BLOCKCHAIN AND INTERNATIONAL IDENTIFIERS FOR MUSIC

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Abstract: The context of revenue generation streams in the music industry has been intermittently discussed since the transition from sales to streaming started when Spotify launched in 2008. Although revenues in the industry have reached new heights, musicians express dissatisfaction with lower royalty payouts. Moreover, it has become increasingly more difficult and convoluted to understand the royalty calculations in the music industry. With today's complicated licensing agreements, money flows through a complex chain of third parties before it reaches the hand of musicians. The industry struggles with transparency and efficiency, and the musicians are paying the price. Meanwhile, the rise of blockchain technology has developed since its first application with Bitcoin in 2008. Today, more and more advanced blockchains can run decentralized transparent applications that utilize the technology's efficient transaction system. With the industry issues and the promises of blockchain in mind, this paper demonstrates how blockchain technology can be applied to solve value chain problems within the music space. This paper identifies core issues in the music industry, proposes a decentralized application (dApp) that attempts to solve these issues and implements the proposed solution. This paper exhibits the business logic by developing smart contracts on the Ethereum blockchain and uses IPFS (Interplanetary File System) for decentralized file storage to make an associated web application choosing a JavaScript framework. The dApp works as a global copyrights database where musicians can register and license musical works. Author exploits Ethereum's efficient transactional system to manage license purchases.

IndexTerms - **Ethereum, Smart Contracts, Ethereum Virtual Machine, InterPlanetary File System.**

I. INTRODUCTION

Blockchain is a revolutionary technology that is capable enough to solve many of the vital basic challenges facing the music industry today. This technology is exclusively suited to address issues across the various industry sectors, including rights management, licensing, copyright ownership, royalty tracking and reporting and the primary and secondary ticketing markets for live events. Likely, however, its adoption will be incremental and more evolutionary than revolutionary -- impacting the music industry in a segmented fashion, as opposed to a global transformation. [From Figure 1.] Blockchains will affect not only the parties who have a financial interest in the distribution of music; e.g. artists, composers, producers, labels, rights managers, digital service providers (DSPs) and performing rights organizations (PROs) but also other various individuals who can demonstrate ability to sing their own composed song which consists proper lyrics.

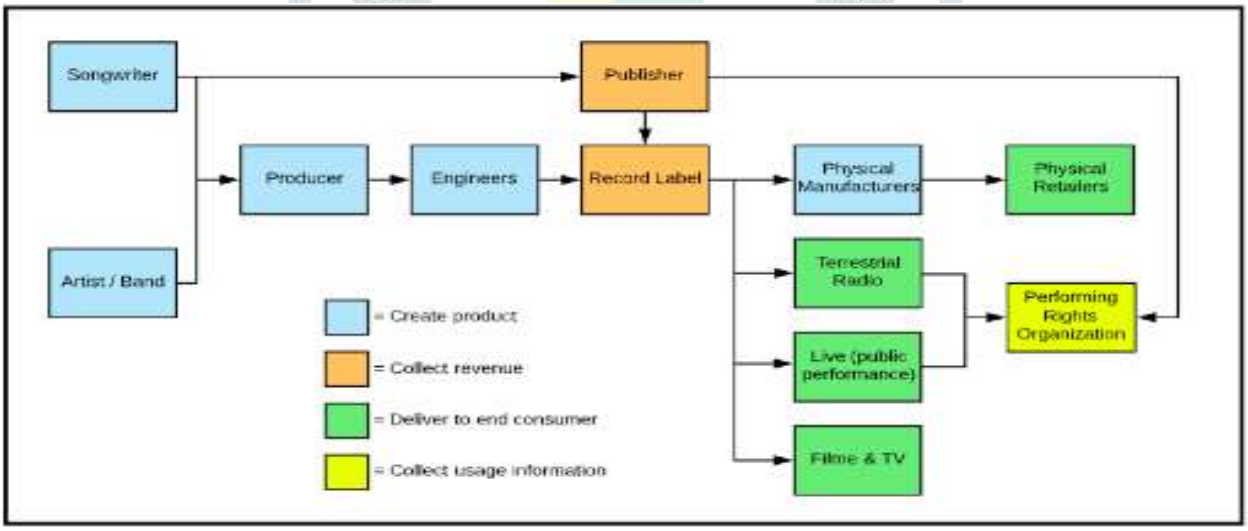

Figure 1. Recorded music supply chain before digital media–adapted from (Hosoi, et al. 2015)

Blockchains will affect listeners and fans, in how they experience and interact with the music. For a blockchain solution to work effectively in the music ecosystem, everyone should be on it. Similar to social networks like Facebook, Twitter, Snapchat, etc. the more users that are on the network, the more powerful the network becomes. The industry must come together to agree upon and adopt data standards for identifying rights. There is no reason why legacy systems cannot co-exist during the transition period. After all, the transition will likely take a very long time. Potentially, blockchain is the only technology that solves lots of problems in the music industry. Issues that face the music industry that need to be fixed include data overload due to streaming; inefficiency of making micropayments; data in silos; delay in payment; delaying licensing permission; failure to track monetization; incompetence of granting micro-licenses; need to move away from advertising-based revenue models for digital; black boxes for payment; etc. In the years to come, this paper will see back end blockchain-based solutions emerge that increase efficiency and reduce frictions and

transaction costs. There will be some collateral damage of course, as parties who benefit from opaque business practices, and unnecessary middle persons, are eliminated. Waste will be reduced, and this is a good thing. This seems likely to happen regardless of whether the change is caused by blockchains, or from consolidation due to marginal players becoming economically inefficient, or from information becoming more readily available. If legacy systems can co-exist with these new blockchains during the transition period, then from a macroeconomic point of view there is no reason to fear blockchains, or even to resist. The investigation of these implications is particularly relevant for artists, who envision the possibility of finally being adequately rewarded for their efforts and innovative endowments. Blockchain promises to give power back to musicians by providing a fair distribution channel. In this case, the idea is to provide an environment in which they will have the freedom to access transactional information and be paid more effectively. This new channel also opens the possibility and creates the means for the introduction of innovative business models, by the artists themselves or any other stakeholder in the market.

II. RESEARCH METHODOLOGY

The music service pays a royalty to the record label for each track that a particular user downloads or streams online. The label passes mechanical royalties to the publishers of the underlying composition and pays a percentage of the remainder to the recording artist and in case of streaming a song, royalty is also paid to PRO as streaming of song is counted as the performance of music composition. The creator of music is rewarded according to the number of plays of the song from the content DSP website. Whenever a user plays a song from the streaming website. There can be two procedures in which a file gets loaded on the user application music player: - By loading songs directly from the DSP server. (i.e., When a music label provides a music file to DSP) By streaming the song from the music label server through the DSP website. (i.e., when music is directly streamed through a music label server). Both of the above procedures contain some trust problems. In the first method the data about music file is siloed (stored on the databases of multiple DSPs) and the problem here is music label needs to trust on whatever data is provided by DSPs (For ex: Number of downloads of a music file) and music artist, in turn, needs to trust on the music label and author proposes that this problem can be solved with blockchain as it can see data that is siloed and multiple parties are involved, and everyone has their profits in hosting blockchain node. Also, PRO and MRO can host nodes. In the second method data is only maintained by the music label so users need some participants involved in business who can host the blockchain nodes because if the proposed platform doesn't have multiple participants involved, then it is inefficient to use blockchain. Here the author thinks the PRO and MRO can come into picture. PRO and MRO can also host their nodes in the first method. In blockchain an entire music file cannot be stored so to solve above problem with blockchain is to create links between transactions on blockchains and the music files that are the subjects of the transactions, by putting an identifier in each transaction record that matches an identifier in each music file.

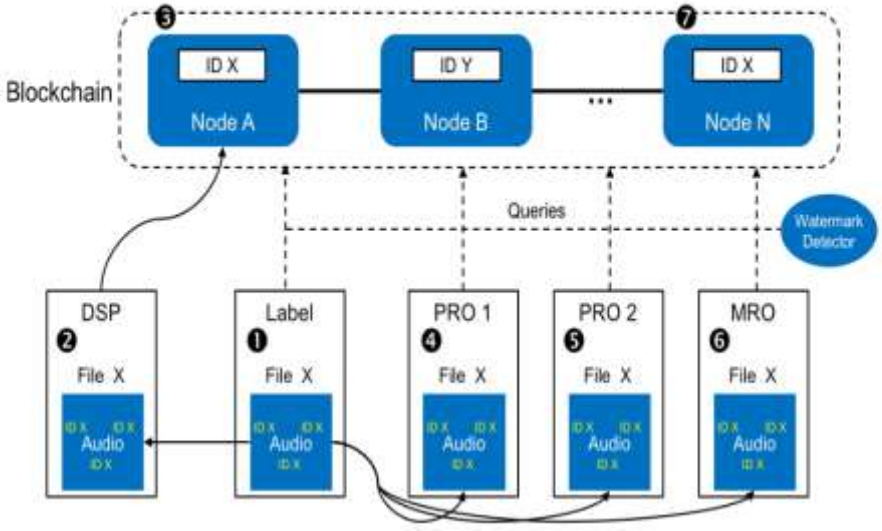

Figure 2. Content and royalties flow adapted from www.digimarc.com

This can be done if the identifier in the music file is robust and immutable enough and if it is sufficiently unique for the application. Using a hash of music file Using watermark in music file Hashes acts as a good identifier, but they are not robust, flexible and secure whereas watermarks are the robust, flexible, secure and good digital identifier. So, the process will be Whenever someone plays music through an interactive streaming service, the service could deposit a transaction on a blockchain so that all metadata related to music files will be recorded on the blockchain, i.e., Increasing the number of plays or downloads in the blockchain. The Entire process in figure 2: -

Figure 2. depicts a label (1) sends a music file, File X, to a DSP (2). File X has the file's ID. ID X, embedded as a watermark. One of the DSP's users plays the track, and the DSP deposits a transaction on the blockchain containing ID X (3). The label (1) also sends copies of the file with the embedded ID to two PROs (4 and 5) and an MRO (6). The label, PROs, and MRO can all query the blockchain, using the ID embedded in File X, to find transactions involving File X. The blockchain in Figure indicates two such transactions: one is from the DSP in the figure (3), while the other (7) could have come from another DSP. DSPs can deposit the transactions in real time, while the royalty processing organizations and also music artists can query the blockchain for them anytime.

III. DISCUSSION

IPFS: InterPlanetary File System is a distributed file system which synthesizes successful ideas from previous peer-to-peer systems, including DHT, BitTorrent, Git, and SFS. The contribution of IPFS is simplifying, evolving, and connecting proven techniques into a single cohesive system, greater than the sum of its parts.

IPFS + Blockchain = Decentralised File Storage

Rather than locking the system to a particular set of function choices, IPFS favors self-describing values. Hash digest values are stored in a multihash format, which includes a short header specifying the hash function used, and the digest length in bytes. Example: <function code><digest length><digest bytes>

How does IPFS work?

Each file and all of the blocks within it are given a unique fingerprint called a cryptographic hash.

IPFS removes duplicates across the network.

Each network node stores only content it is interested in, and some indexing information that helps figure out who is storing what.

Smart Contract: Ethereum features something called smart contracts. These contracts are scripts that can be added to the Ethereum blockchain. Due to blockchain's immutability, a smart contract can never be altered once it is deployed to the network. As a result, there exist pieces of code that all users can interact with on the blockchain. Smart contracts are similar to classes in object-oriented languages. They define state variables and functions. The Author calls the term - former state variables because they define the internal state of the contract. These variables can be of many different types such as integers, arrays, strings and mappings (similar to HashMap in Java). Functions can either read values from state variables or modify them.

Ethereum Virtual Machine: Ethereum is described as a blockchain with an integrated Turing-complete programming language. The part of the protocol that handles the execution and the internal state of smart contracts is referred to as the Ethereum Virtual Machine (EVM). From a practical standpoint, the EVM can be thought of as a large decentralized computer managing millions of objects (smart contracts). To avoid infinite computational loops,

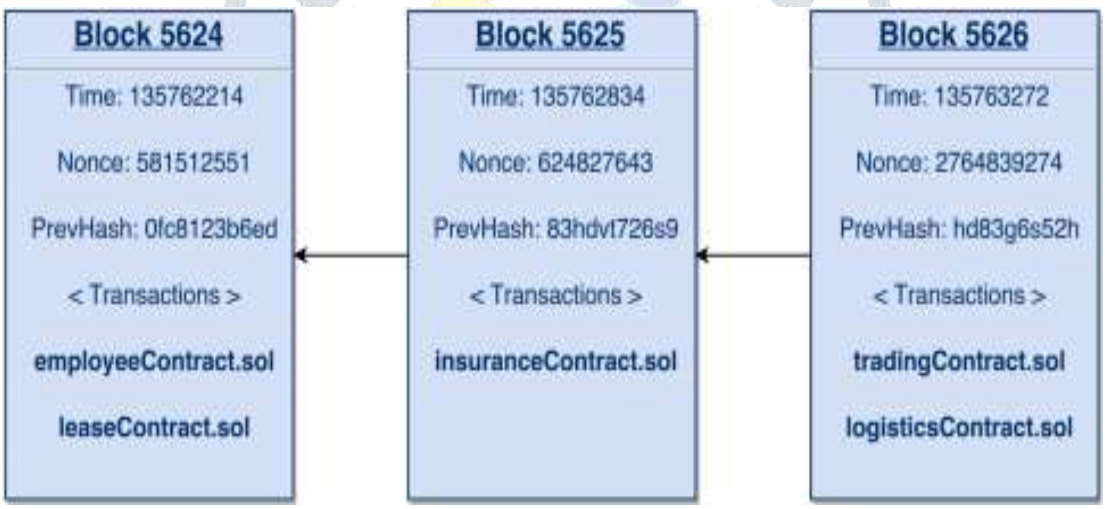

Figure 3. The data contained in an Ethereum block

DDOS attacks, or network spam by deploying infinite worthless smart contracts, the EVM is powered by a gas called ether (ETH). Gas (The cost for running a transaction on the Ethereum blockchain. It represents the "work" a transaction requires to be processed) is paid to the nodes running the EVM. The amount of gas a user has to pay is determined by the amount of computation or storage an execution requires.

IV. SYSTEM ARCHITECTURE:

The dApp is divided into four separate physical nodes: client: web browser, web server: Node.js application, Ethereum blockchain, and IPFS: Data Storage and authentication. The built web application connects to two back-end systems: an external, decentralized database called IPFS and the Ethereum blockchain. Figure 4. follows basic Unified Modeling Language (UML) syntax. It illustrates the different hardware components (nodes), what software components (artifacts) run within each node, and the communication protocols that connect the nodes.

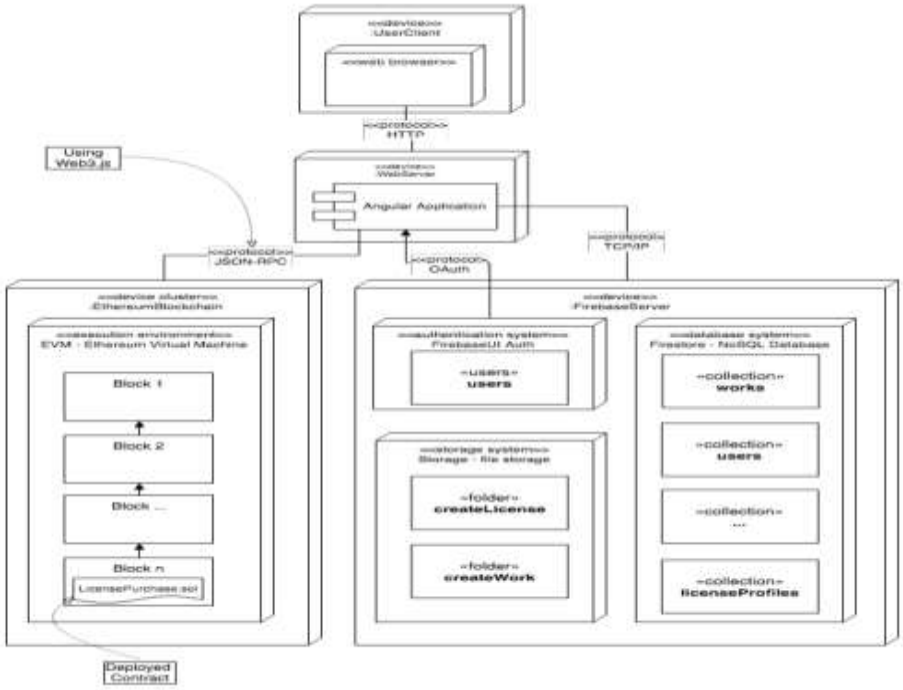

Figure 4. Deployment diagram shows the architecture of the system.

Technologies: The following technologies do not serve a purpose once the dApp is officially deployed, but they have been beneficial for testing purposes. Development environment: Visual Studio Code, Ganache, and most importantly Truffle Framework. Application dependencies: Solidity, Web3.js, Node.js, IPFS.

First 3 available accounts are for artists, and the rest are for consumers. The numbering is given as (0,1,2) for which accounts of artists, i.e., often termed as a content creator. An artist can choose a song, set title and price, and upload songs. Also, he can view transaction logs from the blockchain and his wallet. The numbering for users or consumers is represented as (3,4,5,6,7,8,9). A consumer can browse artists, select songs and buy them, and add money to his wallet. The importance of IPFS is now seen as a valuable feature. Uploading a song twice from different accounts or the same account will also be denied as this is to do with how IPFS stores and indexes the data. The main aim of this paper is also to solve intermittent audio piracy which can be demolished using a combination of blockchain and InterPlanetary File System since using so generates a unique cryptographic hash, called a digital fingerprint. This method denies duplicate uploads resulting in a robust and secure platform.

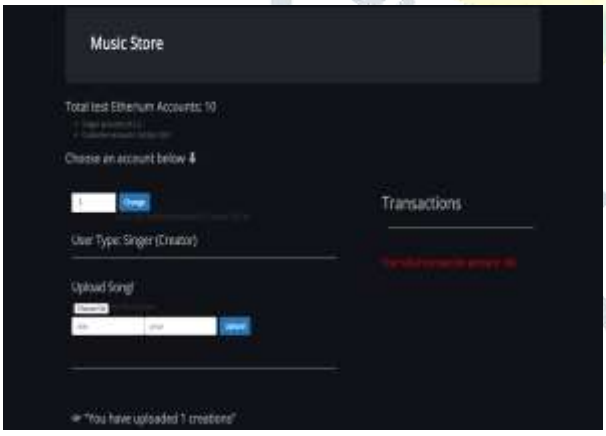

Figure 5.1 - home page

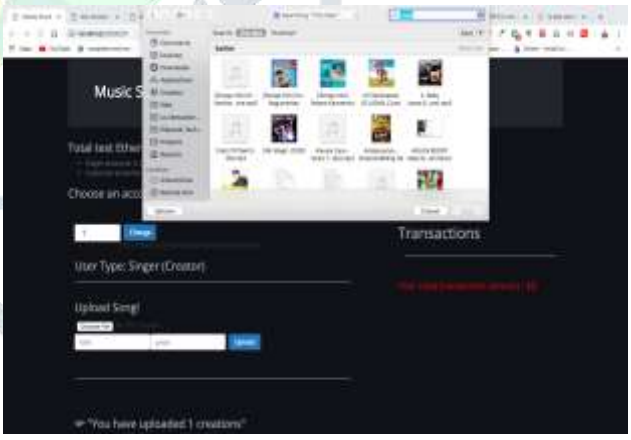

Figure 5.2// uploading a song

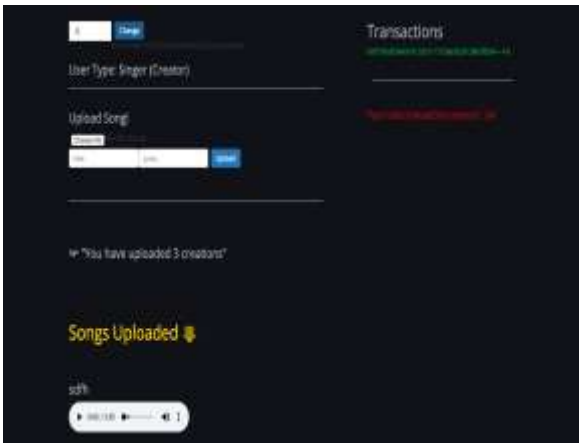

Figure 5.3 - Artist Account

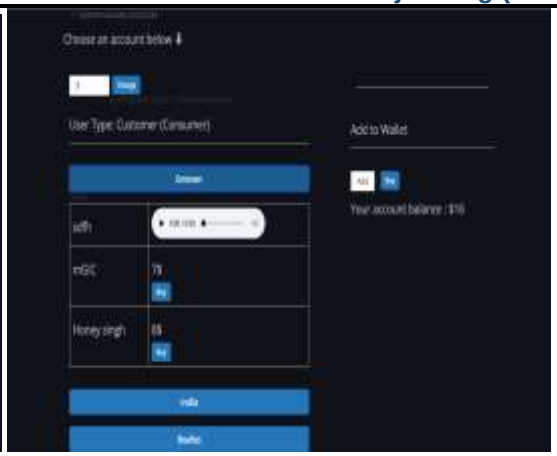

Figure 5.4 - Consumer Account

V. CONCLUSION:

Blockchain technology can be utilized in multiple ways to meet specific problems in today's industry. Our research found problems related to transparency, efficiency, standards, and inaccessible copyright information. One way to utilize blockchain technology has been demonstrated through the development of our decentralized application built with these issues in mind. The application proves that properties of blockchain can be applied to real-world challenges. Ethereum, with its self-enforcing smart contracts, enables automated transactions tailored for specific scenarios. Based on the issues uncovered in our background analysis, our application offers some improvements. It streamlines the money flow by putting the right holders in control of their royalty payouts. Furthermore, it exposes transactions and split sheets for different works to the public, making the payment process more transparent. The application also collects copyright information to a public registry stored on the Ethereum blockchain. By using blockchain as the underlying infrastructure, this paper aims to show that singers can establish trust without the need for a third party.

VI. REFERENCES

[1.] http://www.thembj.org/2015/08/grds-failure/ for a good overview of these efforts and their failures.

[2.] Some DSPs, such as Spotify and Google Play Music, offer both interactive and noninteractive streaming.

[3.] Some of these royalty payments are mandated by law, while others are specified in private agreements between DSPs and rights administrators such as labels, PROs, and publishers. Details are beyond the scope of this white paper, but for a highly useful and discussion, see the U.S. Copyright Office for reporting Copyright and the global Music Marketplace at https://www.copyright.gov/policy/musiclicensingstudy/copyright-and-the-music-marketplace.pdf.

[4.] Some recordings, such as "mashups," can embody more than one composition; see note 17 below for example.

[5.] AFM (American Federation of Musicians) and SAG-AFTRA (Screen Actors Guild-American Federation of Television and Radio Artists) are labor unions that pay royalties to musicians and backing vocalists.

[6.] http://isrc.ifpi.org. The ISRC is administered by IFPI, the international umbrella trade organization for the recording industry.

[7.] http://www.iswc.org. The ISWC is administered by CISAC, the international umbrella trade organization for composers and their rights administrators, a separate organization from IFPI.

[8.] http://www.isni.org.

[9.] Note that this is potentially an M-to-N mapping. A composition can have multiple recordings (think "Yesterday" by Lennon & McCartney), or a recording can embody multiple compositions (think Danger Mouse's The Grey Album, which contains mashups of the Beatles and Jay-Z).

[10.] For example, ASCAP's database lists over 600 different compositions with the title "You and I," each of which has different composers.

[11.] http://www.billboard.com/biz/articles/news/publishing/6114215/nmpa-puts-us-publishing-revenues-at-22-billion-annually.

[12.] For example, SoundExchange maintains a publicly searchable ISRC database at https://isrc.soundexchange.com/#!/search.

[13.] The dotBlockchain Music Project (see p. 16) defines a Minimum Viable Data set for registration purposes consisting of composition title, master recording title, composer name(s), and artist name(s). The difference between the concerned topic and the scheme discussed in this paper assumes that a work is already distributed through a label and registered with a PRO, whereas Dot Blockchain does not.

[14.] http://id3.org/.

[15.] A couple of startup companies built DRM-like solutions for encrypting digital music files as they went from record labels to third-party post-production and distribution companies. These were rejected as too restrictive and inconvenient.

[16.] The academic literature often uses the term "perceptual hash" for fingerprinting.

[**17.]** http://www.ddex.net.

[18.] https://en.wikipedia.org/wiki/Public-benefit_corporation. Several public transportation companies are organized as public benefit corporations.

[19.] https://medium.com/dotblockchainmusic/the-dotblockchain-music-project-update-7-minimum-viable-data-doc-561fdfadd5eb.

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