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Automating Royalties: A Framework of Smart Contracts for Cross-Platform Content Revenue

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Abstract:
The traditional content monetization system is plagued by lack of transparency, delays, and inefficiencies in royalty payments. The creators struggle to receive timely and fair compensation for their work, particularly when their content is distributed across various platforms like Spotify, YouTube, and Instagram. This research proposes a novel framework utilizing blockchain technology and smart contracts to simplify and standardize royalty distributions, ensuring they are transparent, efficient, and fair for creators across multiple platforms. We examine the technical structure of the smart contract platform, analyze its financial characteristics, and demonstrate its ability to revolutionize content monetization. We also consider the mathematical frameworks that support royalty calculations and examine the interdisciplinary aspect of the project, utilizing computer science, mathematics, and economics.The study examines the groundbreaking capacity of instant streaming payments, enabled by Layer 2 scaling solutions such as Polygon and Arbitrum, for microtransactions. We compare this to the shortcomings of existing monthly or quarterly payment lags. Additionally, we explore the aspects of governance and decentralization, suggestinga Decentralized Autonomous Organization (DAO) structure for important decision-making. procedures like royalty division formulas, conflict resolution, and data ownership. Finally,we incorporate reputation systems for creators, utilizing on-chain data such as plays, likes, and NFTs sales, to dynamically modify royalties and tier distributions, fostering a fairer and adaptive remuneration system.

Keywords: Ethereum, creator economy, blockchain, smart contracts, royalties, content monetization, transparency, and interoperability.

1. Introduction:

The digital age has enabled creators to reach an unprecedented number of audiences through a wide variety of platforms. Despite their growth, the rise of these platforms has paradoxically increased the challenges of monetizing content and distributing royalties. Traditional royalty systems are often plagued by:

- Absence of clarity: Creators frequently do not know how their content is utilized and profited from.
- Late payments: Royalty distributions may be delayed for months or even years.
- Elevated transaction costs: Middlemen take substantial shares of royalty earnings.
- Varied standards: Platforms use different computation techniques and payment timelines.
- Restricted control for creators: Creators possess little power regarding royalty conditions

These issues **affect** smaller creators more than big companies because they don't **have** the same ability to **negotiate** as larger businesses. This study **wants** to **fix** these problems by **building** a platform **based**

on blockchain that **uses** smart contracts to **make** royalty payments easier and faster between different content platforms. The goal is to **give** creators more control, better visibility, and more efficient ways to **make** money from their intellectual property.

2. Background and Related Work:

2.1. The Creator Economy and its Challenges: The creator economy involves people generating content for YouTube, Instagram, TikTok, and other streaming services. It is one of the most rapidly growing economies in the world. However, as we explained previously, the system still has many challenges. In recent years, we have observed a significant growth of the digital creator economy. Unfortunately, monetization frameworks provide reliable payment mechanisms significantly behind the speed at which content is produced and consumed. The traditional approach of paying creators monthly or even quarterly, combined with opaque fee structures and centralized platform control, leads to a loss of correlation between the creator's contribution and timely rewards. This results in creators facing cash flow problems, restricted capacity to reinvest capital, and fostering a feeling of reliance on third parties.

2.2. Blockchain Technology and Smart Contracts: Blockchain is a type of technology that **keeps** a secure, unchangeable, and open record of transactions. A smart contract is a set of rules **written** in code that automatically **carries** out actions when certain conditions are **met** (Buterin, 2014). These features **make** blockchain and smart contracts useful for **automating** complex tasks like royalty payments.

2.3. Current Solutions and Shortcomings Some projects have tried using blockchain for managing content rights. They include:

- Vezt: A platform where artists can divide their songs into parts and sell them to fans (Vezt, n. d.).
- Ujo Music: A project that aims to improve transparency by creating a decentralized database of rights information using blockchain (Ujo Music, archived).
- Audius: A decentralized music streaming service that **allows** artists to **earn** money directly from their work (Audius, n.d)

Although these projects do help in some way, they often focus on just one platform or a single use case. Also, making different blockchain networks and older systems work together is still a big challenge (Davidson et al. , 2018).

3. Our framework

aims to improve upon existing solutions by creating an interoperable and modular system that automates royalty payments across various platforms. The architecture includes the following main parts:

3.1. Content Registry Smart Contract:

This smart contract acts as a central place for storing information about content and connecting it with its creators, rights holders, and rules for royalty payments.

It holds details like:

- **Content ID:** A unique number for each piece of content (like the hash of the file or a standard number such as ISRC or ISBN).
- **Creator Address:** The Ethereum address or addresses of the creator(s) who get royalties.
- Rights Holders: Information about other people or organizations that have rights to the content, like publishers or labels.
- **Royalty Split:** The share of royalties each creator and rights holder gets.

This can be set for each piece of content.

Platform Metadata: Links to where the content is available on different platforms (like Spotify or YouTube).

3.2. Platform Integration Modules (Oracles):

These modules act as bridges between the smart contract and external platforms.

They collect usage data (such as streams, views, or sales) from each platform and send it to the smart contract.

Oracle Design: These oracles can be either centralized or decentralized. For the decentralized version, they might use technologies like Chainlink to ensure the data is accurate and trustworthy (Chainlink, n. d).

- **Data Collection:** Each part of the system is **designed** to **connect** with the specific API of the platform it's **working** with. This can **happen** through web scraping, directly **linking** to the platform's API, or by **working** together with the platform's company.
- **Data Validation:** There **are** checks in place to **make** sure the data **collected** is correct and real before it is **sent** to the smart contract.

3.3 Royalty Calculation Smart Contract: This smart contract is responsible for figuring out how much money each creator and rights holder should get based on the usage data from the platform and the agreed-upon royalty shares in the content registry.

- Royalty Formula: The calculation uses factors like the number of streams or views, the money the platform makes, and the specific terms of the royalty agreement.
- Currency Conversion: The contract handles converting money between different currencies when the platform pays in different ones. It might use price data from Chainlink oracles to do this.
- Gas Optimization: The smart contract is designed in a way that reduces the cost of using blockchain resources, like gas fees.

3.4 Payment Distribution Smart Contract: This contract sends the calculated royalties to the correct addresses of the creators and rights holders.

- Automated Payments: Royalties are sent automatically to the specific Ethereum addresses that are set up, based on calculations done by the Royalty Calculation Contract.
- Payment Schedule: You can choose how often payments are made, like monthly or quarterly.
- Payment History: All royalty payments are kept forever on the blockchain.

3.5. User Interface (UI): The UI is easy to use and lets creators:

- Add their content and decide how to split the royalties.
- Keep track of their royalty earnings from different platforms.
- Adjust their payment preferences.

4. Mathematical Formulas for Royalty Computation: The way royalties are calculated uses math to make sure everyone gets their fair share. Here's a simple version of the formula:

Let:

- R = total money made from the content on a platform during a certain time,
- V = total number of times the content was played or viewed,
- S_i = number of plays or views that belong to creator i,
- P_i = the percentage of the royalties that creator i is supposed to get.

Then, the amount of royalty that creator i should get (Royalty_i) is:

$$Royalty_i = R \times (S_i / V) \times P_i$$

For example, if a song earns $10,000 from 1,000,000 streams, and creator A has 250,000 streams with a 60% royalty share, then creator A's share would be:
Royalty_A = $10,000 × (250,000 / 1,000,000) × 0.
6 = $1,500
This approach can also include other factors like different income sources, regional differences, guaranteed minimum royalties, and changes in how royalties are calculated as stream numbers get very high.

5. Economic Consequences: The suggested system brings several important economic advantages and some difficulties:
Benefits:
- More money for creators because it cuts out middlemen and lowers costs of doing business.
- Clearer tracking of income and how royalties are calculated, thanks to the open records of blockchain.
- Faster payment processing through automated systems, which removes delays.
- More control for creators in handling how they get paid and their rights across different platforms.
- Help for new ideas in how businesses operate, like shared ownership and flexible royalty sharing depending on how popular content is.

Challenges:
- Some platforms might not want to use blockchain, making it hard to get started.
- There are not clear rules yet about using blockchain and digital money, which could cause problems.
- The blockchain systems need to be able to handle a lot of transactions quickly and smoothly.
- The value of digital currencies can change a lot, which affects how much money creators actually get.

Ethical Considerations:
This framework takes into account the ethical aspects of blockchain technology, including:
- Privacy: Keeping personal and sensitive information of creators and consumers safe.
- Security: Making sure that smart contracts are protected from possible attacks and weaknesses.
- Accessibility: Creating easy-to-use systems that work well for creators with different levels of technical knowledge.
- Environmental Impact: Finding ways to reduce energy use with more efficient blockchain methods.

By using strong security, protecting privacy, and exploring energy-efficient technologies, the platform will be inclusive and sustainable, offering equal benefits to all creators.

6**. Implementation and Technologies**: The framework will be built using the following technologies:
- Blockchain Platform: Ethereum (because it is widely used and supports smart contracts well).
- Smart Contract Language: Solidity.
- Oracles: Chainlink (to provide safe and reliable data).
- Development Tools: Truffle, Ganache, and Remix.
- UI Framework: React. js or Vue. js.

7. **Interdisciplinary Considerations:** This project involves several areas of study and will use knowledge from different fields:

- Computer Science: Blockchain, smart contract development, distributed systems, and API connections.
- Mathematics: Creating royalty models, optimizing smart contract logic, and applying cryptography.
- Economics: Using game theory for designing incentives, mechanism design for fair royalty payments, and behavioral economics to understand creator and consumer actions.
- Law: Understanding intellectual property, contract law, and staying within legal and regulatory rules.

8. The Future of Creator Compensation: Real-Time Streaming Payments, DAO Governance, and On-Chain Reputation on Layer 2 Solutions

This part of paper posits that a paradigm shift towards real-time streaming payments, enabled by the scalability and efficiency of Layer 2 blockchain solutions, can revolutionize creator compensation. We will explore how microtransactions, previously economically unfeasible due to high gas fees and slow transaction times on Layer 1 blockchains, can become viable. Subsequently, we examine the critical role of decentralization in empowering creators. We propose the establishment of a DAO to govern key operational aspects, shifting power from centralized platforms to the creator community. Finally, we introduce the concept of on-chain reputation systems, demonstrating how verifiable metrics can be used to create dynamic and fair compensation models.

9. Real-Time Streaming Payments: Bridging the Gap with Layer 2 Solutions

9.1 The Inadequacy of Current Payment Models

The current payment models for digital creators are characterized by:

- **Delayed Payouts:** Creators often wait 30, 60, or even 90+ days to receive earnings from platforms. This delay poses significant cash flow challenges, especially for emerging creators who may not have substantial savings. It hinders their ability to invest in new equipment, marketing, or even cover daily expenses.
- **High Transaction Fees for Microtransactions:** Many creator-audience interactions involve small, frequent transactions (e.g., paying for a single song stream, a short exclusive clip, or a digital tip). On Layer 1 blockchains like Ethereum, the associated gas fees and transaction confirmation times make such microtransactions economically prohibitive. This effectively disconnects the immediate value exchange from a timely financial reward.
- **Centralized Control and Opaque Fee Structures:** Platforms dictate payment schedules, fee percentages, and currency conversion rates, often with little transparency. Creators have limited recourse or ability to influence these terms, leading to a power imbalance.

9.2 Layer 2 Solutions: Enabling Viable Microtransactions

Layer 2 scaling solutions address the limitations of Layer 1 blockchains by processing transactions off-chain while leveraging the security of the underlying Layer 1. This drastically reduces transaction fees (often to fractions of a cent) and increases transaction throughput (thousands of transactions per second).

- **Polygon (MATIC):** Polygon offers a suite of scaling solutions, most notably the **Polygon PoS (Proof-of-Stake) chain**. This sidechain is highly compatible with Ethereum's Virtual Machine (EVM), allowing for easy integration of existing dApps and smart contracts. Polygon's ability to process a large volume of transactions at low cost makes it an ideal candidate for real-time streaming payments for microtransactions. For example, a creator could receive fractions of a cent for every second a user streams their music or watches their video content, with these micropayments being

batched and settled to their wallet in near real-time.

- **Reference:** Jain, A., & Kothari, S. (2021). *Polygon: An Interoperability Protocol for Ethereum*. Retrieved from https://polygon.technology/papers/polygon- whitepaper.pdf

- **Arbitrum:** Arbitrum One is a leading **Optimistic Rollup** solution for Ethereum. It processes transactions off-chain and then posts compressed transaction data to the Ethereum mainnet periodically. This offers a high degree of security inherited from Ethereum while achieving significant scaling benefits. Arbitrum's low fees and high throughput are also well-suited for streaming payments, enabling a seamless and cost-effective experience for both creators and consumers. Imagine a scenario where a viewer pays a small amount of cryptocurrency directly to a streamer for each "emote" or "boost" they send during a live broadcast, with these payments instantly reflected.
- **Reference:** Balinas, R. (2022). *Arbitrum: A Primer*. Retrieved from https://developer.arbitrum.io/arbitrum-primer.html

9.3 Implementation of Real-Time Streaming Payments:

The implementation would involve smart contracts deployed on a Layer 2 solution. These contracts would facilitate:

- **Subscription Models:** Users could subscribe to a creator's content, with small, recurring payments automatically deducted and transferred to the creator in real- time.
- **Pay-Per-View/Listen:** Users could pay a micro-transaction for immediate access to specific content, with the payment executed instantly upon consumption.
- **Direct Tipping/Donations:** Audiences could send instant tips or donations to creators during live streams or in response to content, with these funds arriving in the creator's wallet immediately.

This real-time flow of value significantly enhances the creator-audience relationship by providing immediate gratification and fostering a more direct financial connection.

10. Governance and Decentralization: The Power of DAOs

10.1 The Need for Decentralized Governance

Centralized platforms hold immense power over creator livelihoods, dictating terms of service, content moderation policies, and revenue sharing. This can lead to arbitrary decisions, censorship, and a lack of creator agency. A Decentralized Autonomous Organization (DAO) offers a compelling alternative to address these issues.

10.2 Designing a Creator DAO

A DAO built for the creator economy would be governed by its token holders, who could be creators, consumers, or other stakeholders. The DAO's smart contracts would encode the organization's rules and decision-making processes. Key areas where a DAO could exert influence include:

- **Royalty Split Formulas:**
- **Current Scenario:** Platforms often set static royalty splits (e.g., 70/30).
- **DAO Approach:** The DAO could vote on and dynamically adjust royalty splits based on various factors. For instance, a formula could be proposed that rewards creators with higher engagement or longer-term fan loyalty with a larger percentage of revenue. Token holders (creators and fans) could propose and vote on different models, experimenting with tiered splits based on content type, platform usage, or specific collection mechanics.
- **Reference:** Hsieh, T. (2021). *The DAO Handbook: A Guide to Decentralized Autonomous*

Organizations. Retrieved from https://www.trentonhsieh.com/the-dao-handbook

- **Dispute Resolution:**
  - **Current Scenario:** Disputes are often handled by centralized platform support teams, with limited transparency and recourse.
  - **DAO Approach:** A decentralized dispute resolution mechanism could be implemented. This might involve a jury of randomly selected token holders who are incentivized to act as impartial arbiters. Creators and consumers could submit evidence to these jurors, who would then vote on the resolution. The smart contracts would automatically execute the outcome of the vote. This could be used to resolve issues related to content ownership, alleged copyright infringement, or payment discrepancies.
  - **Reference:** O'Connor, E. (2021). *Decentralized Dispute Resolution: The Future of Justice?*. Retrieved from https://medium.com/coinbase- blog/decentralized-dispute-resolution-the-future-of-justice- 1a5a4d6b0d7e
- **Data Ownership and Monetization:**
  - **Current Scenario:** Platforms often claim ownership or extensive licensing rights to user-generated content.
  - **DAO Approach:** The DAO could establish clear protocols for data ownership and monetization. Creators could retain full ownership of their content, and the DAO could govern how this data is used and monetized. For example, if user data is anonymized and used for platform improvement, the DAO could decide on a revenue-sharing model that benefits creators. Token holders could vote on data privacy policies and decide which third parties, if any, can access and utilize creator data, with clear compensation mechanisms in place.
  - **Reference:** Benkler, Y. (2006). *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. Yale University Press. (While not blockchain-specific, this work provides foundational principles for understanding decentralized knowledge production and ownership).

10.3 Tokenomics and Incentives:

The DAO would likely be powered by a native governance token. This token could be used for:

- **Voting:** Token holders can vote on proposals related to protocol upgrades, treasury management, and policy changes.
- **Staking:** Users could stake tokens to participate in dispute resolution or to earn rewards.
- **Incentives:** Tokens could be distributed to creators for engagement, to users for consuming content, or to participants for contributing to the DAO's ecosystem.

11. Integrating Creator Reputation Systems

11.1 The Value of On-Chain Reputation

In a decentralized ecosystem, establishing trust and credibility is paramount. On-chain reputation systems offer a verifiable and transparent way to assess a creator's standing. These metrics are immutable and publicly auditable, providing a robust foundation for trust.

11.2 On-Chain Reputation Metrics:

- **Number of Plays/Views:** A direct indicator of content reach and audience engagement.
- **Likes/Upvotes/Appreciation Signals:** Quantifiable measures of audience reception and content quality.

- **NFT Sales and Ownership:** For creators involved in NFTs, the volume and value of their sold NFTs, and the retention of their own NFTs, can signify market confidence and artistic value.
- **Community Engagement:** Metrics like active participation in forums, successful dispute resolution contributions, or positive interactions within the DAO's governance processes.
- **Content Creation Consistency:** A track record of regular, high-quality content output.

11.3 Dynamic Royalty Adjustments and Tiered Payouts:

By integrating these on-chain reputation metrics with smart contracts, royalty splits and payout structures can become dynamic and meritocratic.

- **Dynamic Royalty Adjustments:**
  - **Mechanism:** A smart contract could automatically adjust a creator's royalty percentage based on their on-chain reputation score. For example, a creator with a high number of plays and positive engagement metrics might automatically receive a higher percentage of the revenue generated by their content.
  - **Example:** If a user streams a song for 60 seconds, the smart contract could trigger a microtransaction. The amount of that microtransaction, and the creator's percentage of it, could be influenced by their reputation score. A "Tier 1" creator (high reputation) might receive 80% of the stream revenue, while a "Tier 3" creator (lower reputation) might receive 60%, with the DAO's governance potentially adjusting these tiers over time.
- **Tiered Payouts and Rewards:**
  - **Mechanism:** Beyond royalties, reputation can unlock additional rewards or benefits. Creators could be tiered based on their reputation, with higher tiers receiving preferential treatment, access to exclusive features, or bonus token distributions.
  - **Example:** Creators who consistently achieve high engagement metrics (e.g., a sustained number of daily active listeners) might be automatically enrolled in a "featured creator" program, gaining increased visibility on platform discovery pages. This could be managed by a smart contract that checks reputation scores at regular intervals.
  - **Reference:** Kroll, J. (2022). *On-Chain Identity and Reputation Systems*. Retrieved from https://www.nas.org/publications/on-chain-identity- and-reputation-systems

This system incentivizes creators to produce quality content and engage positively with their audience, fostering a more sustainable and rewarding creative environment.

12. Challenges and Future Directions

While promising, this model faces several challenges:

- **Scalability of DAOs:** Managing large DAOs and ensuring active, informed participation can be challenging. Sophisticated governance tools and delegation mechanisms will be crucial.
- **On-Chain Data Integrity:** While on-chain data is largely immutable, ensuring the accuracy and preventing manipulation of some metrics (e.g., bot-driven plays) will require robust anti-Sybil mechanisms and community vigilance.
- **User Adoption and Education:** Educating creators and consumers about Layer 2 solutions, DAOs, and blockchain-based payment systems is essential for widespread adoption.
- **Regulatory Landscape:** The evolving regulatory environment for cryptocurrencies and DAOs will need to be navigated carefully.
- **Interoperability:** Ensuring seamless integration with existing content platforms and payment

gateways will be key.

Future research could focus on developing more sophisticated reputation algorithms, exploring cross-chain interoperability for broader reach, and investigating novel DAO governance structures for more nuanced decision-making.

Conclusion

The convergence of Layer 2 scaling solutions, Decentralized Autonomous Organizations, and on-chain reputation systems presents a robust framework for a more equitable, efficient, and creator-centric future. Real-time streaming payments, powered by platforms like Polygon and Arbitrum, can unlock the potential of microtransactions, providing creators with immediate and fair compensation. DAOs offer a decentralized governance model, empowering creators to shape the rules of their economy, from royalty splits to dispute resolution. Finally, on-chain reputation systems introduce transparency and meritocracy, rewarding creators for their contributions and fostering a thriving, self-sustaining ecosystem. By embracing these innovations, the digital creator economy can move beyond its current limitations and usher in an era of true creator empowerment.

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