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ANALYZING BLOCKCHAIN BASED MODELS FOR DIGITAL CONTENT METADATA TRACEABILITY

Deepika Sachdev
VP Delivery, Knowesis Pte Ltd, Singapore,
PhD Scholar, University of Petroleum & Energy Studies, Dehradun, Uttarakhand, India

Dr Shailendra Kumar Pokhriyal
Professor & Head Energy Management,
School of Business, University of Petroleum & Energy Studies, Dehradun, Uttarakhand, India

Nishant
MBA Student, University of Petroleum & Energy Studies, Dehradun, Uttarakhand, India

ABSTRACT

Metadata defines all parties involved in the ownership and creation of the content. This paper analyzes six challenges in existing Digital Content Metadata including Lack of Standards, Transparency in Revenue Settlement, Multiplicity of Music Metadata, Metadata Tampering, International Regulations and Human Error. It classifies three known Industry Models for Blockchain based Content Distribution. It performs a systematic review of each Model to classify the known gaps and benefits including Latency, Storage Limitations and Permissioned Access Control. It proceeds to recommend a framework for Blockchain based Metadata tracking to bring Trust and Traceability amongst Content Providers

Abbreviations: *DRM (Digital Rights Management), CAS (Conditional Access System), ACL (Access Control List), IBC (Inter Blockchain communication)*

Key words: Blockchain, Metadata, Digital Content, Interoperability, RBAC, Latency, Off Chain Storage, Immutability

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1. INTRODUCTION

As explained by IFPI in [7] 2017 was the third consecutive year of growth for global music and the market grew by 8.1%. Digital Revenues grew due to growth in Subscriptions and streaming content accounted for 54% of global recorded music market:

- Streaming Revenue increased by 41.1%
- There were 176 Million users of Paid Subscriptions of which 64 Million were added in 2017
- As of Aug 2017, the Global Value of Black Box Royalties was estimated to be 2.5 Billion USD.

Blockchain is attempting to flatten the Music Industry by bringing the Core of Music distribution closer to the Edge and enabling grass roots level distribution as explained in the Value Chain Dynamics [17]. This paper provides a Systematic Literature Review of:

- Meta Data challenges faced by the Digital Music Industry currently
- Blockchain Value Proposition on resolving the Meta Data Challenges
- Systematic Review of Integration Patterns Per Distribution Model and gap identification
- Proposal of a Meta Data based Market Place Framework based on Blockchain

2. LITERATURE SURVEY

So how does it work and what are the challenges? Metadata provides context data such as dates, lyrics, genre and can be extended to provide additional details such as recording location, production equipment and inspiration. As described by Dair et al. in [3] Metadata embedded into every piece of content can also include terms of use and contact details of the copyright holders enabling easy location of the owners of the recorded music and to obtain license to use it.

Unfortunately there is no Global reliable source for Content Meta Data and to augment the problems, on commonly used file extensions such as WAV and MP3 these are very easy to edit. Public Societies such as ASACP and BMI have Metadata repositories but these are often inconsistent amongst themselves also. As mentioned by Cares et.al in [2] when Spotify was sued for $200 Million in unpaid royalties the company response was that they were not aware of whom to pay due to missing Meta Data.

2.1 Challenges for Metadata in existing Digital Content Distribution

A long-standing drawback to the Internet is the hidden ‘artist penalty’. The very strengths of the Internet make it difficult for creators of digital content to be fairly recognized and compensated for their work. As mentioned by Mc Conaghy et al. in [11] the online attribution problem traces back to the 1989 design of the World Wide Web, which has only unidirectional links and therefore no built-in attribution, let alone ownership. As described in [18] Sony, one of the three big labels, identifies digital piracy as a reason for eroding profit at its music business. It posted a loss of approximately $160 million in the three months as of June 30, 2002.

Rinaldi [14] explained that there have been three generations of Content Distribution systems based on Centralization, Reliability, Scalability and Content Structure. However, below are challenges faced across all the generations:

2.1.1. Multiplicity of Music Metadata

Each track of recorded music has two copyrights

Information about copyright owners are scattered in various databases of record companies, aggregator societies, and publishers, which do not have incentives to share it as described by Savelyev et al. in [15]. The problem is proliferated with artists releasing there albums with multiple labels in different countries. As per a 2017 study from Music Reports

based on ASCAP below is ratio of Song Writers and Publishers per song in the last few decades, which adds to the complexity of Metadata tracking:

Table 1 Multiplicity of Music Metadata

Copyright Category	Description	Meta Data Quality
Musical Composition	Includes the music and lyrics created by Songwriters	Was historically a B2B business, most settlements were based on Sampling or Blanket licensing hence not very detailed information is available
Recording Composition	Created by the recording artists and owned by the labels	Well documented since owned by recording Labels and required for Revenue Settlements

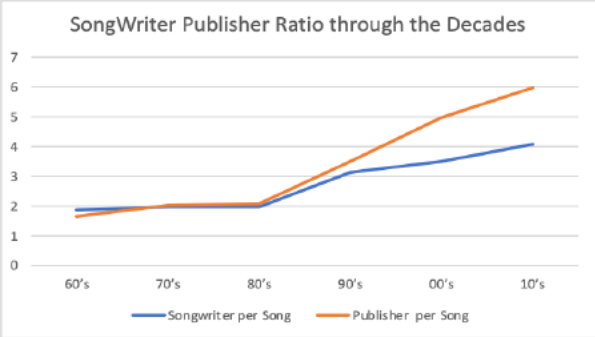

Figure 1 Song Writer Publisher Ratio through the decades

2.1.2. Lack of Standardization for Metadata

As per [16] based on Copyright Category, following is the status of standardization:

Table 2 Lack of Standardization for Metadata

Copyright Category	Standards	Utilization
Musical Composition	ISWCs - International Standard (Musical) Work Codes	Not so widely used since historically involved B2B settlements which were done in Wholesale and not based on Itemized Transaction Tracking
Recording Composition	ISRC - International Standard Recording Code	Widely Used since this is important for Revenue Settlements

There is no single source of truth to correlate the Recordings Copyright information with the underlying Musical Composition. There are a few proprietary databases such as HFA and MRI but those are not comprehensive and standardized. Each database has chosen different Label Fields to for Metadata attributes. For e.g. if the Engineering team is identified as "ProTools Engineers" but the Label Metadata has identified the field as "Pro Tools Engineers" the credits will be lost.

2.1.3 Metadata Tampering

DRM and CAS are applied for almost all commercial-based digital content for the protection. However, in most Content Super Distribution systems [8] there is problem of pirate attacking for taking the content or altering the Metadata without the legal procedure.

CSS (Content Scramble System) which together with regional coding is still used to protect DVDs was broken by a teenaged computer programmer as far back in 1999. As explained by Lee [10] the existing DRM systems are focussed only on the relationship between Media Distributors and Consumers and not on the complex chain of actors involved in processing and creating the content.

As explained by Bhowmik et. al in [1] significant effort was made for efficient multimedia distribution systems which resulted in MPEG format for content centric networking for Multimedia delivery. However, the content integrity and security could still be compromised since indexes can easily be removed.

2.1.4. Human Error

Upon completion of a song, the artist or the artists producer would ideally compile the Metadata and publish the Labels, Distributors and Digital Streaming Providers. However the process of Metadata entry is complex and rushed hence the initial submission has incorrect or missing entries which are corrected later.

2.1.5. International Regulations

Music is heard universally, however there are International Challenges such as carrying languages, different copyright laws per country and reluctance to share Information which results in fragmented and siloed Meta Data for the same piece of Music Content. In the US even though Creative Work is copyrighted as soon as it is created, it needs to be registered with the UC Copyrights office in case a lawsuit has to be filed.

2.1.6. Transparency in Revenue Settlement

A primary trait of Digital Media Distribution by online channels is its direct nature. Transparency and legitimacy of Content Meta Data including the identity of the artist, aggregator and publisher is key to its successful marketing as well as Revenue distribution. Unfortunately the Metadata is fragmented due to the siloed pipelines resulting in lack of Transparency with Content Owners

3 CHALLENGES IN EXISTING DIGITAL CONTENT DISTRIBUTION – SURVEY BASED

To verify the Literature Findings a Qualitative Research based Survey was conducted From Apr- Jun-2020 for gathering challenges faced by existing Content Developers for Content Publishing, Revenue Sharing and Distribution

3.1.1. Challenges in existing Digital Content Distribution – Information Sharing - Survey Questions

Table 3 Challenges in existing Digital Content Distribution Information Sharing - Survey Questions

INFORMATION SHARING SURVEY QUESTIONS			
#	**RQ***	**Questions text**	**Answer Choices**
Q1	RQ1	Name	#
Q2	RQ1	Which Gender do you belong?	[Male, Female]
Q3	RQ1	Age group	[less than 30 years,30-39.40-49,50 and above]
Q4	RQ1	Name of the Organization	#
Q5	RQ1	Names of the platform used for content sharing	#
Q6	RQ1	Select your department	[Content creator/artist, distributor, producer, others]
Q7	RQ1	Experience in Media Sector	[0-1 year,1-3-year, 3-5 year, more than 5]
Q8	RQ1	Number of people working in the organization	#
Q9	RQ2	What are the different categories of information sharing?	[music video, audio, meta data, others]
Q10	RQ2	Do you share your content with multiple aggregators and distributors?	[Yes, No]
Q11	RQ2	What process do you follow for sharing the information	[E-mails, company portals, Social sites, others]
Q12	RQ2	In a month what is the average number of times you publish content to content aggregators and distributors?	[1-2, 3-5, 5-7, >7]
Q13	RQ2	What is the average data volume you share with content aggregators	#

		and distributors?	
Q14	RQ2	Do you refer to achieve historical information in your data base for what duration	[< 3 months old, < 1 year old, < 3 years old, < 10 years old]
Q15	RQ3	What is the cost of posting the content on the platform used by your organization?	#
Q16	RQ3	How much time does it take to upload content and publish?	[Hours, One-two days, A week time]
Q17	RQ3	If you want to publish your content to multiple partners at same time...do you have to individually post or is there central publishing?	#
Q18	RQ3	10. If distributor comes into the role, then what type of distributor due you prefer to go to?	[one who charges a onetime yearly fee, one who charges cut on every content uploaded, one who charges both, and one with zero charges]
Q19	RQ4	What are the different technological barriers for sharing digital information with Content Aggregators and Distributors	[Safety and Security, Distribution channels, Cost issues, Its issues, Others]
Q20	RQ4	Are there any legal/regulatory barriers for sharing digital information Content Aggregators and Distributors	[Yes, No]
Q21	RQ4	Have you ever faced the problem of pirated content?	[Yes, No]
Q22	RQ4	Do the shared information are easily mutable by the third party?	[Yes, No]
Q23	RQ4	Do you get notified when your data is being tampered by the third party?	[Yes, No]
Q24	RQ4	Are there problems related to add fraud?	[Yes, No]
Q25	RQ4	Has there been any problem because of the proxy portals or black marketing?	[Yes, No]
Q26	RQ4	Is there any type of issue related to data security and privacy?	[Yes, No]
Q27	RQ4	What tools or mechanisms are used by your organization for data security, verification and protection?	#
Q28	RQ4	How much time does it take for the verification process to get complete	[Few hours, One to two days, One week, More than a week]
Q29	RQ4	Are the owners' rights maintained on the platform preferred by your organization?	[Yes, No]
Q30	RQ4	Do you prefer sharing information about your email id, mobile number and address on online platforms for getting the content?	[Yes, No]
Q31	RQ5	Being a content creator is there a revenue share arrangement or a onetime fee with the distributor?	[Revenue share, Onetime fee, Other]
Q32	RQ5	Is there any delay in getting the payments from the content uploaded on the preferred platform?	[Yes, No]
Q32	RQ5	Are the compensation mechanisms opaque and inefficient?	[Yes, No]
Q33	RQ5	Are you satisfied with the revenue share that you get from the channel?	[Yes, No]
Q34	RQ5	Are there other people who have to get revenue share (e.g. content writer, producer, performers etc.) how is revenue share done with other partners?	#
Q35	RQ5	Being a customer which package do you use for getting the online content available to you? Or being a producer, which package do you use for selling your content	[Yearly, Monthly, Hourly subscription, Pay per use]
Q36	RQ5	Do you think that the role of distributors/aggregators is decreasing with advanced technologies?	[Yes, No]

3.1.2. Challenges in existing Digital Content Distribution – Blockchain - Survey Questions

Table 4 Challenges in existing Digital Content Distribution – Blockchain - Survey Questions

BLOCKCHAIN SURVEY QUESTIONS			
#	**RQ***	**Questions text**	**Answer Choices**
Q37	BC-RQ1	Has the Organization considered Information Sharing using Blockchain and are there are known challenges?	[Yes, No]
Q38	BC-RQ2	Is there a perceived Use Case where it is believed that Blockchain will bring significant benefits to the organization?	[Reducing cases of data redundancy, Protection from piracy, revenue share]
Q39	BC-RQ2	Do you see Increased Transparency and Trust with Partners by introducing Blockchain for Information Sharing?	[Yes, No]
Q40	BC-RQ2	Do you see new Business Opportunities by introducing Blockchain for Information Sharing? Please state.	#
Q41	BC-RQ2	Do you see increase in Customer centricity/Customer	[Yes, No]

		Satisfaction by introducing Blockchain for Information Sharing?	
Q42	BC-RQ2	Do you see increase in Revenues by introducing Blockchain for Information Sharing?	[Yes, No]
Q43	BC-RQ2	Will Blockchain reestablish the trust of the customers?	[Yes, No]
Q44	BC-RQ2	Will Blockchain help in maintaining the owners' rights and bring new market for digital commerce?	[Yes, No]

3.2. Information Sharing Questions & Responses

Table 5 Information Sharing Questions & Responses

Question	Significance	Observation
IS-RQ2: What is the Profile, Frequency and Volume of Information Shared?	Type and Volume of information shared to help identify Storage requirements Historical Information Accessed for analytics	The range of Content Created and Shared per information per month varies from 5 – 20. Content format is primarily Audio and Music files For analytical purposes 62.5% people rely on historical data that is 3 months old and other 37.5% rely on data that is 1 month old.
IS-RQ3: How do Content Producers share information with Distributors and Aggregators?	The cost involved in information sharing currently will help justify Blockchain investments Time required for uploading the content Role and services provided by Content Distributor	The range of the cost involved for posting the content depends upon the type of the content and type of quality it displays. The range varies from 0 – 1000 Rs per content. For uploading the content, it takes a week time for 37.5% people, for 25% it takes one-two days and for 37.5% people it takes less than 1 day. 62.5% people want that the distributor should be one who does not charge at all, 25% are ok with the one who charges cut on every content uploaded and the remaining 12.5% want one who charges a onetime yearly fee.
IS-RQ4: What are the key challenges faced in Information Sharing and current Data Security tools used	Understand the key challenges faced in Information Sharing Maturity level of existing Data Security Tools. To help determine the different levels of Security and Privacy required in the Blockchain Models	62.5% believe that the major technological barrier for sharing the information is the distribution channel; 25% say it is the safety and security while the rest 12.5% says it is the cost involved. 87.5% strongly believe that there are legal barriers set by government or private bodies which act as a barrier in information sharing. 37.5% people say that the platform on which they work are not secured and the information or the content shared on these platforms are easily copied or pirated hence content immutability is important for them. 50% respondents have faced the problem of data security and privacy loss.
IS-RQ5: What are the Revenue Generation and Sharing Mechanics Used	Transparent revenue sharing mechanism on time revenue generation Type of subscription package	62.5% respondents say that there is a delay in getting the revenue from the platform on which they have shared their information. 100% respondents believe that Compensation mechanism is not transparent

3.3. Blockchain Questions & Responses

Table 6 Blockchain Questions & Responses

Question	Significance	Observation
BC-RQ1: Applicability of Blockchain to Media	To confirm with respondents that with Blockchain do they see a benefit in their domain.	37.5% have already considered blockchain as a possible solution in their organization 100% respondents say that blockchain will help in data security, protection and privacy
BC-RQ2: What are the Key Use Cases where they see benefits of Blockchain?	Understand the key use cases where the respondents see benefits of Blockchain to their domain:	87.5% people believe that transparency in the business operations is the most critical benefit of Blockchain 87.5% respondents believe Blockchain will help in trusted peer to peer sharing mechanism by creating standards for Information Sharing and giving recognition to every individual 100% of respondents believe that removal of the intermediary used will help in getting increased revenue share

4. EXISTING BLOCKCHAIN BASED INDUSTRY MODELS FOR CONTENT DISTRIBUTION

To overcome the challenge of Owner Attribution and Revenue distribution with the producers, there have emerged three distinct distribution Models using Blockchain and Smart Contract technology:

4.1. Direct Distribution Model by Artist

This Model simplifies the Value Chain by decreasing the intermediaries between the Artist and the Music Consumer. Artists can earn financial rewards (in the form of micropayments or digital currency) by publishing their own content directly on their preferred websites. Rather than allowing DSP's to reap all the monetary benefits, this model compensates content creators directly. As explained by Zao et. al. [19] it eliminates the need for traditional layers such as content aggregation thereby reducing the time to market for music producers. This model creates a database of ownership rights and automates royalty payments.

4.1.1. Industry Use Case – Ujo

As mentioned in [13] unlike the Banking Industry where settlements take days to clear, in the Music Industry artists have to wait for royalties up to years. Ujo is an Ethereum based Music Service which allows artists to record their work as a Smart Contract to enable instant payment settlements once the content is downloaded

Founding partner Phil Barry Business Objective is to create an open platform that automates royalty payments based on comprehensive Meta Data

- As mentioned by [12] it enables Music to be fungible by allowing purchase by permitting breakup of the music into individual derivative components e.g. the lyrics, vocal tracks and instrument's thereby creating new revenue monetization opportunities.
- It is planned to use ERC721 to tokenize the rights modelled on COALA IP based Metadata format
- As of October 2019, 2,062 users had registered to buy music on the Ujo site. 662 musicians have registered 2,144 songs. There have been only 275 purchases for a total of $509.

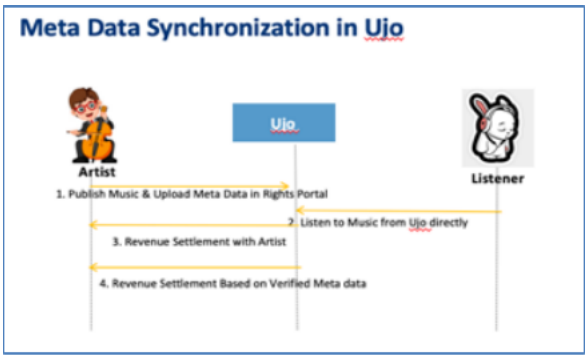

Figure 2 Content Distribution in Ujo

4.2. Digital Content Aggregation Model

In the second business model Blockchain is used to create a comprehensive decentralized Marketplace where the content creators can launch, distribute and monetize content without any dependency on production or distribution houses.

- Artists can choose from various licensing methods, varying from free distribution to paid limited editions. This flexibility lets them select the method that is best suited to distributing their work.
- Revenue collection for the artist is instantaneous and they need not have exclusive contracts with distribution channels.
- Consumers can browse, access and pay for the content through Smart Contracts.
- Digital Content Rights are defined and maintained using Smart Contracts
- Besides distributors, other players typically involved in music rights management (including what are known as "performing rights organizations," who collect royalties for performance on behalf of rights owners) are not needed on this platform since it connects music consumers directly to artists or labels and automatically customizes revenue distribution.
- The Platform owners monetization strategy could be based on content based Commission fees or through Platform licensing

The metadata is compliant to industry standards including genre selection, composer, artist and label splits, ISR and UPC codes. Metadata is placed as Smart Contracts on the Rights Management Platform to enable automated payments. which has two components:

Licensing Conditions – These can be displayed publicly to everyone, and will give users the freedom to pay the necessary conditions to use your music.

Royalty Splitting – This allows a creator to split the earnings to different people.

4.2.1. Industry Use Case - PeerTracks

Peertracks is a Music Streaming and retail platform based on peer to peer discovery. Peertracks CEO, Cedric Cobban Business Objective is to enable new ways of Monetization for the artist. It is built on SounDAC platform (previously MUSE) which in turn is built on Ethereum. As explained by James in [14] Royalty Payments are done every 24 Hours based on the number of streams per second of listening and total value of Peertracks currency. PeerTracks runs on Soundac which supports up to 100,000 Transactions Per Second due to use of Delegated Proof Of Stake as explained by Opal [6]

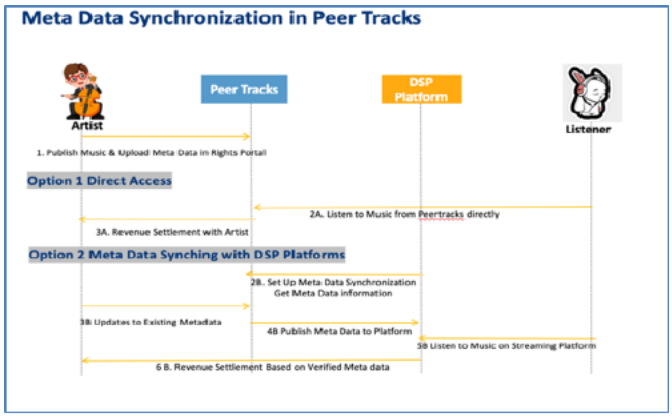

Figure 3 Meta Data Synchronization in Peer Tracks

4.3. Digital Rights Management Model

Digital Rights Management over the Blockchain connects the Metadata and the rights ownership information provided by artists, recording companies, songwriters and the right

holders to the digital content file. As explained by Hongmin et.al in [20] Digital watermarking is a technique of embedding pixelized images into digital content for enabling content tracking. In cases of a copyright dispute the embedded watermark is extracted to verify copyright ownership. By using Blockchain for Rights Management ensures an immutable and decentralized record of Rights Information which is globally available through the content files to digital service providers like Apple and Amazon. As described in [4], companies like Binded who provide Copyright protection on Blockchain are enabling democratization of Copyright.

4.3.1. Industry Use Case – Verifi Media (previously DotBlockChain)

As explained by [19] Verifi Media is established by the PledgeMusic Company in New York. The platform creates a proprietary music format named .bc or dotBC. On the Verifi Media platform, when an artist or rights holder publishes their musical work, they will create a .bc file instead of a standard audio file. Music data is bundled into a .bc file, including information on songwriters, performers, and the title of the music. Once this step is completed, all information is written into the blockchain and available for the public. Specialized players will use .bc rules to decode metadata and authorize or reject the play request.

In December, 2012, Verifi Media has got the permission of more than 65 million songs. Verifi Media uses .bc files to collect and protect the copyright information. The decoding can be done only by their proprietary players. As explained by Richard Skidmore (Head of Business Development), Verifi Media supports Role Based Read Access to ensure that only legitimate users have access to read the Meta Data Properties

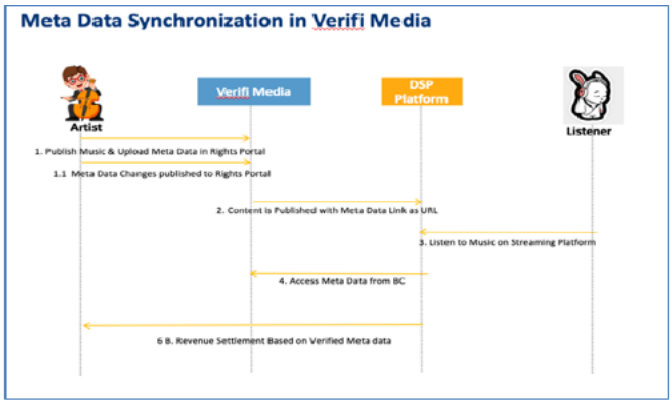

Figure 4 Meta Data Synchronization in Verifi Media

4.4. Summary of Blockchain Benefits

To summarize the focus areas where Blockchain can help resolve the challenges for Online Media distribution based on:

Table 7 Summary of Blockchain Benefits

Meta Data Challenge	Blockchain Functional Description
Lack of Standardization	Adherence to standards-compliant metadata such as COALA IP [9] will enable Standardization
Transparency in Revenue Settlement	As explained by E.Garc et. al [5] Blockchain provides a Decentralized mechanism for Data Sharing and automated Revenue Settlement through Smart Contracts
Multiplicity of Music Metadata	Enabling a Global Metadata repository through Blockchain will reduce Multiplicity Through Decentralized Access Control
Metadata Tampering	Eliminate Metadata Tampering through Blockchain Immutability User Permission Based Access Control on the Blockchain for Data Privacy as

	explained by Jay et. al in [8]
International Regulations	Create International Metadata standards to eliminate Country specific regulations since Blockchain has no Centralized Owner and has proven Data Integrity
Human Error	Ability to update the Metadata by authorized Users in case there is an error detected at a later stage
	Ease of use of entry of the Metadata by the artist

4.5. Analysis of Content Metadata Characteristics for each Blockchain Model

For each of the three Blockchain Models we analyse the architectural characteristics of each Model to see how each will help resolve the Six Content Distribution Challenges identified:

Table 8 Analysis of Content Metadata

Metadata Architectural Requirements	**Ujo**	**PeerTracks**	**VerifyMedia (DotBlockchain)**
Objective	Supports different license type which can be selected by the artist such as right to play in bar, YouTube Video or listen at home. The money can be sent as Ether transferred to the artists and stakeholder's wallet directly.	Ensure immediate revenue payment to artist Enhance the content Meta Data. Focus is on Indie Artists as against the Label Artists who are established by the Brands	To design and develop an open framework for decentralized operability for the Music Eco system. Music files are bundles with Meta Data on the Blockchain to ensure Provenance Traceability and Revenue Monetization
Ownership (Public, Private, Hybrid)	Private	Private	Private
Metadata Storage Mechanics	Meta data Blobs are stored Off Chain in decentralized storage systems such as IPFS[19] or Swarm, OrbitDB. Meta Data is uploaded in machine readable format into IPDB.	The Meta data is stored on Muse Application. Metadata is stored in off chain and the hash stored as part of the Blockchain. This will eliminate tampering.	Metadata is stored Off Chain and the hashed links are stored on Net. The Meta Data URL is embedded in the .bc file
Adherence to standards-compliant metadata	Ujo has a pub-sub based Event Registry that links Ethereum addresses with off chain Meta Data blocks. The events contain schema.org and have a COALA IP compliant Content Type.	It has its own proprietary Meta Data format. 200+ Brands have joined the OMI Initiative to help create a	It has its own proprietary Meta Data format called .bc
Inter Blockchain Communication	Ujo is contributing to COALA IP to create Global Standards. However, the Meta Data repository is currently used by Artists for updating content on Ujo only	It extends the idea of a Global repository by providing an Additional data base for cross reference. In case there is a change in content metadata it can be published to listeners. It is also available as the global repository for any Streaming Platform that wishes to use it.	Audio Watermarking Bundles can be created with Verifi Bundles to help form a Global repository
Role Based Permission Access	The Metadata created in Ujo is compliant to COALA IP Standards. Metadata access is controlled by the Music Owner. It provides coarse grained Access Control for the Owner on the Meta data. However, fine grained access controlled by Multi Partners is not supported	Public Access for Content is available in Wikipedia style. Proposed Edits are supported. These are available to anybody and notification goes to the Manager. The curation is global, but the Content Manager owns the rights to edit it. Access Permissions are coded as Meta Data in Smart Contracts. For every content the	RBAC is achieved through "Transaction Families" provided by Hyper Ledger to give User and Role based Access permissions on Meta Data Creation and Updates. However, Multi Party Based Access Control for Fine grained Access is not supported

		Permissions can be enforced as a Smart Contract which tells who all have edit rights on the Content on the Rights Platform.	
Meta Data Update	Meta data updates can be done on the Ujo Portal	3 Seconds time for Meta Data Update across the platform	Meta Data updates will be performed on local Blockchain and is instantly replicated across all nodes
Ease of use of entry of the Metadata by the artist	Data Entry is still a challenge for artists and a road blocker for Content Sales	Rights Management Platform is an easy to use Platform and does need Crypto Currency	The Bundler App is used for bundling Content with Meta Data
Blockchain Platform	Ethereum. ERC 721 is used to create Non fungible Tokens can be created by an Artist for fans which can be modelled on COALA IP for Standardization	Built on Soundac (Muse) which is a Blockchain Platform for Music. It runs on delegated Proof of Stake	Hyper Ledger Saw Tooth Blockchain. Consensus is achieved through Proof of Elapsed Time
Provenance Trail for Meta Data changes	No specific information available for Meta Data Audit Trail updates	Soundac supports update of Meta Data Information, however no UI is available for Audit Trail access	Provenance Tracking is enabled through Audit Trails

5. ANALYSIS OF BLOCKCHAIN GAPS FOR CONTENT METADATA

5.1. Key Gaps in existing Blockchain Models

This paper has analysed Six Key Challenges for existing Content Distribution. and three Industry Models for Blockchain Based Content. Below is a summary of identified gaps and proposed Framework:

5.1.1. Blockchain Interoperability

Current Blockchain Platforms work in siloes and have Interoperability limitations on:

Proprietary Formats: Data storage formats are specific to every application and are not Interoperable. For e.g. if a song owner wishes to transfer, access or duplicate his metadata from one Blockchain application to the other, it is currently not supported since each application has their own proprietary formats

Application Based ACL's: Smart Contracts are executed based on Signatures which are addressable by the Blockchain applications Users only. As explained by Existing frameworks do not provide a mechanism to produce signatures which can be verified by other Blockchain applications. Hence if Ujo Users wish to execute Smart Contracts on Verifi Media, the same is not supported in existing frameworks

5.1.2. Fine grained Access Control Policies

Current systems implement Coarse grained Policies e.g. Access rights based on User Role on content. However, Fine grained policies based on User Identity, User attributes or Multiuser approvals such as below are not supported:

Time Based: If the user has edited more than "X" Meta Data in the last 1 Hour then do not allow Meta Data editing

Provenance Based: Edit rights are declined if the User does not meet the requisite provenance predicates. For e.g. if the User has transacted with not been associated with the Content for more than "Y" Months then access is not granted

Aggregate policies: if the Selling price is More than X Dollars then Meta Data edit is not permitted unless approved a minimum of "Z" Owners.

Content Category Based: based on Content Category and User Provenance define a *combination of access rules*

Hierarchy Based Access: User access roles can be defined based on Hierarchies and a child can inherit all the Access Control rights assigned to the parent

5.2. Proposed Blockchain Architecture Pattern for Metadata Storage

To overcome the above challenges, below is the proposed architecture of an Meta Data storage Architecture by individual owners to enable an open Market Place. It is important to classify that below are high level solutions and detailed analysis of these would be done as part of further research:

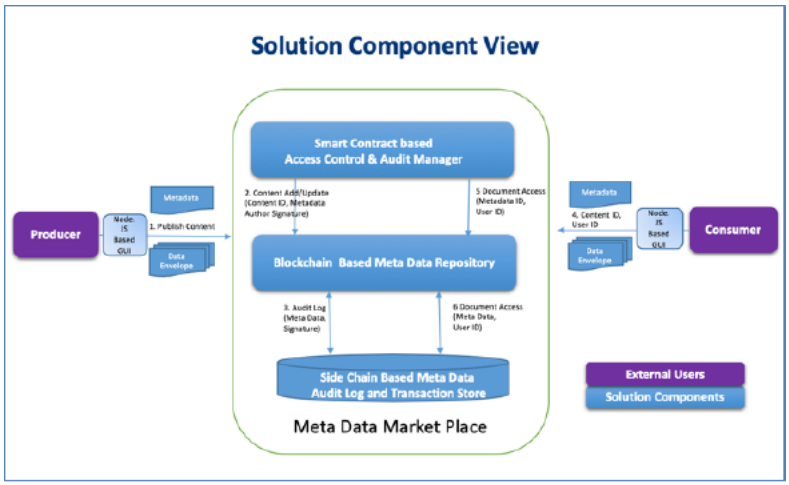

Figure 5 Meta Data Market Place Component View

5.2.1. Interoperability Requirements

Linked Data Sets for Metadata

Decentralization mandates the need for heterogeneous access of currently autonomous and incompatible media repositories, and it is unlikely that there will ever exist a single agreed-upon metadata schema.

To overcome this, the concept of Linked Data Sets is introduced which point the Metadata schema to a standardized schema definition. The below illustrates a Meta Data set based on COALA IP which supports interoperability across Frameworks using Linked Data Sets reinforced through URI's:

```
{
 "@type": "Audio",
 "@id": "<URI pointing to object>",
 "usages": "play/copy/TV/BAR|...",
 "region": "<URI pointing to aPlace>",
 "Content Source": "<URI pointing to a Copyright>",
 "Content License": "<URI pointing to a license on an immutable ledger>"
}
```

Inter Blockchain Communication

Sidechains such as Polkadot and Cosmos, Notaries, Relays, Blockchain Routers and Smart Contracts are available to enable Inter Block Chain Communication and facilitate data exchange between varied organizations

- However, Sidechains are currently focused on Token Based communication primarily.
- Notaries are effective for data exchange, however, are owned by private parties and hence not reliable.

- Relays use chain communication to verify events that have taken place in other chains. However, they are only effective in chains which work on fast consensus and have Multi Sig capability.

Considering that most Metadata Blockchain applications are on Private Blockchains, Relay Chains are the proposed mechanism for IBC for Metadata Blockchains.

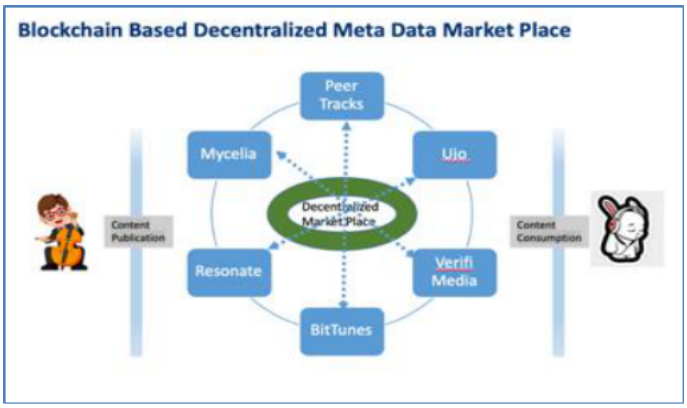

Figure 6 Blockchain Based Decentralized Market Place using Sidechains

5.2.2. Fine grained Access Control Policies

Meta data comprises of 2 categories of Information: Access Information – which is required to get deep insights and search the Content and Regulatory Information – which is required for Revenue Settlement and Legal resolution. This is Private Information and should be Controlled based on Access Rights

Decentralized Access Control Based on Roles

Fine grained Role-based access control (RBAC) is used for defining system access privileges for users based on defined roles. A key vision of any Blockchain system is to have User Control on Content Access based on fine grained Meta Data Permissions. In centralized systems, a hierarchy of roles and permissions are defined, and Users can be assigned to one or many roles based on their and job role and organization function, to defined access control permissions.

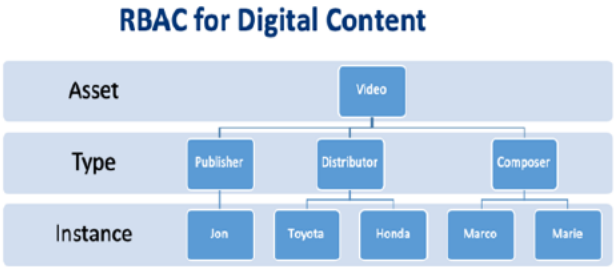

Figure 7 RBAC Framework for Digital Content

RBAC for Data writes can be simulated in a Blockchain by:

- Treating Roles as an "**Asset**" and Categories of Roles are defined as Types
- Create **hierarchies** between Types by using "Link" operator which will help define relationships across assets.
- Each New User in the enterprise created is an **instance** of the Role Asset

- **Admin Users** who can define association across Assets will have "Can Link" asset in their Wallets. The Can Link asset will be transferred to their Wallet based on Consensus which can be implemented through Proof of Stake.

Note: The above RBAC framework is applicable for Write Controls only. Read privilege to different sets of Users will be provided through cryptographic access.

Private Data for Data Isolation

Blockchain based on Hyperledger has added support for Private Data which is applicable for small data sets that are owned by entities. This is implemented through collections where some peers store only hashes of the Private Data. This is supported currently by Hyperledger, but the framework is under verification with other platforms such as Ethereum.

5.3. Summary of Gaps and Proposed Architecture

Table 9 Summary of Gaps and Proposed Architecture

Fine Grained Access Control To for Content Meta Data	Fine Grained Access Control should be based on a combination of Time, Provenance, Aggregate, Content Category and User Hierarchy. This can be achieved in Blockchain by treating Roles as an Asset and Role Categories as Type. Link Operators can then be used to create hierarchies across assets. Data Isolation through Private Data Implementations for low volume highly secure data is implemented in new frameworks which are implemented on some Blockchain platforms such as Hyperledger. This can be used to ensure Fine Grained Access Control.
Interoperable Meta Data Repository	The vision of a Decentralized Meta Data repository is to ensure interoperability across platforms. This can be achieved by following an interoperable Meta Data standard that will ensure Data Sharing using Linked Lists through URI's. In addition Relay Chains are recommended for IBC for frameworks which have low latency and support Multi Signatures.

6 CONCLUSION & FUTURE SCOPE

This paper has analysed 3 Blockchain Based Content Delivery Models with the conceptual lens of six known Challenges. It has identified key benefit of Blockchain based Meta Data as standardization, Metadata Reuse and transaction integrity for Content Providers.

Lack of Interoperable Meta Data Repository and Fine Grained Access Control and are identified as key gaps of existing Blockchain Models. The Paper proposes a Meta data Framework that can be used to enhance the current Models. Further Research can focus on applying this model to Public and Private Blockchains to ensure true interoperability and Fine Grained Access Control.

REFERENCES

[1] W. Al-Saqaf, N. Seidler, (2017) Blockchain technology for social impact: opportunities and challenges ahead, J. Cyber Policy. 0, 1–17.

[2] A. Alketbi, Q. Nasir, M.A. Talib, (2018) Blockchain for government services-Use cases, security benefits and challenges, 2018 15th Learn. Technol. Conf. L T 2018. 112–119.

[3] N. Baym, L. Swartz, A. Alarcon, (2019) Convening technologies: Blockchain and the music industry, Int. J. Commun. 13, 402–421.

[4] D. Bhowmik, T. Feng, (2017). The multimedia blockchain: A distributed and tamper-proof media transaction framework, Int. Conf. Digit. Signal Process. DSP. 2017.

[5] S. Caress, (2017). Piracy, Policy, and Pandora: Outdated Copyright in a Digital World, Student Res. Day Abstr. Posters.

[6] A. Chakravorty, C. Rong, Ushare: (2017). User controlled social media based on blockchain, Proc. 11th Int. Conf. Ubiquitous Inf. Manag. Commun. IMCOM 2017.

[7] U.W. Chohan, (2018).The Concept and Criticisms of Steemit The Concept and Criticisms of Steemit.

[8] S. Cuore, R. Coelho, (2018) Blockchain: a new way of distribution, promotion and improvement of the artistic, economic and cultural situation of a film in the, 408–418.

[9] M.O. Dair, D. Neilson, P. Pacifico, (2016) Music on The Blockchain Lead Researcher, 1–29.

[10] A. Demichev, A. Kryukov, N. Prikhodko, The Approach to Managing Provenance Metadata and Data Access Rights in Distributed Storage Using the Hyperledger Blockchain Platform, (n.d.).

[11] J.S. Downie, The scientific evaluation of music information retrieval systems: Foundations and future, Comput. Music J. 28 (2004) 12–23.

[12] P. Ericson, P. Harris, E. Larcombe, T. Pekari, K. Snook, A. Dubber, (2016) MTF Labs: Blockchain, 1–26.

[13] Q. Feng, D. He, S. Zeadally, M.K. Khan, N. Kumar, (2019) A survey on privacy protection in blockchain system, J. Netw. Comput. Appl. 126, 45–58.

[14] S. Fujimura, H. Watanabe, A. Nakadaira, T. Yamada, A. Akutsu, J. Kishigami, (2016) BRIGHT: A concept for a decentralized rights management system based on blockchain, 5th IEEE Int. Conf. Consum. Electron. - Berlin, ICCE-Berlin 2015. 345–346.

[15] E. Garc, S. Salvador, (2017). Deploying Metadata on Blockchain Technologies Deploying metadata on blockchain technologies.

[16] E. García-Barriocanal, S. Sánchez-Alonso, M.A. Sicilia, (2017) Deploying metadata on blockchain technologies, Commun. Comput. Inf. Sci. 755, 38–49.

[17] O. Gough, (2018) Blockchain : a new opportunity for record labels, Int. J. Music Bus. Res. 7, 26–44.

[18] T. Höppner, P. Westerhoff, J. Weber, (2019). Taking a Bite at the Apple: Ensuring a Level-Playing-Field for Competition on App Stores, SSRN Electron. J.

[19] IFPI, (2018) Global top 10 recording artists of 2017 Global Music Report 2018 Annual State of the Industry, 10.

[20] J. Kishigami, S. Fujimura, H. Watanabe, A. Nakadaira, A. Akutsu, (2015) The Blockchain-Based Digital Content Distribution System, Proc. - 2015 IEEE 5th Int. Conf. Big Data Cloud Comput. BDCloud 2015. 187–190.

[21] O. Labazova, (2019).From Hype to Reality : A Taxonomy of Blockchain Applications From Hype to Reality : A Taxonomy of Blockchain Applications.

[22] J. Lee, S.O. Hwang, S.W. Jeong, K.S. Yoon, C.S. Park, J.C. Ryou, (2003) A DRM framework for distributing digital contents through the internet, ETRI J. 25, 423–436.

[23] W. Li, A. Sforzin, S. Fedorov, G.O. Karame, (2017) Towards Scalable and Private Industrial Blockchains, Proc. ACM Work. Blockchain, Cryptocurrencies Contract. - BCC '17. 9–14.

[24] T. Mcconaghy, D. Holtzman, (2015) Towards an Ownership Layer for the Internet, 1–32.

[25] M. O'Dair, (2016) The networked record industry: How blockchain technology could transform the consumption and monetisation of recorded music, 42.

[26] M. O'Dair, (2019) Distributed Creativity: How Blockchain Technology will Transform the Creative Economy.

[27] M. O'Dair, R. Owen, (2019) Financing new creative enterprise through blockchain technology: Opportunities and policy implications, Strateg. Chang. 28, 9–17.

[28] S. Ølnes, J. Ubacht, M. Janssen, (2017) Blockchain in government : Bene fi ts and implications of distributed ledger technology for information sharing, 34, 355–364.
[29] B.R. On, (2016). The Blockchain Phenomenon the Disruptive Potential.
[30] A.P. Paper, K. Croman, C. Decker, I. Eyal, A.E. Gencer, A. Juels, On Scaling Decentralized Blockchains, (n.d.).
[31] W. Paper, (2018) Community based video A token such as Likecoin changes the game of social, 0–26.
[32] M.E. Peck, (2017) Blockchain World - Do You Need a Blockchain?, IEEE Spectr. 54, 38–60.
[33] J. Rinaldi, (2018).Peer To Peer Digital Rights Management Using Blockchain.
[34] G. Salviotti, L.M. De Rossi, N. Abbatemarco, (2018).A structured framework to assess the business application landscape of blockchain technologies., Proc. 51st Hawaii Int. Conf. Syst. Sci.
[35] Satoshi Nakamato, (2013) Bitcoin: A Peer-toPeer Electronic Cash System, 1–9.
[36] A. Savelyev, (2018) Copyright in the blockchain era: Promises and challenges, Comput. Law Secur. Rev. 34, 550–561.
[37] J. Silver, (2016).Blockchain or the Chaingang? Challenges, opportunities and hype: the music industry and blockchain technologies Preface and acknowledgements, Creat. Work. Pap. 05.
[38] C. Sitonio, A. Nucciarelli, (2018).The Impact of Blockchain on the Music Industry.
[39] W. Technology, and Blockchains in the Music Industry, (n.d.).
[40] D. Trossen, C. Fine, (2005) Value Chain Dynamics in the Communication Industry, MIT Commun. Futur. Program. MIT. 1–17.
[41] J. Umeh, (2016) 470631193, Itnow. 58, 58–61.
[42] X. Wang, (2003) Digital rights management for broadband content distribution, Proc. - 2003 Symp. Appl. Internet, SAINT 2003. 21, 4.
[43] X. Xu, C. Pautasso, L. Zhu, V. Gramoli, A. Ponomarev, (2016) A.B. Tran, S. Chen, The blockchain as a software connector, Proc. - 2016 13th Work. IEEE/IFIP Conf. Softw. Archit. WICSA 2016. 182–191.
[44] S. Zhao, D. O'Mahony, (2018) BMC protector: A blockchain and smart contract based application for music copyright protection, ACM Int. Conf. Proceeding Ser. 1–5.
[45] M. Zhaofeng, H. Weihua, G. Hongmin, (2018) A new blockchain-based trusted DRM scheme for built-in content protection, Eurasip J. Image Video Process. 2018 1–12.
[46] G. Zyskind, O. Nathan, A.S. Pentland, (2015) Decentralizing privacy: Using blockchain to protect personal data, Proc. - 2015 IEEE Secur. Priv. Work. SPW 2015. 180–184.
[47] COALA IP Protocol, (n.d.)
[48] Manisha Valera, Parth Patel and Shruti Chettiar, (2018) An Avant-Garde Approach of Blockchain in Big Data Analytics, International Journal of Computer Engineering and Technology, 9(6), pp. 115-120.
[49] Deepika Sachdev, (2019) Enabling Data Democracy in Supply Chain using Blockchain and IoT, Journal of Management,6(1), pp. 66–83.
[50] Ragh Satya Sai Medida, (2020) Scope of Blockchain Technology in the Retail Industry, International Journal of Computer Engineering and Technology,11(3), pp. 26-30