Towards a Blockchain-enabled Crowdsourcing platform

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Crowdsourcing has been pursued as a way to leverage the power of the crowd for many different purposes in diverse sectors. Crowdsourcing aims at collecting information, aggregating funds and gathering employees to perform tasks of different sizes among other targets. Data Integrity and non-repudiation is of utmost importance in these systems and is currently not guaranteed. Blockchain technology has been proven to improve on these aspects. In this article, we investigate the benefits that the adoption of blockchain technology can bring in crowdsourcing systems. To this end, we provide examples of real-life crowdsourcing use cases and explore the benefits of using blockchain, mainly as a database.

Crowdsourcing has gained a lot of attention, since it was first defined in 2006 by Howe [1], taking advantage of the developments in communications, the Social Media and the Internet. Originally considered as the combination of the words *crowd* and *outsourcing*, it was perceived as a process where a person or company managed to extend their expertise by using services, knowledge or goods provided by a group of Internet users. To enable the announcement of the requests for tasks by possible employers and their matching with expertise offered by possible targeted employees (claiming a certain fee), various Internet-based platforms have been created. Those platforms were, mainly, centralised systems where both the employer and the employee

have to connect to a server to access the provided service. Later, decentralised approaches were developed, as an effort to address the drawbacks of the existing platforms. The main problem was that attacks on the server could destabilize the system, allowing the attackers to gain access not only to the personal data of the registered users, but also to the work that has been delivered as part of the agreements that were reached through the platform. Unfortunately, the decentralised solutions still followed a client-server architecture that exposed their vulnerabilities.

In this paper, we are studying the improvements that the adoption of the Blockchain technology and concepts can bring to the crowdsourcing solutions from the security perspective. Blockchain uses a digital Distributed Ledger Technology (DLT), where no central authority is present, which is shared amongst all the nodes of the network (i.e., Peer-to-Peer networks are supported). In this ledger, transactions between peers can be found that either follow certain agreed rules (i.e., smart contracts) or have been approved as legit by the majority of the network nodes (i.e., consensus between peers). When a transaction is inserted it cannot be deleted or erased. The application of a blockchain enabled crowdsourcing system in real life use cases, which will also be pursued in the framework of the H2020 EUNOMIA project, will be presented and discussed.

The rest of the paper is organised as follows: a description of the centralised and decentralised crowdsourcing platforms will take place next, followed by a description of known attacks that have been attempted against them. Then, the role of the Blockchain in the crowdsourcing systems will be discussed, followed by the use cases that demonstrate the increased system performance that can be expected from a Blockchain-enabled crowdsourcing system is described. Finally, conclusions summarize this work.

CROWDSOURCING SYSTEMS' OPERATION

The traditional crowdsourcing model follows a centralised structure, with "centralized" mostly referring to the task handling process which is an imperative part of the overall crowdsourcing system (and not to its communication structure). Centralised crowdsourcing models inherit the advantage of simplicity in both developing an application and managing the system. Many crowdsourcing platforms have been developed that adopt a centralised architecture the most interesting of them being: Upwork [2], Amazon's Mechanical Turk [3] and Waze Carpool [4], that will be briefly presented here.

Upwork is a platform where numerous projects are posted by people who seek to hire freelancers in order to complete the project's requirements. When an employer hires the freelancer, the platform provides the necessary tools for their communication and the payment. The application uses the data provided by the candidate in order to find the most suitable projects. A similar centralised approach is also adopted by Amazon Mechanical Turk (MTurk), while the Waze Carpool is a crowdsourcing navigation platform with a quite different purpose. It receives the data regarding the traffic and the road conditions as those have been provided by the drivers. This application aims to inform about the traffic by establishing a real time network among drivers. It is a community-oriented solution that is based on the logic that nothing can beat real people working together.

However, any centralised solution comes with the Single Point of Failure (SPOF) vulnerability, with Single Point being the central authority or operator of the platform in the crowdsourcing paradigm, since attacking them the service becomes unavailable. Crowdsourcing applications have attracted attacks, since they contain valuable information generated by the crowd (as will be discussed next).

In the effort to continuously evolve and improve crowdsourcing solutions, there have been various attempts to create decentralised crowdsourcing systems, mainly to address the previously described SPOF problem. In Figure 1, the main differences between a centralised and a decentralised system are illustrated. In fact, task offloading, along with handling, are the most important procedures in a decentralised crowdsourcing system, due to the randomness that may characterize the mobility of users in a network and which, if not addressed properly, will bring great delays in the successful completion of the tasks. Some solutions to address these issues are

presented in [5-6]. In each of these papers, researchers and specialists propose specific algorithms and protocols aiming for faster and fairly task dissemination between nodes. These algorithms are designed so that the nodes can share the workload of any given task, considering the availability of each node. For instance, it has been proven that social relationship data can be exploited by crowdsourcing systems for mobile users and increase efficiency in terms of task completion time [5].

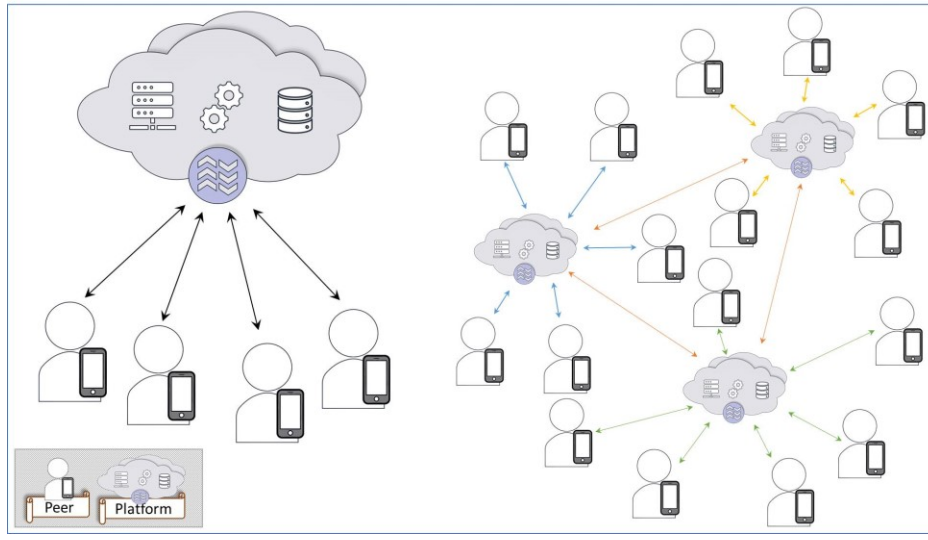

Figure 1: Centralised vs Decentralised Crowdsourcing Systems

However, almost all these models that have been proposed for implementing a decentralised crowdsourcing system rely on one or more central services that all peers have access to (e,g., social network platform). Those peers can retrieve data provided by the central services to optimize their algorithms and improve the system's efficiency and performance. To this end, the described decentralised crowdsourcing applications may share vulnerabilities with the centralised system.

CROWDSOURCING SYSTEM ATTACKS

In the last few years, Crowdsourcing systems have been victim to a number of cyber-attacks, most of which aimed to compromise and steal data or render systems unavailable. For example, in March 2014 the freelancer platform *Elance* experienced a Distributed Denial-of-Service (DDoS) attack [7] which kept the systems unavailable for more than a day. More precisely, attackers employed the use of a Network Time Protocol (NTP) reflection attack. Another large-scale cyber-attack against a well-known crowdsourcing system happened in October 2016 affecting *UBER*. According to Bloomberg [8], hackers were able to steal personal data by gaining access to *Uber*'s private Github account which contained developers' credentials for their Amazon Web Services platform. This ultimately provide access to *Uber*'s AWS databases containing driver's personal data.

Furthermore, free-riding (e.g., benefiting from crowd-sourced task output without having contributed to its production) and false-reporting (e.g., to avoid the payment the employer lies regarding the task's status) are common attacks on crowdsourcing platforms, therefore, the need to propose and apply countermeasures is of great importance for maintaining the data integrity and utility of crowdsource platforms. For example, the use of EFF (Eliminating Free-riding and False-Reporting with arbitration) and DFF (Discouraging Free-riding and False-Reporting with arbitration) auction-based mechanisms and the development of reputation protocols in those untrusted environments are solutions able to prevent these problems [9]. The EFF and the DFF are based on any existing truthful double auction scheme for winner selection and pricing. The

auction winner is required to deposit a warranty and then submit a report regarding the status of the corresponding task. The payment is determined by the platform and is based on these reports.

Finally, the crowdsourcing platforms should perform regularly security assessments regarding their status. These assessments should be carried on by experienced security officers who will, at the end of the process, provide a report that highlights the vulnerable points of the system. To this end, the platform should apply the best practices regarding the storage of sensitive information (i.e. encryption) and should be GDPR compliant.

BLOCKCHAIN AND CROWDSOURCING

Blockchain technology can efficiently address the weaknesses of crowdsourcing systems, this way boosting their attractiveness to solve several problems and widening their application potential. A blockchain database retains the complete, indelible and immutable history of all transactions, assets, and instructions executed since the very first one. With this, blockchain allows participating parties—and only those parties—to share accessible, transparent, and trusted information. The main characteristics to remember are: a) decentralised and distributed ledger storage and integrity, b) the ledger is irreversible and immutable, c) its operation is near real time (i.e. transactions verified and settled in minutes vs. days) and in any case satisfies the speed requirements of crowdsourcing which are significantly looser than those of the financial sector initially targeted by blockchain and d) it respects privacy (no personal data need to be registered). Users are identified by digital identities (exactly as credit cards) and only when physical world personal data are linked to those digital identities, is the linkage in place.

Blockchain technology can decrease the service fees demanded by centralised crowdsourcing systems while at the same time overcoming the problem of SPOF, due to the adoption of the distributed ledger maintenance as explained in 1. Adopting blockchain technology, the ledger of all transactions can be kept in a set of nodes (belonging either to workers or to requesters) obviating the need for a central authority/entity. The node resources are thus contributed by the peers that benefit from the platform and a small reward is granted to them. Such a system is proposed in 1, where the system (entitled *CrowdBC*) is organised into three layers: the application layer, the blockchain layer and the storage layer. The blockchain layer is where the attributes of a transaction are kept (i.e. the ledger) while the storage layer includes the details and the content of the work produced by the workers. The application layer implements the business logic which, in the considered use case, is the user manager, the task manager and the program compiler. An important element of the *CrowdBC* is the use of smart contracts which follow the concept of smart contracts defined in *Ethereum*, [12]. The smart contract is a self-executing digital contract in a secure environment with no intervention, which is verified through network peers. In crowdsourcing systems, the smart contract can describe the request-worker relationship (where the task ID, the task owner, the relevant deposit and task status are kept). Another equally important advantage of CrowdBC is the fact that there is no “central” authority to judge the quality of the work of a worker and this functionality is done in a distributed way, which results in building the worker trust model.

With respect to crowdsourcing, targeting information collection for different purposes ranging from facts (as e.g. Waze Carpool), opinions on events, products and solutions to collection of pieces of evidence and verdicts, blockchain makes possible the involvement of a larger number of people, which increases the quality of the data and thus of the offered service. Blockchain has been proposed for judgement produce to increase the quality of justice in [123].

Blockchain technology is also leveraged to improve other crowd-sourcing cases, like crowdfunding. Equity crowdfunding is considered a new channel of raising money for start-ups encouraging innovation and the adoption of blockchain based solutions has important advantages as reported in 14: 1) Blockchain technology represents a secure, efficient, low-cost solution for the registration of stocks and shares of a firm financed by crowdfunding; 2) it significantly simplifies the transaction and transfer of crowdfunding equities, 3) it supports peer to peer transactions between investors and entrepreneurs, and solves the problems of regulatory compliance and se-

curity of fund management; 4) it can be used to develop a voting system for crowd funders, which enables them to be involved in corporate governance. It is also considered that it helps regulators know about market conditions and supports regulatory activities such as managing investors and fighting money laundering.

POTENTIAL USE CASES OF BLOCKCHAIN-ENABLED CROWD SOURCING SYSTEMS

As we have seen in the previous section, the crowd sourcing Blockchain-enabled systems, until now, have been mainly comprised of approaches that include the creation of a platform for advertising crowd-working tasks that initiate partnerships between possible "workers" and employers.

In this section, we describe novel real-life use cases where a different approach in the form of a decentralised Peer-to-Peer (P2P) network is adopted. The proposed blockchain-based system could provide access to information on registered users to local news, along with the reputation scores of their publishers, allowing the combination of those information in order to deliver a decision about the truthfulness of a specific story. This way, the result could match the performance of the traditional method (i.e., using specific topic experts to validate a story) in a quicker and efficient process. We assume that the posts from Social Networks (SNs) and the users of the P2P network are used as crowdsourcing input data and are stored in a Blockchain to ensure information integrity and traceability. The users have access to the Blockchain and the information and (meta)data that are covered within, while a trustworthiness scoring system, is proposed in order to provide a validation regarding the integrity and veracity of the stored data.

Three different real-life use-case scenarios are considered: i) Fake news detection, ii) Organization of traditional media, and iii) Access to user's personal information through SNs. In the remaining of this section those use case scenarios will be presented, emphasising the benefits stemming from the adoption of blockchain concepts, as illustrated in Figure 2.

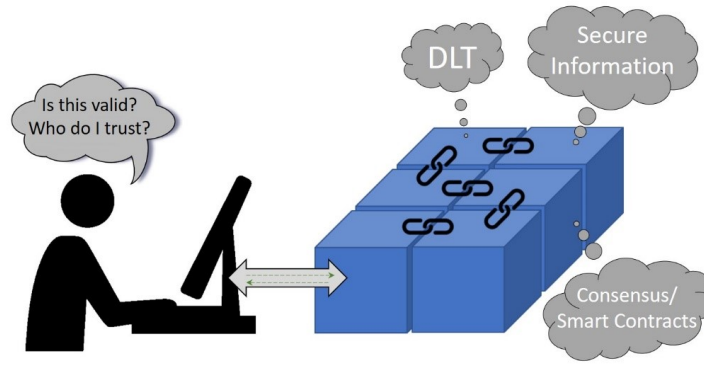

Figure 2: Blockchain - Enabled Crowdsourcing Systems

For the first use case, John, a social journalist in one of the most influential modern web sites is considered. As part of his work, he is supposed to check out on SN platforms (as *Mastodon* [15]) for stories related to a specific issue (e.g., the latest news about a soccer team). Consider the scenario where a certain story is presented in *Mastodon*, with multiple comments on it, regarding breaking news about a potential injury of one of the star players of the team. Trying to identify the truthfulness of the story, John is unable to find any other confirmation about it and, therefore,

has to decide whether he should spread it only based on the noticed number of comments (called *toots* in *Mastodon*). Since the number of comments is not a reliable measure to describe a source as reliable, a more efficient one is needed. Consulting a trustworthiness scoring system that will be developed for this reason, the journalist would be able to judge more efficiently on whether the source is reliable and the story is to be published by her website or not. He would, also, be able to check in the specific Blockchain application on whether the related news have been published elsewhere, along with the rating of those users that have published it. This way, data would be gathered from various sources to prevent the aforementioned journalist from making (or rushing into) the wrong decision.

In the second case, traditional journalism dictates the use of subject experts and domain-specific journalists to check for the veracity of a story before this is published by the media. Those experts could use their experience and sources to check whether a story is true or biased and, therefore, prevent the publishing of articles that could harm the reputation of the media. But, since consulting an experienced person is often a time-consuming process, there is a need in modern internet-based journalism to search for validation and confirmation about a story quickly and efficiently. Therefore, a database (or system) that could be used as a source for confirmation would be highly appreciated. To this end, the proposed Blockchain database would be of great help to a journalist that needs confirmation regarding the news about an incident that takes place in the capital city of a foreign country.

The final use case regards the way that a blockchain enabled crowdsourcing storage could prevent users from actions that could, even, prove malicious to their health. In this use case, the collection of user data from SN applications is studied and a way to protect from the targeted prioritization of the news by the SN is suggested. In this scenario, a student, Lucy, is using *Mastodon*, a social platform that offers instances (or groups) where people with similar interests could exchange ideas and experiences. Especially, Lucy is following an instance regarding studying art and, often, posts and discusses her problems and struggles at keeping up with her studies at the local University. One day, entering her account, Lucy finds a thread on her timeline regarding the use of a legal “smart” drug that will allow her to enhance her performance and, therefore, be able to meet up with the strict schedule of the University. Even though no scientific basis is provided regarding the performance of the drug and its effect on the user’s health is not described, the narrative is very persuading and seems to match her needs. By using the blockchain data storage, Lucy could be able to search further and read reports by people that have already used the drug to find whether it is efficient and healthy to use it. Considering, also, the reputation scoring of the reporting users, Lucy would be able to reach the right decision regarding the use or not of the suggested drug, without hesitation about making the right call.

CONCLUSIONS

Blockchain’s specific inherent characteristics, such as enhanced integrity and tamper proof operation (mainly attributed to the maintenance of the “ledger” in a distributed manner) are studied here, on how they can increase the performance of a novel crowd-sourcing platform. Especially, the use cases of EUNOMIA are presented, where the creation of a P2P network with reputation mechanisms between the peers manages, by using Blockchain as a database, to enhance the performance of the system and to meet the requirements of modern professionals (e.g., social journalist). The described scenarios are indicative on the many aspects of a human’s life that can be affected and improved with the use of a Blockchain and how crowd-sourcing data can be efficiently used in this direction.

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