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Blockchain technology and its applications in mining industry

Blockchain technology is basically a digital ledger in the cloud which is distributed and decentralised. Blockchain is getting popularity in different industries these days because of its specific applicability features like data integrity, security, fast, transparency etc. There will not be any third party organisation intervention for control of the transactions within it. Therefore it creates interesting and vast research areas, especially from the perspective of technical challenges, expectations and limitations. These days blockchain is having wide range of applications in various industries and mining industry is no where exception to that. Many leading mining companies started implementing this technology into their operations and major application areas are fixing up smart contracts, compliance issues, addressing sustainability etc. It has got tremendous potential to fundamentally change the way the mining industry and connected supply chains operate.

Keywords: *Blockchain, smart contracts, sustainability.*

1. Introduction

Today's mining industry has been struggling with process complexities and associated risk involvements which put pressure on bottom line results. Minimising the risk of data corruption due to change of custody, complex accounting and settlement processes, proving the provenance of minerals mined, providing visibility across the value chain, and difficulties with reconciling the ore extracted in a mine with the amount transferred to processing plants are few of the challenges facing in the mining industry. In order to mitigate those challenges many leading mining companies have been exploring to adopt suitable technologies. Blockchain is one such technology which is gaining popularity now in various industries.

A blockchain is a distributed database of records that contains all transactions that have been executed and shared among participating parties in the network. This distributed databased is called distributed ledger. Each transaction is stored in the distributed ledger and must be verified by consent of the majority of participants in the network. Blockchain technology provides an efficient way of recording transactions or any digital interaction in a way that makes it secure, transparent, highly resistant to outages, auditable. This technology is still new and changing very fast; adopting it in the commercial market is still a few years off. However, decision-makers across industries and business functions are paying their attention now and start to investigate applications of this technology to avoid disruptive surprises or missed opportunities. The aim of blockchain technology is to create a decentralized platform where no third party can control of the transactions and data. The information about every transaction is stored in blockchain is shared and available to all nodes. This attribute makes the system more transparent more than centralized transactions involving a third party. In addition, the nodes in block chain are all confidential, which makes it more secure for other nodes to confirm the transactions.

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2. Blockchain

Blockchain is a type of distributed ledger which contains information about transactions or events. It is replicated and shared among the participants in the network. There are two types of networks exist presently at all the industries for the control of their transactions and operations like centralized and decentralized out of which centralized network is generally preferred over the other type (Figs.1 and 2). However this blockchain technology is based upon decentralized network. The size of chain unceasingly increases since blocks are

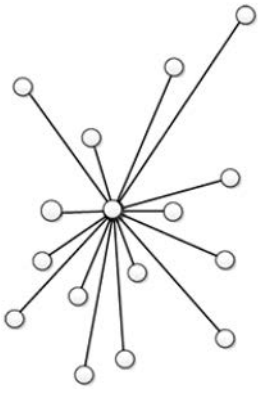

Fig.1 Centralized network

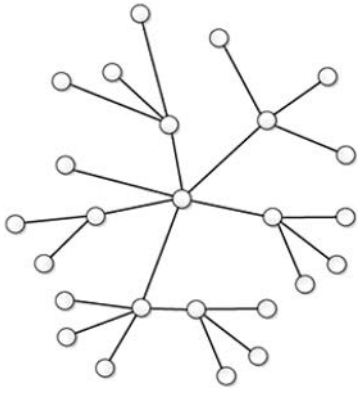

Fig.2 Decentralized network

added and chained to the previous block using a hash function. The ledger in the blockchain is validated and preserved by a network node (user) in pursuance of consensus mechanism a collection of rules that allow users to reach a mutual agreement thereby a central authority or intermediary is not required. Each node keeps a complete replica of the entire ledger.

A blockchain consists of two main elements (Fig.3):

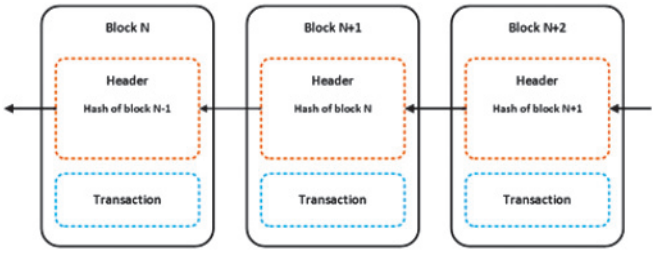

Fig.3 A chain of blocks - blockchain

- Transactions: These are the actions generated by the participants in the system.
- Blocks: To record the transactions and make sure they are in the correct sequence and have not been tampered with.

2.1 Characteristics of blockchain

The blockchain has many features that make it very attractive for the utility in various industries (Fig.4).

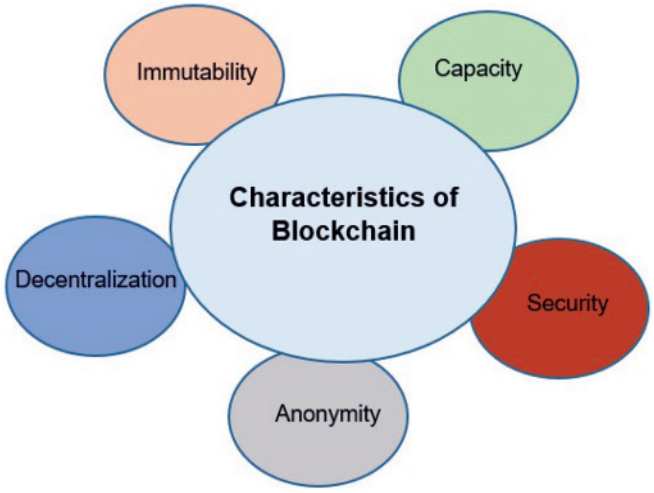

Fig.4 Characteristics of blockchain

1. Immutability: Once a record is added to blockchain and verified through consensus, there is no way I can be altered. It becomes unalterable part of blockchain. To say there is one truth which everyone refers to. There can be more records added post that but existing records stay there forever. Building immutable ledgers is one of the key values of blockchain. All centralized databases can be corrupted and commonly requires trust in a third party to keep the information integrity. Once you have agreed on a transaction and recorded it, it can never be changed.
2. Decentralization: The lack of centralized control ensures scalability and robustness by using resources of all participating nodes and eliminating many-to-one traffic flows, which in turn decreases latency and solve the problem of single point of failure that exists in the centralized model.
3. Anonymity: The anonymity provides an efficient way of hiding the identity of users and keeps their identities private.
4. Better security: Blockchain provides better security because there is no single point of failure to shutdown the entire network.
5. Increased capacity: One of the significant things about blockchain technology is that it can increase the capacity of an entire network. Having thousand so few computers working together as a whole can have greater power than a few centralized servers.

2.2 How blockchain works?

Blockchain is a distributed database solution that maintains a rapid growing list of information and data records that are confirmed by the nodes participating in it. The data is recorded in a public ledger, including information of every transaction ever completed. Although the blockchain is still new and in experimenting stage, it is being perceived as a revolutionary solution that addresses modern technology issues such as decentralization, identity, trust, data ownership and data-driven decisions. The blockchain is generally a database that stores all the transactions in blocks. When a new transaction is created, the sender broadcasts it to the peer-to-peercommunication channel to all other nodes in the network. The transaction is still new and not verified. When the nodes receive the transaction, they validate it and keep it in their ledger.

Transaction validation is performed by running predefined checks on the structure and the actions of the transaction. Special node types called miners create a new block and include all or some of the available transactions from their transaction pool. Then the block is mined, which is a process of finding the proof of work using variable data from the new block's header. Finding the proof of work is the continuous calculation of a cryptographic hash that fits the defined difficulty target. Mining requires a lot of processing power and the miners use a dedicated mining hardware. The miner that first finds a solution for its block is the winner. His candidate block becomes the new block in the chain. Because transactions are added in the mining block as they arrive, therefore, the latest block in the blockchain contains the latest transactions. When a new block is created, it is time-stamped and propagated to all network nodes. Every node receives the block, validates it, validates the transactions, and adds the block to his ledger. When the majority of nodes accepted the block, it becomes authorized and non-reversible part of the blockchain. In addition to transactions, every block stores

some meta data and the hash value of the previous block. So, every block has a pointer to its parent block. That is how the blocks are linked, creating a chain of blocks called blockchain.

The distributed ledger is available for every one in the network to check the blocks and the transactions within. However, the users stay anonymous, they only identified by their public key as an address. Moreover, the transactions are encrypted. Invalid transactions are rejected and are not included in the blocks. Malicious attempt to make a change in the transactions will require repeated calculation of the proof of work for the attached block and all the blocks afterwards. These calculations are in feasible unless the majority of the nodes in the network are malicious.

3. Application of blockchain in mining

Blockchain is getting popularity in different industries these days because of its specific applicability features like data integrity, security, fast, transparency etc. There will not be any third party organisation intervention for control of the transactions within it. Therefore it creates interesting and vast research areas, especially from the perspective of technical challenges, expectations and limitations. These days blockchain is having wide range of applications in various industries and mining industry is no where exception to that. Many leading mining companies started implementing this technology into their operations.

3.1 Smart contracts

A smart contract is a computer programme or protocol running on top of a blockchain containing a set of rules under which the parties to that smart contract agree to interact with each other. If and when the pre-defined rules are met, the agreement is automatically enforced. The smart contract code facilitates, verifies, and enforces the negotiation or performance of an agreement or transaction. It is the simplest form of decentralized automation. It is a mechanism involving digital assets and two or more parties, where some or all of the parties deposit assets into the smart contract and the assets automatically get redistributed among those parties according to a formula based on certain data, which is not known at the time of contract initiation.

Smart contracts radically reduce transaction costs. Auto enforceable code whether on the protocol level or on the application level standardizes transaction rules, thus reducing the transaction costs of reaching an agreement, formalization and its enforcement. Smart contracts are capable of tracking performance in real time and can bring tremendous cost savings. Compliance and controlling happen on the fly. These contracts are self-verifying, self-executing and tamper resistant.

Smart contracts have following characteristics:

- Turn legal obligations into automated processes.
- Guarantee a greater degree of security.
- Reduce reliance on trusted intermediaries.
- Lower transaction costs.

Mining companies are not willing to give up control of their contracting or procurement process lightly, because disclosure of sensitive commercial terms. Blockchain technology has the potential to fundamentally change the way the mining industry and connected supply chains operate. Blockchain is an immutable and cryptographically secure archive of records stored on a distributed ledger, which uses smart contracts built on the Ethereum platform. The technology facilitates stakeholders connected on a chain to securely exchange critical trade documents, such as bills of lading and letters of credit, via the use of smart contracts. The benefits of blockchain technology link perfectly to the commercial and operational aspects of mining, metals and other industries in the broader value chain such as shipping. The benefits of the smart contracts can only be realised if one of the market leaders adopts the technology and forces others to react, and the R&D spend on deploying such technology is significant. The potential for blockchain and smart contracts in the mining and metals global supply chain is immense and its adoption is inevitable. Mining which by its nature is already truly global, characterised by global trading hubs, relatively homogenous global trading norms and a strong ethos of adoption of automation in the search for productivity (e.g., driverless trucks and trains) considered as largely revolutionary. The initial applications for blockchain-based platforms were focused on precious metals and global trading exchanges. The potential that blockchain offers in terms of traceability means the incorporation in supply chains is almost inevitable.

3.2 Sustainability

Blockchainis also used to develop comprehensive end to end tracking of ores and minerals. The process requires sealed bags or containers of concentrates and ore to be stamped with a unique identifying ID that will subsequently be logged on the blockchain. The ID will contain information on the quality and quantity of each parcel of ore or concentrate, as well as being continually updated with an ongoing timeline tracking and logging movements. The initial applications of this are twofold; first, it will provide clients with peace of mind when transporting high value minerals, and second; it will help confirm that the minerals being purchased are from compliant and conflict-free regions. However, the risk that concentrates and ores could be mixed with materials of undetermined origin prior to being sealed in a bag and assigned an ID remains a possibility.

Blockchain's role in sustainable and transparent supply chains could be a game-changer, thanks to its ability to promote trackability, transparency and security through open, peer-to-peer and incorruptible data sharing. Blockchains might be the gateway to a new era offering the tools to monitor and confirm compliance with sustainability and

environmental and ethical standards.

3.3 Mining supply chain

Mining equipment OEM sources parts from various vendors, and work together in a high performance environment. In case of critical failure situations, in a standard supply chain model, the OEM is the only one aware of the different vendors. A mining maintenance department attempting to look into part failure history could put a request through the OEMs. The blockchain attached to the relevant part for the OEM contract, could give the authorization to view the relevant data on the part. Both the client and the OEM can work together, and the end customer is assured of the quality of the parts and systems used. With blockchain it becomes easier to identify which part was sourced from which vendor. Followings are the few application areas of blockchain:

- Blockchain can also provide transparency to JV partners. Most mining companies have fragmented value chain with transactions spread across multiple parties.
- Blockchain could lead to the automation of invoice reconciliation. Ore is assigned a quality certificate and the customer sends it for lab testing for reassurance. There may/may not be a dispute over the ore quality and price. This whole process can leverage Blockchain technology with the three parties involved like miner, customer and the arbitrator.

By recording information flows throughout both the mining and commercial functions on a blockchain platform, mining and metals sector participants, from producer to end user, will be able to track title, as well as technical, environmental, social and regulatory attributes, through their global supply chains, from first shovel to final refined product. This will enable identification of the drivers to value creation (including quality and efficiency of production) and recoding all transactions in a consolidated and accessible form. For example, digitising individual mined parcels of ore as assets that can be traded on a blockchain platform could open new investing and trading opportunities by enabling individuals to participate in previously closed negotiations, and tailor their purchases to the precise product grades that are currently available in the market.

Empowering miners to trade more directly with customers has potentially profound implications for trading houses, although so far the various digital platforms do not seem to have had major impacts on the role of the trading houses in the global supply chain. Online trading platforms such as Trade Cloud already exist, but these are largely limited to spot trades and, at present, a producer would likely not risk tying up substantial long-term offtake on an unproven platform or with an unknown counterpart. Mining and metals companies are already following the lead of manufacturing and industrial giants such as Unilever, Nestlé and Dole in tracking products. BHP Billiton is already using blockchain with its vendors, including recording movements of wellbore rock and fluid samples and securing real-time data generated during production, De Beers is using this technology to track diamonds, and Barrick has committed to invest US$75 million in 2018 in digital systems that aim to reduce operating costs and increase productivity.

3.4 Faster transactions and broad adoptability

The synchronised nature of blockchain will allow ecosystem participants to be notified of trade developments at the same time. This will result in swifter consensus on additional trade terms, such as a shipment schedule, between parties. In addition, the exact nature of information logged on the blockchain, combined with synchronicity, should reduce the number of disputes and make their resolution more straightforward.

Blockchain solutions are applicable to all stakeholders connected to the broader value chain, from financial institutions and ship operators to surveying laboratories, warehouses and many others. It is hoped this will drive innovation and compliance beyond mining and smelting and into connected industries that might otherwise have lacked the resources to develop technology to address these needs.

4. Conclusion

Blockchainhas got potential application areas in mining industry. Mining companies are struggling to remain globally competitive through the increasing adoption of technological solutions into their operations over the coming years. Blockchain being a decentralised, secure and automated digital ledger, it has been touted as being able to improve various aspects of mining operations, including smart contracts, sustainability, mining supply chain, cyber and physical asset security. However, the technology’s biggest growth potential lies in its ability to help miners improve transparency across mineral supply chains, an increasingly important consideration as the industry becomes more consumer-conscious.

Blockchain has been receiving increasing interest as the mining operations become more digitalised and thus more vulnerable to hacking. Blockchain also offers the potential for mining companies to improve their physical asset risk exposure. Blockchain technology could be used to identify an existing orebody and subdivide it into cubic metre segments, which would be verified by a trusted on-the-ground third party and recorded or “tokenised” into the blockchain. At this point, the blockchain could link to a physical tag that would detect if an orebody is tampered with, thus providing an efficient safeguard against illegal mining activity for mining companies operating in less regulated markets.

5. Reference

1. Stanciu, A. (2017): "Blockchain based distributed control system for Edge Computing," in 21st International Conference on Control Systems and Computer Science Blockchain, pp. 667–671.
2. Nakamoto, S. (2008): "Bitcoin: A Peer-to-Peer Electronic Cash System," www.bitcoin.org, p.9.
3. A. Dorri, A., Kanhere, S.S., and Jurdak, R. (2016): "Blockchain in internet of things: Challenges and Solutions," arXiv1608.05187[cs], no. August.
4. Gupta, N., Jha, A. and Roy, P. (2016): "Adopting Blockchain Technology for Electronic Health Record Interoperability."
5. Kshetri, Nir. (2017): "Can blockchain Strengthen the Internet of Things?," IEEE Computer Society, no. August, pp. 68-72.
6. Christidis K. and Member, G. S. (2016): "Blockchains and Smart Contracts for the Internet of Things," IEEE Access, vol. 4, pp. 2292-2303.
7. Conoscenti, M., Vetro, A., and Martin De, J. C.(2016): "Blockchain for the Internet of Things: A systematic literature review," 2016 IEEE/ACS 13th Int. Conf. Comput. Syst. Appl., pp. 1-6.
8. Vandervort D.(2014): Challenges and Opportunities Associated with a Bitcoin-Based Transaction Rating System. In: Bhme R, Brenner M, Moore T, Smith M, editors. Financial Cryptography and Data Security.vol. 8438 of Lecture Notes in Computer Science.Springer Berlin Heidelberg; pp. 33–42.
9. Crosby, M., Pattanayak,P., Verma,S. and Kalyanaraman, V. (2016): "Blockchain technology: Beyond bitcoin," Applied Innovation, vol.2, pp.6-10.
10. Kosba, A., Miller, A., Shi, E., Wen, Z. and Papamanthou, C. (2016): "Hawk: The blockchain model of cryptography and privacy-preserving smart contracts," in Proceedings of IEEE Symposium on Security and Privacy(SP), San Jose, CA, USA, pp. 839-858.
11. Sharples, M. and Domingue, J. (2015): "The blockchain and kudos: A distributed system for educational record, reputation and reward," in Proceedings of11th European Conference on Technology Enhanced Learning (EC-TEL2015), Lyon, France, pp. 490-496.