartphone video taken during a concert or a cover version produced at home.[127] Many fans are passionate about publishing videos of their favorite artists and personal covers of their favorite songs. BCE expects that most artists approve of UGC as a form of interaction with fans, especially when it is properly credited and generates new income streams for artists.

C. *Dispute Resolution*

BCE designs a dispute resolution scheme on the basis of the notice and takedown procedures under the Digital Millennium Copyright Act of 1998.[128]

If a user publishes a new work that incorporates another original work without obtaining a license or sending a proper application, the original owner may send a notice to request BCE to take down the new work. Upon receipt of the takedown notice, BCE would expeditiously remove the new work and promptly forward the notice to the publisher. If the publisher believes the notice is mistaken, she may send BCE a counternotice to dispute the former within ten days of receipt. BCE would promptly forward the counternotice to the original owner. BCE would revive the new work after ten days, unless BCE has received a further notice that the

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127. *See generally* UMG Recordings, Inc. v. Shelter Cap. Partners LLC, 718 F.3d 1006, 1011 (9th Cir. 2013); Viacom Int'l, Inc. v. YouTube, Inc., 676 F.3d 19, 28 (2d Cir. 2012).

128. *See generally* Digital Millennium Copyright Act, Pub. L. No. 105-304, 112 Stat. 2860 (1998).

original owner has filed a legal action seeking a court order to enjoin the new work.

Alternatively, the original owner may send a notice to request BCE to transfer a percentage or the entirety of royalty revenues derived from the new work. BCE would expeditiously seize the revenue streams and promptly forward the notice to the publisher. If the publisher agrees with or does not respond to the notice within ten days of receipt, BCE would start to distribute revenues in accordance with the notice. If the publisher believes the notice is mistaken or unreasonable, she may send BCE a counternotice to dispute the former within ten days of receipt. BCE would promptly forward the counternotice to the original owner. BCE would revive the revenue streams after 10 days, unless BCE has received a further notice that the original owner has filed a legal action seeking a court order to seize the royalty revenues.

D. *Automated Investigation*

As BCE produces digital fingerprints of creative works on the blockchain in a transparent and immutable way, copyright owners may take advantage of the digital fingerprints to optimize copyright enforcement on the internet. For example, BCE may develop a digital fingerprint search engine to detect infringing copies of original works on unlicensed websites. The search engine would be accessible exclusively to copyright owners and their trusted agents who use it for anti-piracy purposes only. Furthermore, BCE may implement a crowdsourcing system to invite "bounty hunters" to anonymously investigate and report online infringements in exchange for BCE tokens. Once copyright owners successfully recover damages from the infringers, the BCE blockchain would automatically distribute a percentage to the bounty hunters. The bounty system through a distributed network is particularly useful in places on the internet where search engine crawlers may not reach, such as the dark web and password-protected digital lockers.

E. *Fundamental Solution*

Fundamentally, BCE may in effect prevent copyright piracy by providing overwhelming ethical and financial reasons for users to do the right thing.

Copyright piracy arises from a combination of social norms and economic incentives that work against legitimate licenses. First, copyright piracy is often rooted in a confusion over the economics of copyright protection.[129] Many consumers regard a creative work purely as a public good that is non-rivalrous in consumption: where is the harm of an unlicensed stream or download, if it does not prevent the author from enjoying the work herself or distributing the same to others? This view is flawed in its narrow focus on inexhaustibility of consumption rather than scarcity of creativity. Second, there is a widespread perception that copyright protection primarily benefits multinational corporations that unduly exploit artists.[130] This perception may lead to a glorification of copyright piracy as a kind of anti-establishment movement aiming to liberate artists. Third, certain consumers may turn to copyright piracy simply as an alternative to conventional online services.[131] They are unwilling to pay for offerings that charge high prices as a result of exorbitant transaction costs, lack variety in new content, and revolve around popstars at the expense of emerging artists and independent artists.

The BCE ecosystem cultivates a sea change in social

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129. For comprehensive surveys of economic theories of intellectual property, see, for example, ROBERT COOTER & THOMAS ULEN, LAW AND ECONOMICS 135–149 (1988); PAUL A. SAMUELSON & WILLIAM D. NORDHAUS, ECONOMICS 37 (17th ed. 2001); William M. Landes & Richard A. Posner, *An Economic Analysis of Copyright Law*, 18 J. LEGAL STUD. 325, 326–44 (1989).

130. For a summary of diverse perceptions on copyright, see, for example, Peter K. Yu, *The Copyright Divide,* 25 CARDOZO L. REV. 331 (2003); Daniel C.K. Chow, *Why China Does Not Take Commercial Piracy Seriously*, 32 OHIO N.U. L. REV. 203 (2006).

131. *See, e.g.*, CHRIS ANDERSON, FREE: THE FUTURE OF A RADICAL PRICE 135–61 (2009).

dynamics surrounding copyright protection. First, the BCE community reinforces the direct bond between artists and users through mining, sponsorship, and other communications. Second, by channeling reasonable royalties directly to artists, BCE highlights the fact that flesh-and-blood authors rather than corporate machines are the ultimate beneficiaries of copyright protection. Ethically, consumers may respect copyright more with the understanding that copyright royalties provide economic lifeblood for creative artists and piracy is by no means a victimless infringement. Third, BCE generates a number of financial incentives for users to consume licensed content: BCE coupons allow free access to creative works by average users with minimal transaction costs. After downloading legitimate copies of creative works, users may mine BCE tokens by marketing, distributing, and voting for these works. Users may earn additional BCE tokens through direct investment in new works. Changing social norms and financial calculus may influence legal behaviors much more effectively than legal punishments alone may achieve.

VI. BCE Technological Infrastructure

The BCE ecosystem is built principally on a technological infrastructure comprised of the following key elements:

A. *BCE Token*

The BCE community operates on an ERC20 utility token that enables all users to access creative works and participate in community activities. The ERC20 interface allows for the emission of a standard token that is backward compatible with the existing infrastructure of the Ethereum network, e.g., wallets, development tools, and token exchanges. [132] Additionally, BCE implements a token

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132. *See* Fabian Vogelsteller & Vitalik Buterin, *EIP 20: ERC-20 Token Standard*, Ethereum Improvement Proposals (Nov. 2015), https://eips.ethereum.org/EIPS/eip-20.

mechanism to incentivize contributions by users, ensuring equitable rewards not only for artists who publish creative works but also for those who market and promote the works.

The emission of ERC20 tokens may in theory employ one of the three approaches introduced below. Of the three, the BCE approach is superior in measuring both subjective and objective values of creative works.

1. Spotify Approach

If we intend to closely imitate current market structures dominated by freemium services such as Spotify, we could consider issuing two different kinds of tokens, respectively for the free tier (e.g., Silver Token) and for the paid tier (e.g., Gold Token). BCE would reward artists Sliver Tokens for advertisement-supported free consumption by users, and Gold Tokens for advertisement-free paid consumptions by users. By the end of each reporting period, BCE would distribute advertisement revenues in accordance with the percentage each artist earns in the total Silver Token pool accumulated during the same period. Similarly, BCE would distribute royalty payments in accordance with the percentage each artist earns in the total Gold Token pool accumulated during the reporting period.

There are a number of limitations inherent in this approach, which does not take full advantage of the blockchain technology. First, as discussed above, freemium and other advertisement-based services, by exchanging free access to creative works for user attention to advertisements, tend to undermine the market value of creative works. The experience so far suggests that the conversion rates from free users to paying users are fairly low.[133] The conversion rate could be lower in the blockchain environment unfamiliar to mainstream users. Second, the nascent stage of a freemium

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133. *See, e.g.*, Jon Porter, *Spotify Is First to 100 Million Paid Subscribers*, THE VERGE (Apr. 29, 2019, 7:39 AM), https://www.theverge.com/2019/4/29/18522297 /spotify-100-million-users-apple-music-podcasting-free-users-advertising-voice-speakers (paying users are less than a half of all users).

service is often vulnerable when users, particularly paying subscribers, are limited in number and the service is forced to rely heavily on advertisements for revenues. However, there is a chicken-and-egg problem to the extent that advertisers are similarly reluctant to patronize a new service that has yet to establish a substantial user base.[134] Third, the distribution of advertisement revenues on the basis of free access leaves room for malicious users to game the system, e.g., by employing robotic tools to play a single song day and night to misappropriate an unwarranted share of the revenue pool.

We may theoretically remove the free tier and only retain the paying tier, which would require users to purchase all their tokens spent on content consumption. However, this paywall may erect an entry barrier, financially and mentally, for average consumers who are not so sophisticated in cryptocurrency transactions. Currently, it is rarely straightforward to purchase a cryptocurrency in a secondary market. Users usually need to first create a digital wallet with an exchange (e.g., Coinbase) that offers leading cryptocurrencies such as Bitcoin and Ethereum in exchange for fiat currencies. Afterwards, users may need to find another exchange (e.g., Binance) that offers the desired cryptocurrency in exchange for Bitcoin or Ethereum. Apparently, the need to purchase cryptocurrency for any consumption, no matter how trivial it is in market value, may create substantial transaction costs that impede market expansion to mainstream consumers.

2. Steem Approach

The widely acclaimed blockchain platform Steem implements a scheme of token emission that improves upon the market approach: it removes the financial need for

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134. *See* Bernard Caillaud & Bruno Jullien, *Chicken & Egg: Competition Among Intermediation Service Providers*, 34 RAND J. ECON. 309, 310 (2003).

artists to rely on advertisement revenues.[135] Instead, it periodically distributes a predetermined quantity of tokens pro rata among users in accordance with the subjective values of their individual contributions, as measured principally by the weighted votes by all stakeholders.[136] The voting system does not necessarily preclude the possibility of malicious manipulation, such as voting repetitively for oneself. In response, Steem imposes a cap on voting power so that individual users can only vote for a limited number of works per day.[137]

The Steem approach has an important shortcoming: it invariably distributes a fixed quantity of tokens no matter how many people participate, how many works are published, and how often these works are consumed.[138] In other words, the fixed quantity basically sets a ceiling for token emission. The more users participate and the more works are published, the less tokens each user and each work would receive.[139] In economic terms, the Steem approach focuses on the relative weights that consumers attach to individual works on the platform but falls short of measuring the values of these works against other products in the general market.

3. BCE Approach

First, BCE allocates each subscriber a predetermined quantity of free BCE coupons on a weekly basis. The BCE coupons are inalienable and may only be converted to BCE tokens through stream, download, or other activities within the BCE community. We may set the value of free BCE coupons constantly at the equivalent of 600 streams per

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135. *See* STEEM, STEEM: AN INCENTIVIZED, BLOCKCHAIN-BASED, PUBLIC CONTENT PLATFORM 31–32 (2017), https://steem.com/SteemWhitePaper.pdf.

136. *Id.*

137. *Id.*

138. *See id.*

139. It is unclear whether such a decrease in token quantity allocated could be offset by an increase in individual token value in the marketplace as the community grows in number of members and works.

month, given the standard length of a song is generally believed to be three minutes and assuming a user spends one hour per day enjoying the works in the BCE community.[140]

Second, we need to determine the exchange rate between stream and download. Billboard currently equates one album to 1,500 streams and ten downloads for the purposes of charting, which appears to be consistent with current streaming rates at freemium services but, as mentioned above, significantly underrates the market values of creative works. [141] Therefore, we set the ratio of stream versus download of a song at 100-to-1.

Third, if a subscriber streams or downloads a work, a portion of her BCE coupons will automatically be converted into BCE tokens and transferred to the relevant artists. This is one of the major channels in which new BCE tokens are emitted after the initial sales. BCE tokens are the utility tokens for the BCE community, enabling subscribers to stream, download any works, and participate in other activities in the BCE community. Because BCE tokens are alienable in nature, a subscriber may either earn BCE tokens by her contributions to the BCE community or simply purchase BCE tokens from third parties at the market rate.

Fourth, when BCE coupons are converted into BCE tokens, the value of a download is artificially set at $1, the market rate established as early as the advent of the iTunes store in 2003.[142] Accordingly, the value of a stream is set at $0.01. We may also set the price of a BCE token at a certain price during the initial sales but allow the price to fluctuate afterwards in the secondary market. As long as we hold the

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140. *See* Rhett Allain, *Why Are Songs on the Radio About the Same Length?*, WIRED (July 11, 2014, 8:31 AM) https://www.wired.com/2014/07/why-are-songs-on-the-radio-about-the-same-length/ (maintaining that songs tend to be around three minutes long).

141. *See Billboard 200 Makeover: Album Chart to Incorporate Streams & Track Sales*, BILLBOARD (Nov. 19, 2014), https://www.billboard.com/articles/columns/chart-beat/6320099/billboard-200-makeover-streams-digital-tracks.

142. *See supra* note 64 and accompanying text.

value of a download constant at $1, the emission of new tokens will decrease over time as the market value of BCE tokens gradually increases in the long run, although the amount of enjoyment per subscriber permitted by BCE coupons stays constant. [143]

Fifth, for each stream or download, BCE automatically generates an additional 10% of the value for mining by hosting and 20% of the value for mining by linking.

Sixth, BCE takes several measures to minimize the risks of sybil attacks and other automation: (i) A user may sign up for the BCE community through a social media account including Facebook, Twitter, or WeChat. If she does not provide her social media account, she may alternatively sign up with her phone number and email address. (ii) We may during the sign-up process implement the reCAPTCHA technology, which has proven to be effective and economic in preventing robotic spams.[144] (iii) Although free BCE coupons may be more than enough for a causal member in the BCE, a high frequency user who quickly spent all her BCE coupons would be required to purchase BCE tokens to further enjoy the creative works and other activities. (iv) BCE regularly recoups unused BCE coupons and issues new BCE coupons on a monthly basis. And (v) a download triggers a transfer of BCE tokens once the download is complete. A download triggers the emission of new BCE tokens after a subscriber has played the work for at least thirty minutes cumulatively. A stream triggers a transfer or emission of BCE tokens on the condition that a subscriber has played at least three minutes of a work.

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143. In other words, the amount of enjoyment allowed by free BCE coupons per subscriber per month stays constant at 600 streams although the amount of BCE tokens that the BCE coupons may be converted into fluctuates depending on market situations.

144. *See What Is reCAPTCHA?*, GOOGLE, https://www.google.com/recaptcha/about/ (last visited June 27, 2021).

B. *Distributed Ledgers*

The BCE ecosystem entails multiple blockchains to process complex copyright transactions of distinct natures. For example, when artists auction off copyright ownership in their works during crowdfunding campaigns or otherwise assign copyright ownership to third parties, these transactions are low-frequency and high-value in nature. By contrast, when artists license their works for public consumption and when users are mining BCE tokens by distributing, marketing, and voting for new works, these transactions are high-frequency and low-value in nature. Therefore, BCE introduces a bi-ledger structure to streamline smart contracts and increase transaction security. The following explains how the two layers of distributed ledgers function and interact.

1. Ledger I – Low-Frequency and High-Value

Ethereum, a public blockchain based on a proof-of-work ("PoW") protocol, is one of the most popular blockchain environments for building decentralized applications.[145] It pioneers the smart-contract functionality by providing a decentralized Turing-complete virtual machine, the Ethereum Virtual Machine ("EVM"), to execute scripts, i.e., smart contracts written in a Turing-complete scripting language and stored on the Ethereum blockchain. A PoW protocol like Ethereum features a high degree of security and integrity, as anyone who intends to engage in double spending has to at least accumulate more than 50% of the processing power of the whole network, which is sometimes called a "51% attack."[146] It is estimated that it takes about

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145. *See Prices*, COINBASE, https://www.coinbase.com/price (last visited Aug. 4, 2021) (showing Ethereum is the second largest cryptocurrency in value); *see generally* Vitalik Buterin, *Ethereum Whitepaper: A Next-Generation Smart Contract and Decentralized Application Platform*, ETHEREUM (June 27, 2021), https://ethereum.org/en/whitepaper/ (describing the history of proof-of-work protocol and how Ethereum works).

146. MIT MEDIA LAB, *51% Attacks*, DIGIT. CURRENCY INITIATIVE,

525 times Google's entire computing power to hack the Bitcoin blockchain, and Ethereum is about a third of Bitcoin in size.[147]

PoW protocols currently have certain limitations in scalability. First, unlike credit card systems that may process over 1,500 transactions per second, Bitcoin may only handle three to four transactions per second, and Ethereum may relay around twenty to twenty-five transactions per second.[148] Second, Ethereum implements a transaction fee called "gas" in order to prevent spamming the network.[149] However, the transaction fee, calculated on the basis of required computational resources rather than the values of transactions, happens to make micropayments financially unsustainable. The hurdles of high latency and transaction costs make Ethereum less attractive for high-frequency, low-value transactions.

BCE may instead deploy low-frequency, high-value transactions onto Ethereum, such as copyright ownership information and smart contracts for copyright assignment transactions. In other words, the copyright exchange that facilitates crowdfunding, auctions, and other sales is set up principally on Ethereum as its backend.

2. Ledger II – High-Frequency and Low-Value

The BCE ecosystem involves various high-frequency and low-value microtransactions, including end user licenses for consumption and mining activities by means of distributing, marketing, and voting for new works. BCE currently has two options to improve upon Ethereum by minimizing transaction fees and maximizing transaction speed. First,

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https://dci.mit.edu/51-attacks (last visited Aug. 4, 2021).

147. Josh Hall, *How the Technology Behind Bitcoin Could Change the Music Industry – and Help Everyone Get Paid*, FACT MAG. (Feb. 21, 2017), http://www.factmag.com/2017/02/21/blockchain-bitcoin-music-industry/.

148. In other words, it takes Bitcoin approximately ten minutes and takes Ethereum approximately fifteen seconds to process a block.

149. *See* Buterin, *supra* note 145.

BCE may employ such an off-chain scaling solution as the Raiden Network to facilitate seamless microtransactions through state channels.[150] The Raiden Network elegantly allows secure token transfers without the need for a global consensus, by using digitally signed and hash-locked transfers, called balance proofs, fully collateralized by previously setup on-chain deposits. The Raiden Network has the technological potential to scale up the Ethereum blockchain to one million transactions per second.[151]

Alternatively, BCE may deploy high-frequency and low-value microtransactions onto a public blockchain like EOS, Steem, or BitShare, which are based on a delegated proof of stake protocol ("DPoS"). For example, the first EOS blockchain depending on EOSIO 1.0 went online in June 2018.[152] It has a remarkably low degree of latency, taking a half-second to generate a block, and currently processes up to a thousand transactions per second, forty times faster than Ethereum does. In accordance with the EOSIO Technical White Paper (v2), an EOS blockchain may ultimately scale to millions of transactions per second while totally removing transaction fees.[153]

Meanwhile, a DPoS blockchain has its own limitations.[154] Taking EOS as an example, all blockchain stakeholders, e.g., EOS token holders, elect twenty-one block

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150. *See generally What Is the Raiden Network?*, RAIDEN NETWORK, https://raiden.network/101.html (last visited Aug. 4, 2021) (describing Raiden's off-chain scaling solution).

151. *See* Alyssa Hertig, *Will Ethereum Beat Bitcoin to Mainstream Microtransactions?*, COINDESK (June 1, 2016, 9:04 AM), https://www.coindesk .com/ethereum-bitcoin-mainstream-microtransactions/.

152. *EOSIO 1.0 Release*, B1 (June 1, 2018), https://b1.com/press/eosio-1-0-release/.

153. *EOS.IO Technical White Paper v2*, GITHUB (Mar. 16, 2018), https://github.com/EOSIO/Documentation/blob/master/TechnicalWhitePaper .md.

154. *See, e.g.*, Vitalik Buterin, *Governance, Part 2: Plutocracy Is Still Bad*, VITALIK BUTERIN'S WEBSITE (Mar. 28, 2018), https://vitalik.ca/general/2018 /03/28/plutocracy.html.

producers through a continuous voting system. These block producers generate blocks in the rounds of 126 (six blocks each, times twenty-one producers) in an order agreed upon by fifteen or more producers. As a consequence, a DPoS blockchain may be prone to a concentration of power in the hands of a small number of majority stakeholders often called "whales," especially when minority stakeholders are inclined to delegate their voting power to others. Whales, as well as block producers, may collude with one another to manipulate the blockchain and further their private benefits, e.g., by censoring transactions to be included in blocks. Although the EOS blockchain is still at a nascent stage, the experience on the Steem blockchain, which has been implementing a similar DPoS protocol since 2016, indicates that merely 6.73% of stakeholders vote for block producers (called "witnesses" in the context of Steem), with most of the voters being whales.[155]

BCE employs a bi-ledger structure by deploying copyright ownership and assignment transactions on Ledger I (low-frequency and high-value) and deploying copyright licensing and mining transactions on Ledger II (high-frequency and low-value). The two layers of distributed ledgers are synchronized on a daily basis through inter-blockchain communications to increase network security. BCE distributed ledgers would be able to respond promptly to, and withstand, malicious attacks unless both layers were compromised simultaneously.

3. Encryption

At present, it is technologically difficult and unnecessary to record a whole audio or audiovisual file in a blockchain. We may instead derive a hash from a file and incorporate the hash into a blockchain. As mentioned above, a blockchain is useful to stamp the time of publication, establish priority to

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155. Tanishqyeverma, *Is This a Shortcoming of DPOS and Will Remain One?*, STEEMIT, https://steemit.com/blockchain/@tanishqyeverma/is-this-a-shortcoming-of-dpos-and-will-remain-one (last visited June 27, 2021).

resolve potential disputes on copyright ownership, and facilitate copyright enforcement against piracy. Figure 17 compares four potential approaches to generating the hash of an audiovisual file for a blockchain.

FIGURE 17.   Leading Encryption Technologies

	Header	**Encryption**	**Fingerprint**	**Watermark**
Security	Low	Medium	High	Medium
Robustness	Low	Medium	High	High
Flexibility	High	High	Medium	High
User-Friendliness	High	Low	High	Medium

a. DRM

While it appears straightforward to generate a hash by inputting the entire file, such a method has inherent limitations in security[156] and robustness[157] as a file identifier. For example, a user can randomly delete a small fragment (say 0.1 second) at the beginning or the end of the file and generate a different hash without substantially affecting the audiovisual quality. In this way, one may easily evade the usage tracking in a blockchain. In the worst-case scenario, one may set up an infringing account, with a different hash for the essentially same file, to divert payment of royalties from the rightful owner.

Sometimes, copyright owners insert ownership information and/or license conditions into the headers of audiovisual files. However, such header data is as vulnerable to alteration and removal as the files themselves. It is technically trivial for professional hackers to identify and remove header data. There is no guarantee that the header

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156. Security describes whether a file identifier is susceptible to removal or change without substantially affecting the content quality.

157. Robustness refers to whether a file identifier may be lost or altered during the course of file transformation from one format to another.

data may even survive after one transforms the file from one format to another ("transcoding"). If one plays a song in a digital format over a speaker and records it in another digital file (the "analog hole"), all header data would certainly be lost.[158]

For the purpose of enhancing security and robustness in an audiovisual file, a user may encrypt the entire file with one of the existing digital rights management ("DRM") protocols.[159] DRM greatly minimizes the risk of undue alternation, as only authorized users who possess the decryption key may access the file. Nonetheless, DRM has so far proved to be unpopular in the marketplace, because it tends to be overly restrictive of secondary usages by consumers and too cumbersome for digital distribution.

b. Digital Fingerprint

A copyright owner may employ a digital fingerprint algorithm to generate a set of descriptors of the sound contained in an original audiovisual work. By comparing the digital fingerprints of the original and of other files, the system can automatically identify all the files that essentially sound the same to listeners as the original does. Because digital fingerprints are inherent in audiovisual files, it would be unlikely to disappear no matter how many times users have transformed them into different formats. Also, it is technologically difficult to separate them from the files without significantly altering the quality. If well developed,

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158. *See generally* Douglas C. Sicker et al., *The Analog Hole and the Price of Music: An Empirical Study*, 5 J. ON TELECOMM. & HIGH TECH. L. 573, 576 (2007) (defining the analog whole and describing how it arises).

159. *See, e.g.*, Carlisle George & Navin Chandak, *Issues and Challenges in Securing Interoperability of DRM Systems in the Digital Music Market*, 20 INT'L REV. L. COMPUTS. & TECH. 271, 272–275 (2006). The article introduces the following DRMs implemented by iTunes: (1) Users can make a maximum of seven CD copies of any particular playlist of songs purchased from the iTunes Store; (2) Users can access their purchased songs on a maximum of five computers; and (3) Songs can only be played on a computer with iTunes or an iPod, and other MP3 devices do not support FairPlay encoded tracks.

a fingerprint-based hash results in a meaningful improvement in robustness and security over a simple hash of the whole file, to the extent that deleting small fragments of a file typically would not affect its digital fingerprints. The market abounds in sophisticated digital fingerprint solutions, including Audible Magic, Gracenote, and TuneSat.[160]

c. Digital Watermark

A digital watermark is a unique marker (e.g., a serial of numbers) inserted into an audiovisual file as its identifier to connect the file with its ownership information and/or licensing terms ("payload"). Copyright owners may employ watermarking tools to embed a payload identifier into a file, detect the watermark, and/or extract the payload identifier from the watermark. However, a well-developed watermark does not affect the audiovisual quality, because it is imperceptible to general audiences. Additionally, certain digital watermarks are so robust as to survive transcoding, excepting, and analog holes. Unlike digital fingerprinting, digital watermarking allows copyright owners the flexibility of assigning different identifiers to different copies that contains essentially the same content. For examples, music labels sometimes allocate multiple identifiers for the same song to be distributed in multiple channels.

A digital watermark has its own drawbacks compared with a digital fingerprint. First, copyright owners need to insert digital watermarks into audiovisual files before their distribution in order to effectively track their usage. In contrast, digital fingerprints may work equally well no matter whether the copies have been distributed or not. Second, there are documented incidents where hackers successfully detected and removed digital watermarks embedded in audiovisual files.[161]

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160. *See generally* U.S. COPYRIGHT OFF., *supra* note 33, at 62 (describing digital acoustic fingerprinting).

161. *See, e.g.*, *Princeton Scientists Sue Over Squelched Research*, ELEC. FRONTIER FOUND., https://www.eff.org/press/releases/princeton-scientists-sue-

C. *Distributed Storage*

BCE does not store any audiovisual files in centralized servers, which would not only be prohibitively expensive but also vulnerable to malicious attacks. Instead, BCE establishes a storage layer based on the InterPlanetary File System ("IPFS"), which is a peer-to-peer distributed file system that may connect a large number of scattered computing devices in a global network.[162] A file in the IPFS system is divided into small fragments and stored on a cluster of remote nodes to achieve faster transmission speed.[163] Unlike the de facto HTTP protocol, IPFS addresses all files by the hashes of their content as opposed to URL addresses.[164] Additionally, nodes need not trust one another, and there is no single point of attack.

BCE may implement an asymmetric encryption system to control access to IPFS-hosted files, consisting of the following steps: First, the IPFS system automatically encrypts all audiovisual files published in the BCE community by BCE's public key. Second, when a user streams or downloads a file, the system retrieves its IPFS address, loads the file from the IPFS swarm, and decrypts it by BCE's private key. Third, the system re-encrypts the file by the user's public key and then distributes it to the user. In this way, the IPFS system ensures that, even if a hacker managed to comprised some of the BCE nodes, what she could obtain would not be more than encrypted fragmental files of negligible commercial value.

As mentioned above, users who operate hosting nodes in the BCE community are qualified to mine BCE tokens in proportion to the extra storage space and bandwidth devoted.

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over-squelched-research (last visited Aug. 4, 2021).

162. *See IPFS Powers the Distributed Web*, *supra* note 117.

163. *How IPFS Works*, IPFS, https://ipfs.io/#how (last visited Aug. 4, 2021).

164. *See id.*

D. *Decentralized Application (daap)*

The BCE daap is comprised principally of a media player, an IPFS node, and a graphic user interface. It may be deployed through the App Store and Google Play.

The BCE website, which serves as an online gateway for the BCE community, may incorporate the same components, which are regularly synchronized with the BCE daap.

E. *Copyright Exchange*

BCE builds a copyright exchange around two categories of complex smart contracts that automate market transactions regarding copyright assignment, copyright licensing, and BCE mining.

1. Assignment Market

Artists may launch their crowdfunding campaigns in the copyright exchange, offering a portion of copyright ownership and royalty revenues in their creative works in exchange for upfront investments by sponsors. Once artists set the crowdfunding targets—e.g., the percentage of copyright ownership offered, the maximum number of sponsors, and the minimum amount of investment raised—BCE smart contracts would automatically enforce the crowdfunding process by setting up escrow accounts, distributing funds, and arranging approval and delivery of creative works. Alternatively, the copyright exchange allows artists to directly auction or sell their shares in creative works to third parties.

2. License Market

Once a user streams or downloads a licensed work, BCE smart contracts generate or transfer the predetermined amount of BCE tokens to relevant artists. Furthermore, BCE smart contracts simultaneously award BCE tokens in proportion to the contributions by users who distribute, market, and vote for creative works. As mentioned above, the

assignment market is built on Ethereum while the license market is built on Raiden or EOS.

CONCLUSION

Healthy copyright markets depend on a delicate balance between strong incentive for intellectual creation and broad access to intellectual products.[165] Existing online services like Spotify and YouTube significantly broaden access by offering free and low-price content to the general public. However, they are falling short on the incentive side of the equation by denying artists their equitable rewards. The BCE ecosystem redresses the balance between incentive and access. BCE hardcodes a complex web of thousands of copyright rules and license terms through blockchain-based smart contracts. By doing so, BCE eliminates substantial transaction costs in copyright industries, which traditionally deprive artists of the majority of their royalty revenues. BCE establishes a sustainable ecosystem that maintains free access to creative works for average users while dramatically increasing incentives to all contributors to the BCE community: Artists who publish creative works may earn a royalty per stream potentially sixteen times larger than Spotify offers and eighty times larger than YouTube offers, at a speed millions of times faster. Sponsors who finance creative productions through copyright crowdfunding or upfront sales may directly receive a percentage of royalty revenues. Miners who distribute, promote, and vote for creative works may mine BCE tokens in accordance with their respective contributions. The BCE ecosystem embodies the vision that the best way to combat piracy is to develop a product serving consumers better than piracy.

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165. For detailed surveys of economic theories on copyright, see PAUL GOLDSTEIN, GOLDSTEIN ON COPYRIGHT § 1 (3d ed. 2016); WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW 37–84 (2003). *See generally* Gillian K. Hadfield, *The Economics of Copyright: An Historical Perspective*, 38 COPYRIGHT L. SYMP. (ASCAP) 1 (1988).