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An Overview of Blockchain Online Social Media from the Technical Point of View

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Abstract: Social media is becoming one of the dominant ways to communicate. Before social media, people were extremely limited in their means to interact with others, and they were limited largely to the people that they knew in person. However, this impact on people in real life has damaged privacy. Alternative solutions have been proposed in order to overcome current social media issues. In this direction, blockchain is one of the most promising, and several blockchain-based social media have been proposed. In this paper, we analyze blockchain online social media from the technical point of view in order to understand the current trend of social DApps and to describe which characteristics are important in a blockchain-based social media scenario. We analyze real data by exploiting one of the most well-known DApps sites, and we compare current technologies in order to highlight which ones can be better applied to a real social scenario, such as Facebook.

Keywords: blockchain online social media; social media; blockchain; DApps

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1. Introduction

Social media is rapidly evolving, and the widespread use of social media has changed the way people communicate. However, this change is not necessarily positive. Several issues concerning privacy, fake news, and censorship have arisen.

The business model of these platforms is based on providing users services free of charge in order to attract more people, but, in return, everything shared on the platform becomes the property of the platform owner; usually, this information is not clear to the users. The activity of the users is then used by the platform owners in order to generate profits. Furthermore, the primary way in which social media make money is also through selling advertising. Over the years, researchers have started to consider new solutions based on emerging technologies, such as AI or blockchain. As concerns blockchain technology, new business models were introduced, focusing principally on increasing the privacy of the users. Indeed, centralized social networks are based on servers where all information provided by users are stored. These data can be used to find out user preferences and habits, or to provide targeted advertisements. Decentralization was addressed as a promising technology for Social Media. Accordingly, new platforms were born to implement these business models, called previously decentralized online social networks (DOSNs) [1,2] because they were based on P2P networks. Then, platforms based on blockchain technology, named blockchain online social media (BOSMs) [3], were introduced.

The idea behind BOSMs is to employ blockchain technology for different purposes, such as to decentralize control on social data, in some cases letting users maintain control of their social content [4], or for introducing a rewarding system. Using blockchain, BOSMs have the capability to track the contribution and level of participation of a particular creator, or even users. The blockchain technology is decentralized in nature, and it is also known as distributed ledger technology (DLT). One of the main characteristics of blockchain technology is its immutability. Indeed, every activity is irreversibly stored in the blockchain, and all interactions are protected by end-to-end encryption. Furthermore, it is trustable, verifiable, and reliable [5]. One of the objectives of BOSMs is to reward content

creators for valuable content, following the attention economy [6]. Indeed, the attention economy is an approach where the attention of each user is the product; in BOSMs, users are rewarded for their attention and activity. In detail, attention economics is an approach to the management of information that treats human attention as a scarce commodity. It is a subcategory of the information economy which concerns the definition of a marketplace where consumers agree to receive services in exchange for their attention.

Current BOSMs provide free content that is usually visible to anyone and encourage users to produce valuable content, which is rewarded by the community in order to limit the spread of fake news [7–9]. The common way to reward users is with cryptocurrency.

During recent years, several BOSMs have been presented, such as Sapien (https://www.sapien.network/, accessed on 1 September 2021), Minds (https://www.minds.com accessed on 1 September 2021), Appics (https://appics.com/index.html accessed on 1 September 2021), Hive Blog (https://hive.blog/ accessed on 1 September 2021), and Steemit (https://steemit.com accessed on 1 September 2021), which is currently the most successful proposal with more than 1 million registered users [8,9]. All these platforms guarantee social services, and they are based on the most important OSNs, principally Twitter and Reddit, as their social media model. From the technical point of view, the main difference among these platforms consists of the blockchain that they use and the characteristics of the blockchain, such as the consensus algorithms, transactions fees, etc. Nowadays, blockchains have drawbacks that can affect their application in the social scenario. For this reason, and considering that the number of blockchains are increasing day by day, it is important to highlight the requirements of a social scenario and analyze the current blockchains in order to determine whether these requirements are covered or which features should be provided.

In this paper, we propose a study in this direction by analyzing blockchain online social media from the technical point of view in order to understand the main challenges that these platforms face by taking into account a real social scenario, such as Facebook or YouTube. To provide a concrete idea of the current trend of DApps, and in particular, which blockchains are being used, we downloaded information about the social DApps from 2019 to today. We show the number of social DApps and the most used blockchains by describing them. We highlight the most important issues of BOSMs by using real social scenarios, and we compare the most popular blockchains used in social DApps in order to understand which blockchain can be preferable or which new features should be provided in future blockchain technologies.

The rest of this paper is organized as follows: Section 2 is dedicated to the background concerning blockchain technology and blockchain online social media. In Section 3, we provide an overview of the blockchain social DApps by exploiting the ranking of the site (www.stateofthedapps.com accessed on 1 September 2021). In Section 4, we describe the most used blockchains to develop social DApps, and we describe their main characteristics in order to compare them from the point of view of social media application (Section 5). Finally, Section 6 concludes the paper.

2. Background

In this section, we present an overview of blockchain technology, and we present the current status of the blockchain online social media.

2.1. Blockchain Technology

Blockchain is one of the most promising, disruptive and revolutionary technologies. From the technical point of view, a blockchain is a decentralized, distributed digital ledger of economic transactions, which are managed by a cluster of computers and is a perfect example of a democratized system [10]. Blockchain consists of a chain of consecutive blocks of transactions. It is a decentralized, peer-to-peer (P2P) network, and is distributed in nature. It consists of many computers connected together, called nodes, and each node contains a copy of the digital ledger. Blockchain is characterized by consensus, distributed

computation, immutability, and authentication. Validating new blocks is followed by a set of protocols and consensus from every participant of the network. The records are stored in a linear chain. Pointers and linked list data structures are used in blockchain for the block representation. Blocks are arranged in sequence and lined with each other, using a linked list. Pointers are used to point the location of the next block. A block is a collection of data that stores transaction details, such as the timestamp and link to the previous block, which is generated by a secure hash algorithm. Each block contains two parts: a block header and block body.

We can identify four main categories of blockchain:

- **Public.** A public blockchain is non-restrictive and permissionless, which means that anyone with internet access can join the network. Public blockchains are considered to be "trustless", which means that people participating in the blockchain do not need to trust each other. The main example of a public blockchain is Bitcoin.
- **Private.** A private blockchain works like a closed network, under the control of a single entity. Those who want to join need to be accepted. Private blockchains typically are used inside a company or organization, and they are also known as permissioned blockchains. The organization can decide who can read the blockchain, submit transactions to it, and participate to the consensus process.
- **Hybrid.** As the name explains, a hybrid blockchain is a type of blockchain that combines elements of both private and public blockchains. Usually, this kind of blockchain is run by a single company that grants access to any user who satisfies pre-established criteria.
- **Consortium.** Known also as a federated blockchain, it is similar to the hybrid blockchain because it has private and public features. The main difference is that a consortium blockchain is a private blockchain with limited access to a particular group, eliminating the risk that just one entity takes control of the network. Indeed, the consensus process is controlled by a preselected group of corporations, for example. Consortium blockchains are considered permissioned blockchains, and they are suited for use in business.

2.2. Blockchain Online Social Media

Nowadays, blockchain technology is applied to several research fields, including social media. Indeed, there is great interest concerning the application of blockchain as a tool or underlying network to social services; in this direction, several blockchain-based social media have been proposed [11,12]. Their usage has increased year by year; platforms such as SteemIt, have surpassed more than 1 M users (https://btcmanager.com/steemit-announces-over-1-million-users/ accessed on 1 September 2021). An interesting overview of BOSMs is provided by [3]. We highlight the following list of key features:

- *Data control and content management.* In a decentralized network, there is no central authority that collects and stores data. Indeed, users are part of the network and are able to establish their own rules for the content that they generate. They have more control over their data, and they can control the monetization of their content. The blockchain authentication process makes data leaks almost impossible. This means decentralized networks offer maximum confidentiality. Unlike OSNs, such as Facebook and Twitter, decentralized networks offer control to the users. Users have more control over private data, and also on published content. Indeed, they can decide the visibility of the content and the target audience.
- *Censorship and democratized governance.* Censorship is one of the most important issues concerning social media. In detail, users are opposed to the censorship of sensitive topics, principally to guarantee freedom of speech and expression. However, in current OSNs, content is checked and eliminated if does not respect certain rules. Furthermore, countries such as China have significant control over the content published in social media. In contrast, decentralized networks offer users independence because of the lack of a central authority. Users can set their own rules for censorship and governance.

- *Content originality and authenticity.* BOSMs use distributed consensus technologies (DCT) to ensure both the originality and the authenticity of content. While fake news and unauthorized contents are a common phenomenon in OSNs, a BOSM uses the blockchain technology to verify authenticity and that contents are not manipulated or created by malicious third parties.
- *User reward strategies.* OSNs, such as YouTube, reward only popular content creators and celebrities. In contrast, BOSMs have a reward system to evaluate content, such as liking, sharing, etc. Usually, these systems use different types of rewards, depending on the role of the user. For example, active users can receive a content reward if they are the owner, or a curation reward if they collaborate to increase the popularity of a content through likes or re-sharing actions. Others kind of rewards could be attention rewards and stake rewards.
- *Interoperability, open access, and flexibility.* All BOSMs are curated to be both accessible and flexible. The infrastructure is built in a way that supports a range of assets and blockchain platforms. The interoperability creates a standard for the governance and comparison of the application and smart contracts.

During recent years, several BOSMs have been proposed. Steemit was the first proposed platform with more than 1 million users. Nowadays, the popularity of Steemit has reduced, due to the introduction of Hive. Indeed, in March 2020, a new blockchain called Hive was launched from a fork of the Steem blockchain. All Steem users at that time automatically existed on Hive, and a mirror of current balances was airdropped in the new HIVE token. After the fork, several users left Steemit to join the DApps proposed on Hive, such as PeakD and Hive Blog. All the current BOSMs are DApps built on top of a blockchain, and they require users to join the system in order to be rewarded. An interesting project that goes in another direction is Yup (https://yup.io/ accessed on 1 September 2021). Yup represents the new idea of BOSMs, where users are not obliged to join the new platform; instead, each registered user can easily use their current social media platform, such as Twitter or Youtube, and they are rewarded for the social activity. The idea is to curate and share content across the web, and collecting rewards provides validation for a valuable social activity.

3. Blockchain Social DApps: An Overview

Blockchain-based decentralized applications (DApps) are applications that enable end users to interact directly with the blockchain. Generally, a DApp consists of two parts: web pages as the front end, and smart contracts as the back end.

There are a number of social DApps built on top of the most used blockchain, such as Ethereum, EOS, Steem, and so on. Some of them are always active, which means that there are, at the time of writing, new transactions corresponding to those DApps, while some of them have seemingly been dead for a long time.

We developed a crawling application to retrieve public information from the site www.stateofthedapps.com (accessed on 1 September 2021). We collected the information concerning all the DApps in December 2020 in order to analyze the status of blockchain social services. The dataset provides information about the DApps' activity, such as their transaction counts, total transaction values and active users for 24 h, 7 days and 30 days.

4. The Choice of the Blockchain in Social DApps

We elaborated the data collected in order to better understand the status of current DApps and compared them with the data collected in 2019 from the same site, presented in [13]. Figure 1a shows the status of the DApps by grouping them into the categories in which the DApps is built in 2019. As we expected, there are several DApps concerning the financial and game DApps; as concerns the social scenario, social DApps are within the top 5 DApps categories, which describes the importance of DApps in the social environment. The trend of the DApps is increasing year by year, as we can see in Figure 1b,c; social DApps have increased from about 250 proposals in 2019 to about 300 proposals in both

2020 and 2021. This means that the scenario has big interest and potential by considering the new blockchain proposed. Indeed, the scenario concerning the blockchain technology applied to social DApps have completely changed from 2019 to 2020 and 2021, as we can see in Figure 2.

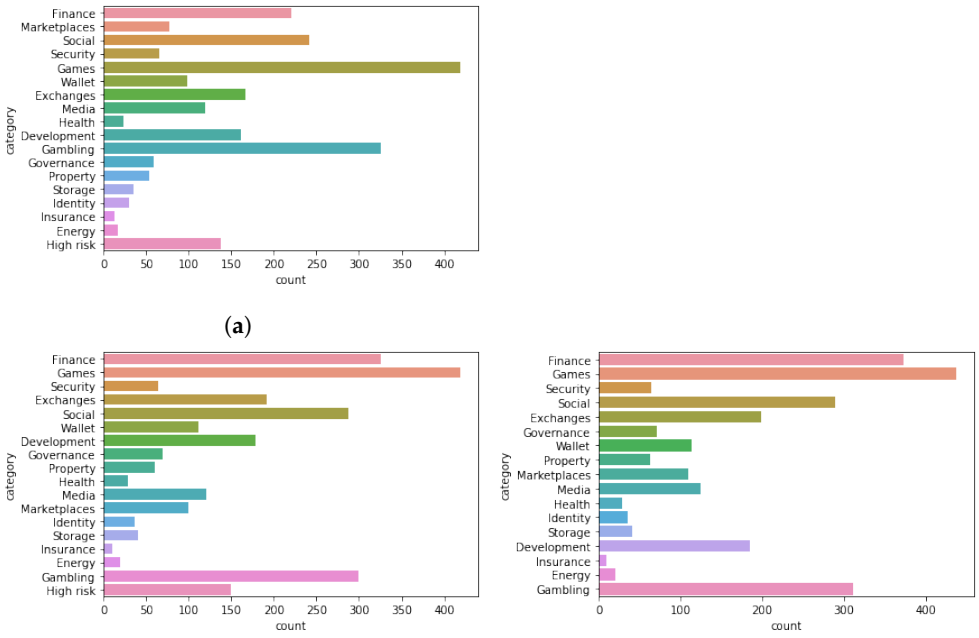

Figure 1. Status of DApps (information collected from the site www.stateofthedapp.com the 14th of May, 2021). (**a**) List of DApps (2019); (**b**) List of DApps (2020); (**c**) List of DApps (2021).

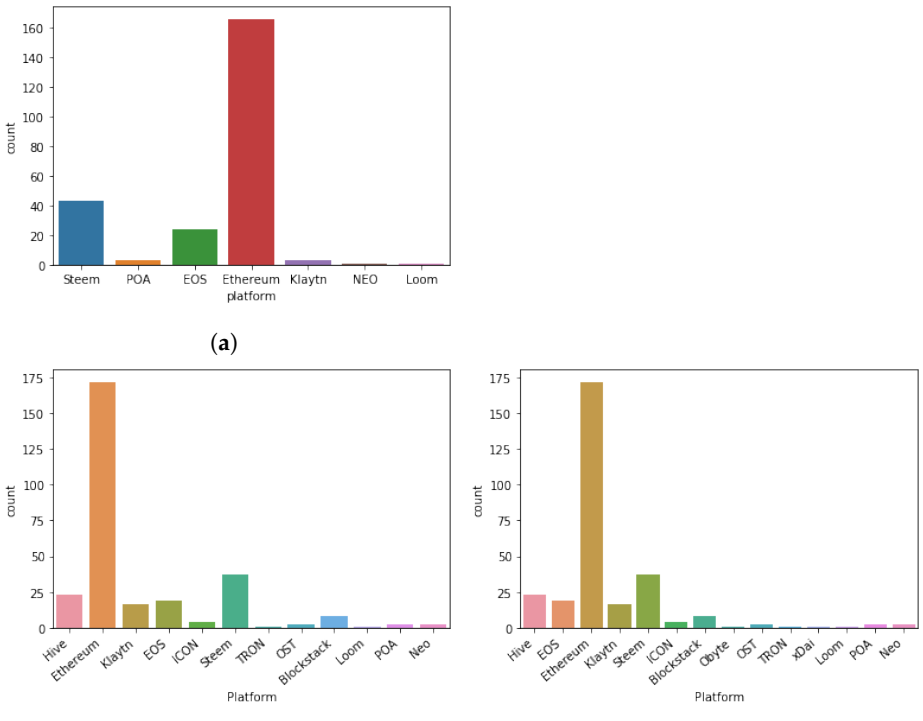

Figure 2. Blockchain used by DApps considering the social category. (information collected the 14th of May, 2021) (**a**) Overview of the Social DApps (2019); (**b**) Overview of the Social DApps (2020); (**c**) Overview of the Social DApps (2021).

We analyze the top 5 blockchains, considering Figure 2c in the social category, in order to understand the characteristics of the blockchain technology tailored in the social scenario as well as the pros and cons.

4.1. Ethereum Blockchain

Ethereum [14] was launched in 2015 by a young Canadian–Russian programmer named Vitalik Buterin. It is a blockchain platform that allows people to send and receive funds without the need for a third party, such as a bank. Just like Bitcoin, the Ethereum blockchain is decentralized, meaning that nobody controls it. This prevents any single person or authority from changing or amending the data that are posted to the blockchain.

The Ethereum project became the first blockchain protocol to install something called 'smart contract' technology. A smart contract consists of a set of cryptographic rules that are executed only if certain conditions are met. These set of rules are snippets of code or protocols. The code of the smart contracts is distributed in the blockchain.

As a permissionless blockchain, in order to provide anonymity, accounts are pseudonymous and are linked to one or more addresses. For mining, Ethereum uses proof-of-work (PoW). In this protocol, for the generation of blocks, computers burn energy to solve cryptographic problems. In Ethereum, processing transactions requires computational power, so gas is the fee paid to miners for providing this computational power. It is clear that attaching cost for every transaction can prevent spamming or other kinds of transaction loops. On Ethereum, there are a few different types of transactions:

- Regular transactions: a transaction from one wallet to another.
- Contract deployment transactions: a transaction without a 'to' address, where the data field is used for the contract code.

Ethereum has its cryptocurrency, called Ether (ETH), which is the second most popular digital token after bitcoin (BTC). ETH is used mainly for two purposes: it is traded as a digital currency on exchanges, and it is used on the Ethereum network to run applications.

4.2. Steem Blockchain

Steem is a social blockchain built to support social applications. As stated in [15], it is the first blockchain that focuses on the social issue. One of the characteristics of Steem is that it stores immutable social content (posts, comments, etc.) in the form of plain text. It provides an incentivization mechanism that rewards the community, and in particular, all the content contributors and distributors, with its cryptocurrency, called STEEM. The cooperation between cryptocurrency and social media thus gives the blockchain Steem a big advantage in the market.

An important aspect of the blockchain is that it is based on a multi-token economy; indeed, multiple cryptocurrencies coexist on the platform. The three currencies are `STEEM`, `VEST`, and `STEEM Blockchain Dollars` (SBD) [16]. STEEM is the liquid currency of the system; indeed, it can be freely transferred. VEST is a measure of the wealth staked in the platform. It cannot be directly traded, but it gives more power and importance in the platform. Finally, SBD is a stablecoin [17] designed to help newcomers invest in the Steem economic system.

Steem is based on Graphene, the same technology that powers BitShares (https://bitshares.org/ accessed on 1 September 2021). It produces new tokens whenever a block is produced.

For creating blocks, Steem uses a consensus mechanism called delegated proof of stake (DPOS) [18,19]. While in the Bitcoin network, and other similar blockchains, everyone can be a miner without anyone's consent, in Steem, only a small number of users can do it, called witnesses. Any user of Steem can become a witness; they just need to set up a witness node. Witnesses are special nodes that can approve forks of the blockchain; they have to publish a price feed, which is the value of the cryptocurrency STEEM. All the users can vote to elect the witnesses. Each user can vote for up to 30 witnesses. The top 20 witnesses, plus one extra witness chosen at random, are also in charge of producing

new blocks. These 21 witnesses act as the network's block producers and governance body. Blocks are produced once each 3 s, thus 21 witnesses produce 21 blocks every 63 s.

As concerns the reward strategy, the rewards are distributed to the creators of content, those who produce and curate content, those who participate in content discussions, and those who vote on the content.

Users also obtain a share of the new coins generated during block creation. Indeed, 10% of the new STEEM coins are paid to the witnesses, while the other 90% of the coins are awarded to curators, producers, and Steem Power (SP) holders. Steem Power (SP) is basically a token representing how much influence a user has inside Steem. Steem Power cannot be traded on digital currency exchanges.

Steem provides a set of 38 transaction types to support its operations and the development of social applications.

4.3. Hive Blockchain

Since its launch on 20 March 2020, when Hive was hard-forked from Steem, it has been growing and evolving every day. When Hive was created, the blockchain was copied from the Steem blockchain, so all content posted to Steem, as well as wallet balances, appeared on Hive. The principles used in Hive are the same as those of Steem, but Hive eliminates the centralization and unbalanced control structures that have plagued the Steem blockchain for the last four years. It offers a blockchain to develop social media apps, and the main front ends are peakd.com or hive.blog. The biggest gaming DApp, Splinterlands, moved to Hive; this has seen huge adoption in the platform. Hive has the same three cryptocurrencies of Steem, called here HIVE Token, Hive Dollar, and Hive Power. As in Steem, when a user creates new content, he/she needs to select how receive payment. The possibilities are dual: a user can receive 50% of the payment in Hive Token and 50% in Hive Dollar, or the entire amount in Hive Power. Not only was the content copied when Hive was proposed, but also all Steem accounts with a mirror of their STEEM, Steem dollar and Steem Power token balances were airdropped to the HIVE wallets.

The decentralized Hive fund (DHF) supports the creation of the Hive network and its ecosystem. The DHF is an on-chain decentralized autonomous system that allows users to submit proposals for funding and vote on which proposals should be funded.

Every day, the Hive blockchain mints new HIVE tokens and adds them to the 'rewards pool'. These tokens are then awarded to users for their social contributions. Content can be rewarded by posting and depending on the number of upvotes that a content receives. Moreover, it is possible to obtain a reward by voting and curating a post. Users who hold more tokens in their account as 'Hive Power' get to decide where a larger portion of the rewards pool is distributed.

To anticipate potential collusion and to protect against governance attacks on the network, the Hive DPoS algorithm was changed. Users can only vote with coins that have been stored in their accounts for more than thirty days.

4.4. EOSIO Blockchain

EOSIO is a next-generation blockchain, launched in 2017, considered one of the most important Ethereum alternatives. The aim of EOSIO is to be the fastest, cheapest and most scalable smart contract blockchains in the world. Indeed, it is designed as a P2P blockchain network, which uses optimized techniques for a particular execution environment. EOSIO, like other blockchains, has its cryptocurrency, called EOS, which can be used to send and receive funds, wallet to wallet.

The aim of EOSIO is to build a decentralized blockchain that can process fast and free transactions, and be a user-friendly and business-friendly tool for building DApps. Indeed, it provides smart contracts to be built on top of it. Furthermore, it provides a secure and scalable platform to run thousands of transactions every second.

Users can interact with the blockchain only after the creation of an account [20]. This unique identity can invoke a smart contract through a transaction, which consists of one or

more actions to perform. Indeed, smart contracts in EOS are defined by a combination of actions and action handlers, and actions represent the communication interface between contracts and accounts. Actions define atomic behaviors within a smart contract. When an account wants to invoke a contract, it must first delegate appropriate permissions, granting it the privilege to act on its behalf. EOSIO is based on the delegate proof of stake consensus algorithm (DPoS). Most of the EOSIO smart contracts are not open sourced and are typically compiled to WebAssembly (Wasm) bytecode, making it challenging to analyze and detect the presence of vulnerabilities [21].

Accounts are utilized like user profiles rather than a simple public/private key pair with cryptographic validation [22].

EOSIO block producers are highly centralized; users can only access the network using block producers as intermediaries. Block producers are a single point of failure for the entire system. All actions operate in an environment that lacks cryptographic validation of the contracts and transactions. Additionally, there is no economic incentive mechanism that is enforced to facilitate proper execution in the system. This interaction offers the services of a traditional computing environment with no cryptoeconomic system. In [22], the EOSIO system architecture is not defined as a blockchain, according to the traditional definition, but rather a non-autonomous homogeneous distributed database system. In [23], a range of serious misbehaviors are highlighted. In detail, EOSIO has a huge amount of bot-like accounts, permission misuse issues are overlooked by users, and finally, it suffers from suspicious attack accounts, causing over 1.5 million EOSIO losses. The EOSIO platform can be split into two layers: the core, which is open source and implemented in C++, and the system, which is implemented in smart contracts running on the core. The core provides the basic building blocks, which are (https://developers.eos.io/welcome/latest/protocol-guides/index, accessed on 1 September 2021):

- Consensus protocol.
- Transactions protocol.
- Peer to peer protocol.
- Accounts and permissions.

Core blockchain features, such as consensus, account creation, block producing, etc., are implemented inside smart contracts. These smart contracts are referred to as *system contracts*.

4.5. Klaytn Blockchain

Klaytn is a blockchain whose main goal is to enable reliability at the enterprise level. Klaytn uses both public and private blockchain technology in an innovative hybrid model. Public blockchains are used to keep data decentralized, and to facilitate distributed governance. Instead, private blockchains are used to improve scalability and reduce latency, in addition to securing sensitive data. The blockchain utilizes the practical Byzantine fault tolerance (PBFT), an enhanced version of an Instanbul BFT.

The Klaytn network has a transaction confirmation and block generation time of only one second. This means that the blockchain can process 4000 transactions per second. It also boasts a gas rate of almost 1/10 ETH.

Klaytn can be partitioned into three logical subnetworks based on their roles and purposes:

- Service chain network (SCN).
- Endpoint node network (ENN).
- Core cell network (CCN).

CCN consists of core cells (CCs) that verify and execute transactions submitted through the endpoint nodes (ENs). CCN is responsible for creating and propagating blocks throughout the network. ENN consists of endpoint nodes (ENs) that mainly create transactions, handle RPC API requests, and process data requests from service chains. SCNs are subnetworks composed of auxiliary blockchains independently operated by blockchain applications (BApps). Service chains are connected to the main chain via ENs.

The core cell network and endpoint node network form a Klaytn main chain, or mainnet. Klaytn has also multiple node types, where each serves a different purpose: consensus node (CN) decides blocks by running consensus; proxy node (PN) is able to protect CNs from adversarial attacks, such as DDoS; finally, endpoint node (EN) serves as an endpoint for the Klaytn network, handling RPC API requests and processing data sent to and from service chains. A core cell (CC) is composed of a single consensus node (CN) and two proxy nodes (PNs). EN nodes form a P2P network called endpoint node network (ENN).

An important aspect of Klaytn is the Governance Council (GC). GC is "an alliance of multinational businesses and organizations, responsible for operating the consensus node network and driving the ecosystem growth" (https://medium.com/klaytn/klaytn-governance-council-makerdao-37173c3668d3, accessed on 1 September 2021). Council members can vote on proposals to make changes to the platform, including the development of layer 2 solutions, transaction fee policies, and other structural adjustments. In particular, members of Klaytn GC are responsible for the operation of the Klaytn node network, ensuring consensus is reached for each transaction made on the Klaytn network. Indeed, instead of requiring all nodes to participate consensus, only a random subset of nodes is chosen to run consensus. These nodes are chosen among the GC and they are the consensus nodes, explained above. Nodes use the verifiable random function (VRF) to generate a random value that can be verified cryptographically. For every block generation, Klaytn picks a random number using VRF and identifies a group of nodes, called a committee, to run the consensus protocol. Currently, Klaytn handles more than 4000 transactions per second with only 50 GC nodes.

5. Comparison and Discussion

Considering the characteristics highlighted in the previous sections and summarized in Table 1, we want to highlight which technology could be considered a good choice in a social environment, such as Facebook. Principally, in a traditional blockchain network, every computer attempts to process every transaction, which can be very slow. The average confirmation time for a Bitcoin transaction is over ten minutes (https://www.statista.com/statistics/793539/bitcoin-transactionconfirmation-time/, accessed on 1 September 2021), and it takes an average of 15 s for a transaction to be verified on the public Ethereum blockchain (https://ethgasstation.info/blog/ethereum-transaction-how-long/, accessed on 1 September 2021). Our question is as follows: how can current blockchains be used in the case of Facebook, where over 50,000 Facebook 'Likes' happen every single second of the day? Every 'Like' is an individual data transaction that the system has to process. In order to be able to manage platforms such as Facebook, the main challenges to face in a social environment, and by taking into account our research question, are scalability and transaction fees. Scalability is the ability to allow more users to join the network while the chain grows in length. This is an ongoing issue with most blockchain models currently in use. A scalable blockchain solution needs to allow transactions to occur at a much higher speed. Another issue is the transaction fee on blockchain networks.

The five analyzed blockchains have different characteristics. Steem and Hive are born to be social, instead of the other three, which are general blockchain with the possibility to build a DApp. Ethereum is the most popular blockchain in terms of social DApps, as shown in Figure 2. The alternative is now represented by EOSIO. At the time of writing, Klaytn did not provide any important characteristics, which can be considered in a real social scenario. For this reason, in the rest of the section, we analyze Steem and Hive as examples of social blockchains, and consider Ethereum and EOSIO, by taking into account both the scalability and transaction fees challenges, which are the main challenges considered before, to be a good choice.

Table 1. Comparative analysis of the popular blockchain platforms.

Features	Steem	Ethereum	EOS	Hive	Klaytn
Type of Blockchain	Permissionless	Permissionless	Permissionless	Permissionless	Permissionless
Smart Contract	-	✓	✓	✓	✓
DAPP	✓	✓	✓	✓	✓
Languages	-	Solidity	Any	-	Solidity
Confirmation Time	60 min	1 min	1 sec	30 s	1 sec
Block Production Rate	3 sec	10–19 sec	0.5 sec	3 sec	1 sec
Fees	-	✓	-	-	✓
Consensus Algorithm	DPoS	PoW	DPoS	DPoS	PBFT

5.1. Steem vs. Hive

Steem and Hive are two examples of blockchain proposed to manage social applications. In March 2020, the decentralized content network Steem was acquired by TRON. The Steem community responded to the hostile takeover by launching Hive, a blockchain based on Steem code that aims to combat centralization. Steemit offers a Reddit-like service built on top of the Steem blockchain. As one of the largest DApps across all the blockchains, Steemit has over 1 million users. Some popular real-world use cases on Steem blockchain include a decentralized version of Youtube called DTube, an Instagram alternative called APPICS, and the fitness DApp Actifit. Hive was created as a copy of Steem, and it has no official leadership. Indeed, there are about 30 community developers and 80 contributors working on the project, and there is no company behind the project with a concrete idea of decentralization. This is one of the most important points which can highlight Hive as being better than Steem in terms of decentralization. Another important difference is the decentralized power that in Hive has been addressed with the introduction of the DHF, which allow users to suggest proposals, fund them, and vote for changes, unlike Steem. Both of them can be considered good alternatives to provide decentralized social apps; however, Hive can be considered a real decentralized social blockchain, while Steem is now nothing more than a centralized database, controlled by Justin Sun.

5.2. EOSIO vs. Ethereum

Both EOSIO and Ethereum are smart contract–based blockchains. This guarantees the possibility to develop social DApps. However, there are several differences between these two technologies, which can affect the choice of one over the other. The primary limitation of the Ethereum blockchain is that a collusion of 51% of miners could result in altering the structure of the Ethereum blockchain. Therefore, the Ethereum blockchain could only prove beneficial if participants trust that at least 51% of miners would not breach the immutability of the Ethereum blockchain. On the contrary, a permissioned blockchain reduces the possibility of external users to access EHRs or inspect information in it. Public blockchain platforms allow nodes to perform unfavorable network analysis. An attacker can easily analyze transactions on the public blockchain to infer users' actions. However, a permissioned blockchain is resilient to such analysis. Finally, storing large data directly in the blockchain would result in high storage and processing costs [24]. Thus, blockchain proves useful for access control for data stored entirely separate from the blockchain.

An important difference between EOSIO and Ethereum is the transaction cost. EOS is based on the ownership model, which means that a user is the owner of the resources which are provided, such as CPU, RAM, and NET bandwidth, and there is no need to pay fees. Instead, Ethereum operates on a rental resource mechanism, which implies that users should pay transaction fees to use the blockchain. Transactions require transaction fees, which must be paid using the Ether coin. Furthermore, Ethereum uses the PoW consensus algorithm, and this consumes a lot of electricity, which is not good for the social scenario, where there is a huge amount of social actions. The consensus mechanism used by EOS is the DPoS, and anyone with a certain number of coins can help verify transactions on the network. The chances of winning the reward depend on the number of coins. However, in

DPoS, one who holds coins cannot validate transactions but can vote on who should verify transactions, which is similar to democracy. In total, 21 block producers are responsible for the security of the network.

Finally, Ethereum is currently stuck at 15 transactions per second; instead, EOS is planning to guarantee millions of transactions per second.

An application like Facebook would be perfect for EOS if it can achieve these scalability goals.

5.3. BOSMs Requirements

Currently, the main blockchains used in social applications are both social blockchain (Steem and Hive), and general blockchain, such as Ethereum and EOSIO. It is clear that in that specific scenario, scalability is very important, as are the transaction fees. Nowadays, Ethereum is the most used, but this is probably related to the fact that Ethereum, as well as Bitcoin, is the one of the most well-known platforms, and it provided the smart contracts to be able to provide DApps. As described before, in a real scenario, such as Facebook, we could have a huge amount of social activity. This requires two important features in a BOSMs: scalability and no transaction fees. In particular, without scalability, a structure might fail to hold a massive amount of accounts. The characteristics of Ethereum are not well suited for a social environment, due to the block production time and the transactions fee. It is worthy to notice that new solutions were proposed and are currently included in Ethereum to reduce these two issues. For example, Arbitrum is a Layer 2 scaling solution that promises to handle many more transactions than Ethereum at lower costs. It processes transactions on a sidechain that uses optimistic rollups technology and then regularly settles them in batches to the main Ethereum blockchain. However, the technology, as is, is far from being a good solution for a social application. It is clear that a social blockchain, such as Steem or Hive, represents today the best solution, even if the current consensus protocol used by them, which is the DPoS, has problems concerning the control over the blockchain, as happened to Steem.

Platforms such as Facebook or YouTube are also easy to use. Instead, several DApps require knowledge about the blockchain as well as wallets in order to use them. The complexity of blockchain technology might pose a serious barrier to the adoption of BOSMs. In this direction, Steem and Hive are more user friendly than DApps built on top of Ethereum, which require installing plugins to interact with the wallet.

Another important goal to reach is to provide consensus protocols that can be feasible in a social scenario. Several consensus protocols have been proposed [25]. However, the analysis proposed in previous works described that DPoS, the most used consensus protocol used by social DApps, may not be a desirable approach for establishing highly decentralized social media platforms [12].

Finally, another important point is the reward strategy used to reward users in social media. The current reward strategies do not provide a good way to reward the user. Indeed, the economic impact affects the reward strategies, as described in [8,9,26], and they incentivize bot activity [27].

6. Conclusions and Future Works

Blockchain-based social media represent a good alternative to current OSNs. Users gain full control of their content and are rewarded in order to encourage engagement, participation, and, in particular, the production of valuable content.

Indeed, users make contributions, promote and monetize their content through tokens, and receive rewards for their contributions. This drives the social network's tokenized economy, creating more profit for business owners.

In this paper, we introduced BOSMs from the technical point of view by taking into account the issues concerning current blockchains and determining which properties are the most important ones for choosing a suitable blockchain. This work provides a study of the technical side of BOSMs, which was not investigated before. We described the most

used blockchain by analyzing the list of the DApps from the last two years, collected from the site www.stateofthedapps.com (accessed on 1 September 2021). We found that almost all the social DApps are based on Ethereum. Other important blockchains are Steem and Hive, which are born to be social; for this reason, they provide a set of social features that are not provided by other blockchains. The other blockchains used in this scenario are EOSIO and Klaytn, even if they are not so well investigated in the social environment. As suggested in this work, scalability and transaction fees are the most important points in choosing a blockchain. Furthermore, it is important to take into account the consensus algorithms. We compared the current blockchains used in social DApps in order to highlight their characteristics and how they could be improved to face the social requirements. We emphasize that all the current blockchains are not a good choice when we take into account the social scenario, such as Facebook or YouTube. However, Steem and Hive, which are social blockchains, are preferred, and EOSIO is a good alternative to Ethereum in a social environment. Furthermore, we provide an overview of current changes in blockchains, such as Ethereum, which can help to improve its application in a social scenario. We are planning to extend this analysis in different directions. First, we want to investigate new reward strategies based on the social scenario, and examine how the current reward strategies can be improved. Furthermore, we want to analyze other BOSMs, such as Yup, and new social blockchains.

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