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Research Article

A Survey of Blockchain and E-governance applications: Security and Privacy issues

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Abstract

In a world full of e-services that provide speed of implementation and comfort to customers and users and provide high-luxury features, whether in the world of stock's trading or e-government systems or others. However, any system can suffer from serious challenges such as security and privacy issues, so the existing infrastructure of e-Governance paves the way for a powerful underlying technology. Using Blockchain technology is a strong option to secure platforms and services. Therefore, a new framework that integrates Blockchain into any platform is proposed, especially in Saudi Arabia. This paper surveys research related to Blockchain technology and developments of its witch cut across both public and private sectors. The adoption and integration of e-governance is linked as a key point towards smart applications in the smart environment is discussed. For the improvement and development of any country, there is a need to connect technology-based services and products. These are the main points of an intelligent environment with e-governance in any area. This work refers to these views of e-governance and online services.

Key words: Blockchain, Internet of Things, E-governance, Security, Privacy, Smart contract.

1. INTRODUCTION

E-governance mentions to the use of technologies based on information and communication to integrate government with public services for the citizens. The goals and objectives of e-governance are to supply citizens with more accurately perceived services to achieve the general social and economic leverage with high performance and the capabilities available in the main escalating points. Since Bitcoin first appeared in 2009, its underlying technology, Blockchain, has displayed bright application potentials and has attracted a great of attractiveness from academia to industry. Blockchain methodologies have sprung up countless other applications since then and have been adopted successfully in various fields, even if the financial industry is seen as a direct beneficiary of the Blockchain. Blockchain has the characteristics of security, decentralized, transparency, traceability, immutability, distributed ledgers, transparent log, and irreversible data storage[1]. The Blockchain depends on an ordered list of nodes where nodes store the information and joined through links to each other called chains. Explore the role of Blockchain in the sustainability and powerfulness of electronic services[2] and especially e-governance systems, without storing data in any central unit.

Often, e-governance transactions are centralized and completely linked to one huge database that uses Client-Server. Here, the server holds all the information required in one domain so it is simple to control and update by decision-maker such as "Absher"[3]. Absher is a system developed by the Saudi Ministry of Interior for Saudi citizens and residents to conduct their transactions with no departments. The government of the Kingdom of Saudi Arabia attaches great importance to the concept of e-government and the transformative procedure involved in its implementation. The Saudi government believes in the tremendous benefits of the e-government project on the national economy, the main objectives as shown in Figure 1.

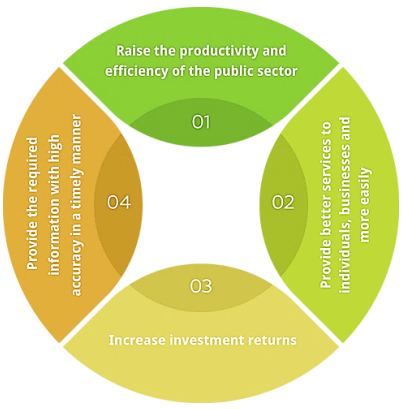


Figure 1. The e-governmental objectives of Saudi Arabia program.

Oppositely, every participant within the distributed Blockchain network records, confirms and updates new data with no central node or governing authority. Systems need to be trust to be confidently available to users and perform all their services over the internet as well as requires trusted third parties. Even so, they have many difficulties that contain but are not limited that these make a bottleneck on the server which affects the system and it may crash. Other e-governance services explored Blockchain technology to provide secure and transparency transactions or any exchange of value whether it is money, gold, information, legal document or data. A 'Smart Dubai' aims specifically focus and leverage on all emerging technologies in order to be able to allow government operations, government departments, and government structures to convert around 50 percent of their transactions in the Blockchain platform. This survey studies a current problems and highlights to promising solutions for a Blockchain revolution technology. The Blockchain was premier presented by Nakamodo as a ledger of Bitcoin, which was the premier distributed digital funds, so close to the ancient American coin.

The main areas and sectors of e-government include the following:

A Government to:

- A Citizen (G2C).
- A Government (G2G).
- An Employees (G2E).
- A Business (G2B).

These are the main delivery channels for citizens and general applications. The e-government model is having various aspects of interpretation and fortification towards huge points such as e-government services, business aspects and internal organizations[4].

The last of this survey is prepared in the following:

Section II, discusses some background knowledge about the various Blockchain types, structures, frameworks and the characteristics for Blockchain then Blockchain applications present in section III.

Section IV surveys Blockchain restrictions and some available promising solutions for Blockchain challenges techniques.

Section V the current and future situation of Saudi Arabia Blockchain case study for e-governance techniques.

Finally, section VI concludes the study and suggests future research directions in e-governance research techniques.

2. Background

2.1 Blockchain Structure

In a block, it contains the major data, hash from the prior block, a hash of the present block, timestamp and finally the other information. Figure 2 shows the Cryptographic hash mechanism[5].

- Blocks:

A block is the primary unit and every block has a block header with nonce, previous block hash, timestamp, Merkle root, and several transactions with in a block body.

- Transactions within the ledger:

Where the distribution of ledgers is public (users are anonymous or private) or private (users are not anonymous or private).

- Cryptographic hash functions:

Variable-length input to constant-length output as it's shown in figure 2.

$$\boldsymbol{h}\rangle : \{\mathbf{0}.\mathbf{1}\}^{*} \rightarrow \{\mathbf{0}.\mathbf{1}\}^{\boldsymbol{n}} \qquad (1)$$

- Digital signature as a set of three algorithms

$$(sk, pk) = Keygen\ (n)$$

$$Verify\ (pk,m,sign(sk,m)) = True$$

- Timestamp: Time of block generated.

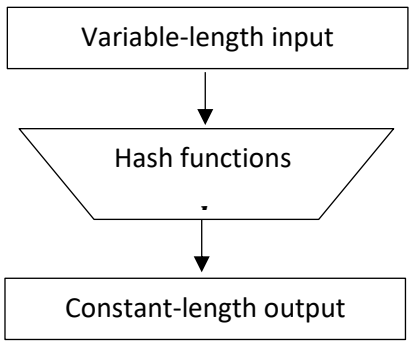


Figure 2. Cryptographic hash function

2.2 Blockchain framework

A basic Blockchain framework consists of distributed ledger, cryptography[6],[7],[8] consensus protocol, and smart contract. According to[9], The Blockchain is a database be shared, distributed and agreed across A Peer-to-peer (P2P) networks. It comprises file sequence blocks, holds timestamp transactions that secured with the public key Network encryption and verification of social communication as shown from figure 3. Once an element is attached to the Blockchain, can't be changed, transformed Blockchain in the changeless recording of previous activities.

The technology of Blockchain is secured as the ledger is distributed over the network. If a hacker wants to modify the ledger, he needs to hack every node in the Blockchain network.

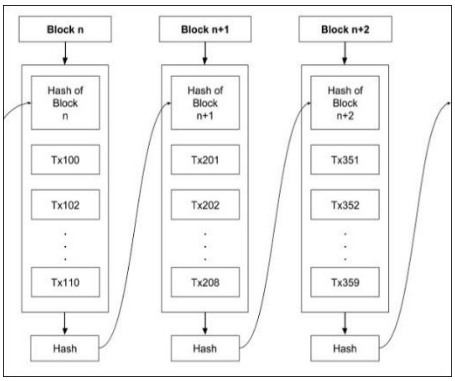


Figure 3. Example of Blockchain frameworks.

2.3 Types of Blockchain

The technology of Blockchain can be split into three types.

- Public: Everybody can verify and confirm a transaction, and they can also share in the consensus-building process such as the Ethereum and the Bitcoin[10].
- Consortium: such as R3CEV and Hyperledger Blockchain means that the node that has authority can be pre-selected, usually has partnerships like a business concern, and the data can be private or open, and it can be considered decentralized partially[11].

- Private: in this type of Blockchain the node will be limited, the participation for not each node and the Blockchain strict the authority login to the data access.

2.4 Blockchain Characteristics

- Decentralization: every node has the same rights and obligations accountability of wish means all the nodes are equal[12].
- Traceability and review: All data is encrypted and stored in nodes, and anybody can access the information through the block header hash value. The data is hard to hide, so the entire system is very transparent.
- Open Source: Blockchain system can be check publicly it is opened to every-one, also users can create any application using Blockchain unique technology.
- A Merkle root: is a mathematical method to validate data integrity, and used in cryptocurrency to ensure that blocks of data passed between peers on a P2P network are complete, unmodified and undamaged. Merkle Tree Construction requires a Merkle signature were the initial step of generating the public key Ai and private key Yi of 2n message blocks. For each key Yi a hash value Vi = H (Yi).
- Block Propagation and Synchronization: The transactions and blocks must be coordinated on the Internet between the Blockchain miners. Virtualization strategies for software-defined networking and network functions help dynamically allocate computing resources to core and edge cloud servers. For Blockchain authentication, authorization, and accounting (AAA) services, an adaptive broadcast algorithm[13]. By using a broadcast mechanism, cryptography is propagated across the Internet. A propagation delay and duplicate transmissions can incur the broadcast message. For data verification, the overall propagation delay is presumed to be a combination of transmission time and computational time.

3. Blockchain Applications

A Blockchain technology is widely used in numerous fields starting with financial to industry applications. This

section discusses many Blockchain applications such as:

3. Business services applications

The emergency in Blockchain systems such as Bitcoin has had a major effect on traditional business and financial services. That the Blockchain can interrupt the global of banking. Blockchain technologies can be used in different domains include clearing and the settlement of financial property. In any case, it displayed that there are actual business conditions such as collateral for financial derivatives that can leverage the Blockchain to decrease risks and costs[14]. Blockchain has also attracted immense interest in the eyes of large software companies such as IBM and Microsoft Azure have introduced Blockchain as a service.

- A Bitcoin: Digital Currency

Bitcoin is a decentralized digital currency and network that verifies and processes transactions using a peer-to-peer system. Bitcoin technology utilizes cryptographic evidence in its computing device program to process transactions, validate Bitcoin and spread processing tasks between the network rather than relying on trusted third parties, such as card processors and banks, to process payments.

- Ethereum: A Smart Contract

The smart contracts based on Blockchain have proposed contracts that can be achieved, which implemented in part or in whole without human intervention. Automated security is one of the major objectives of the smart contracts[15]. The main advantage of smart contracts is that a trustworthy third party (such as a guardian) need not act as an intermediator between the contracting entities. A contract is executed by the Blockchain network on its own. When exchanging value, this can reduce friction between entities and open the gateway to a higher level of transaction automation.

- Hyperledger platform

Hyperledger is an associate open-source Blockchain platform[16], launched by Linux Foundation in December 2015, to aid distributed ledgers based on Blockchain. Hyperledger focuses on ledgers planned to support international business transactions, including main technology, financial, and supply chain firms, with the goal of rising many characteristics of execution and reliability.

3.1 Blockchain Service Availability applications

Lately, Blockchain has gained traction. Using Blockchain for huge applications, such as supply chains, health records, general registries, and polling is being explored by startups, corporations, banks, and government agencies worldwide. For many of these applications, dependability properties, such as availability, are important, but the guarantees provided by Blockchain technology remain uncertain, especially from the application perspective.

3.2 A Blockchain data storage framework

Ouaddah and al., based on Blockchain technology, introduced the FaiAccess platform with its various components to enable users to monitor their data. The access control option offered by the Blockchain with storage in a distributed hash table of several chosen nodes was exploited by Zyskind et al. The Blockchain is used for the control and access to data locations here. To construct "Blockstack ID," which is an identification scheme and a decentralized PKI, Ali and al. used Blockchain. This device consists of a control plane that is a protocol and links for name registration and planning a data is responsible for saving the data that must be signed by the key of the owner of the name. The technology of Blockchain shows promising use of prospects starting with cryptocurrency to the smart contract, which has been implemented in wide range areas.

3.3 Blockchain in cloud computing

The provenance of the data cloud is metadata so as to record the improvement of history and process conducted on a data cloud object[17],[18],[19]. For data accountability, forensics and privacy, stable provenance of data is important. A suggestion of a decentralized and trustworthy framework for cloud data provenance in many papers using blockchain technology[20]. Data provenance based on Blockchain can provide tamper-proof records, allow data transparency in the cloud to be transparent, and assist improve the availability and the secrecy of source data.

3.4 Blockchain Distributed computing

Initially, Blockchain was developed as a duplicate computing architecture that runs the same code with the same ledger for every Blockchain node. As a consequence, the problem of scalability is that the output such as transaction latency and throughput can't be scaled up on a propositional basis besides increasing a lot of nodes.

Because of the faster consensus that Blockchain broadcasts all transactions of purpose ledger modifications to all members, the output of each node is greater than several nodes. It is meanwhile the broadcast protocol that distributed ledger modifications are agreed upon unanimously.

3.5 IoT in Blockchain

The IoT, or The Internet of Things is still the brightest communicating and information technologies, has been

intensifying newly. The IOT is presented to incorporate things to the Internet and provide users with various services[21]. Typical practical application of the IoT involves logistics managements using radio-frequency identification technologies (RFID), a smart home and the e-health[22]. Blockchain technologies could improve the IoT sector. The Internet of Things or (IoT) goal is creating an intelligent world that allows all to use new cyber technology to perceive, observe, monitor, and optimize conventional physical structures. In recent years, many IoT applications have been produced and deployed, and they in turn make our lives even more convenient than ever. However, they also jeopardize cyber risks to conventional physical networks[23]. Towards greater availability and transparency via a Blockchain for IoT updates. It is important to deploy a large number of objects with complete or partial access to the Internet to create the Internet of Things. It is important to be able to upgrade, patch their vulnerabilities and prevent hackers from enrolling them in botnets, considering that these artefacts are exposed to attackers and usually not secured-by-design. Ideally, the CIA triad functionality, i.e. confidentiality, honesty and availability, should be incorporated in the upgrade infrastructure. In this work, with a focus on availability, we explore how the use of a Blockchain infrastructure will fulfil these requirements. Furthermore, we suggest a peer-to-peer mechanism to disseminate notifications between objects that have restricted Internet access capabilities, and creating a false sense of security.

3.6 Other Applications

Relative to the orientation of the governance blockchain technology can be implemented to educational and learning platforms.

4. BLOCKCHAIN CHALLENGES AND SOLUTIONS

Several studies are presented on the privacy issues and security of Blockchain, however, that is an existing problem and challenges it has to be dealt with and the lack of systematic examination on the security of Blockchain systems. This section discusses the most challenges and difficulties of Blockchain is facing.

- **Scalability challenge**

As the volume of transactions increases all the time, blockchain acts as a heavier. Presently, the Bitcoin from blockchain has passed 100-gigabyte storage capacity. Storing all the transactions before validating any transaction. Moreover, despite the major limitations of block volume and the time used to create a new block, the Bitcoin from the blockchain able to serve close to seven transactions each second, which can't meet the demands of the process the millions of transactions in current time. In the meantime, because the block capacity is so small, it may delay many small transactions, as miners choose those transactions with higher transaction fees. Even so, the huge block volume would delay the spread and lead to the branches of the Blockchain. So the scalability issue is very challenging. There are several proposed attempts to study the scalability issue of the Blockchain.

To fix the massive Blockchain problem, a new cryptocurrency scheme has been suggested in [14]. In the new system, the network removes old records transactions and a database called account tree is utilized to hold the balance of all non-blank addresses. In this way, the contract needn't store all transactions to verify whether or not the transaction is valid. Coupled with a lightweight client can also help solve this problem. A new scheme called VerSum has been presented to supply another method that allows lightweight clients to existing. VerSum lets lightweight clients outsource costly accounts to bigger inputs. Ensures correct calculation results by distinguishing results from several servers[14].

- **Blockchain Redesign challenge.**

Bitcoin-NG proposed a decouple conventional block into:

A major block for electing a leader and a smaller block for storing transactions. Miners compete to become leaders. The leader will generate the small blocks until appearing the new leader. Bitcoin-NG has further expanded its heavier chain strategy, with only major blocks counting and smaller blocks bearing no weight. Also, the blockchain is redesigned and addressed by making the trade-off between network security and the block size.

- **Leak Blockchain privacy challenge**

The public believe that the blockchain to be extremely secure as users only transact with the created addresses instead of the actual identity. Users can also create multiple addresses in case it leaks the information. Nevertheless, it appears in that the blockchain can't warranty transaction privacy because of the amount of all transactions and balances per genera key are visible to the public. Also, a recent paper showed that we can link the Bitcoin user's transactions to reveal user data. A proposal in a method for associating user aliases with IP addresses when individuals are behind firewalls or network address translation. This method allows each customer can identify uniquely by the group of nodes to which they are connected. Nevertheless, this combination can be learned and utilized to discover the root of the transaction. Several methods have been presented to develop blockchain

anonymity[14].

A study proposed a novel method called the Mixing method. The aim of this method is the user addresses in blockchain are aliases however these addresses still be connected to a real user ID as multiple users frequently transact with the same address. The key concept of a mixing method is the service that allows anonymity by transferring money from several input addresses to several output addresses. A proposal introduced a new method titled Mixcoin for avoiding Illegal Behaviors. The broker encrypts users' data such as the amount of funds and the date of the transfer, with his private key. Then if the broker does not transfer the funds, then anyone can verify that the broker is cheating. Nevertheless, the stealing was cached but not banned. Coinjoin relies on a central mixing server to randomly switch output discourses to stop theft. Inspired by Coinjoin, CoinShuffle has used decoding networks to mix addresses[14].

5. BLOCKCHAIN E-SERVICES AND E-GOVERNANCE

Governments have introduced an e-government service that utilize the information technologies to upgrade the efficiency and quality services. Although it invests a huge number of funds in e-governance however, it achieves a little. Blockchain is can provide a good opportunity for governments by enabling it to apply and implement the e-governance services professionally. A good illustration of this issue is the food safety as the customer has a low knows about the most products daily used. Starting from the retailers passing to the distributors and the storage facilities and providers stands between the customers and their products. Agencies are established for food safety by governments to force each component of the chain to follow the standards to overcome the food contaminations crisis, such as happens in Chipotle. The tainted Chinese milk scandal shows that the governments have failed. Management of food supply chain by Blockchain technology might be a smart solution. The collaboration between IBM, Walmart and Tsinghua University provides high confidence for both the customers and the service providers.

Everyone can track food products using the blockchain digitally starting with an ecosystem of the suppliers and storing shelves and finally to the consumers. Product information now is digital such as batch numbers, farm creation, expiration dates and other details all linked digitally to the blockchain also each stage of this process. Governments can use every bit of info to detect important data that can display the issues of food safety for any product. Because it cannot alter the information on the blockchain, this guarantees that all data is very accurate and not cheated.

The main objectives of this section is to study the available opportunities for the Blockchain field to treat the current issues in the impact of ensuring transparency, traceability, security, and management issues. Blockchain implementation on the sustainability and effectiveness of systems and services. E-Governance also aims to equip people by giving them access to information that makes the entire administrative process friendly and is essential for a developing country like India.

6. BLOCKCHAIN E-GOVERNANCE SAUDI ARABIAN CASE

Denmark, the Republic of Korea and Estonia top the ranking of the 193 member states of the United Nations in 2020 in terms of e-governance which embodies the range and goodness of online services, state of the communications infrastructure and current human capabilities. Between the world's lowest developed states, Bhutan has become a leader in e-government advancement in (EGDI) or e-Government Development Index group in 2020. Mauritius leads the digital government rank in Africa. Generally, 65% of the member states are high at the e-Government Development Index. E-governments have introduced new techniques in response to the exist health COVID-19 pandemic, online services, medical merchandises, apps support self-diagnosis[24].

Several countries were speedy to roll out tracing, home learning, and tracking applications and applications for work at home. The government's advance digital effects to COVID-19 consider the online dashboards to share their information and flow the emergency responses. Chatbots are widely used to evaluate the patients' probability of infection. Some communities' engagement applications have let the governments to collaborate straight with their voters, considering by sharing COVID-19 info, sending photos, and even forming virtual proceedings[25]. A virtual doctor application is implemented and developed by RMS engineers in collaboration with medical scientists.

Applications were proposed using sensors, cameras, and AI algorithms[26]:

- Usually prepared to control tracking.
- Measuring the distance for pedestrians to observe social distance.
-

Fig. 4 The EGDI appears as an indicator of Saudi Arabia's development [27] in the global implementation scores in 2020 with value 0.7991 and rank 43 versus 0.7119 with rank 58 in 2018 and shows that there has been a significant rise in integrating citizen services in the last two years. The development and implementation of e-government is troublesome and its acceptance among citizens can be slow. While Denmark is the main country in moving services online in 2020, over 89% of its population was seen using online services. Many countries are

struggling to advance e-government, for example, the percentage of e-services in Egypt is only 2%.

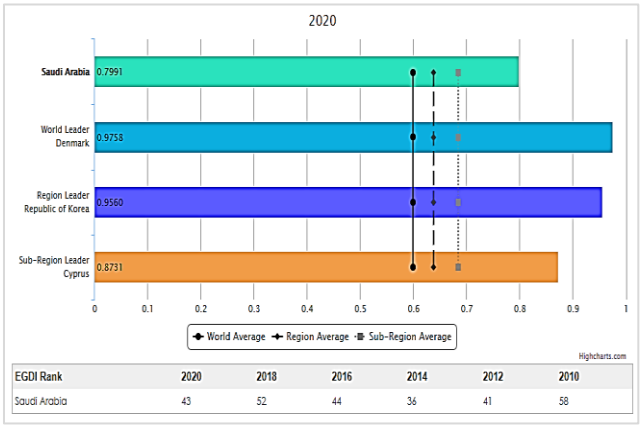


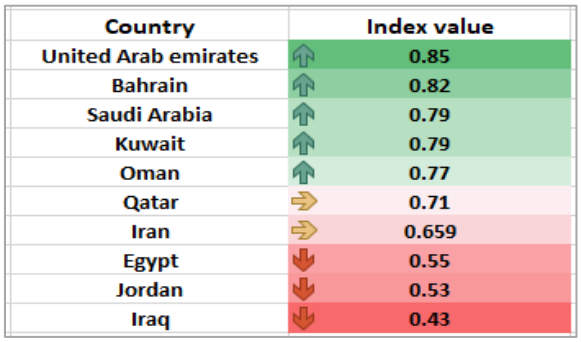
Figure 4. E-Governance Development Index (EGDI) of Saudi Arabia in 2020 [27].

Table 1 illustrates the region countries' E-Governance Survey Report 2020 with key perspectives so it can portray cumulative performance as a higher performance which denotes that the first five countries move in the right way.

Table 1: The region countries' E-Governance Survey Report 2020

Country	EGDI 2020 Rank	Region Rank	Index value
United Arab Emirates	21	1	0.85
Bahrain	38	2	0.82
Saudi Arabia	43	3	0.799
Kuwait	46	4	0.791
Oman	50	5	0.77
Qatar	66	6	0.71
Iran	89	7	0.659
Egypt	111	8	0.55
Jordan	117	9	0.53
Iraq	143	10	0.43

Figure 5. show that (EGDI) of Saudi Arabia in 2020 overcome the overall the world average (0.6), region and sub-region average values (0.637), (0.68) respectively which indicates that it is heading in the right direction.



Country	Index value
United Arab emirates	0.85
Bahrain	0.82
Saudi Arabia	0.79
Kuwait	0.79
Oman	0.77
Qatar	0.71
Iran	0.659
Egypt	0.55
Jordan	0.53
Iraq	0.43

Figure 5. (EGDI) of Saudi Arabia in 2020

7. CONCLUSION

At present, e-governance is subject to adoption and implementation by many countries so that citizens' services can be escalated with higher performance without any scope for corruption. The field of e-governance is not limited to specific areas, but rather extends to services, including electronic benefits, electronic salaries, electronic

identification and many other services. Electronic management includes the use and use of the wings and innovation-based modules of the open area so that ordinary individuals can use this section without provocation in the open workplace. The e-government approach cooperates with online departments so that continuous investigation and use can be made promptly and with greater precision in open administrations. Using electronic management is very important in a variety of flows where it is important to link the distinct evidence of residents and organizations supported by taxpayers so that there are better implementation and overall presentation. It requires the global outlook and perspectives for the use of electronic management in the nationality-based departments of the administration and departments to access government plans, and this original version has the main objective in this section. For electronic management, models use from different angles. With clear positions in establishing states. In this exploratory work, the selection and integration of e-government as a major point towards smart applications in a smart field is related. For the progress and development of any country, it is important to integrate innovation-based and departmental elements. These are the focus points with intelligence with e-government in any region. This work illustrates these prospects for e-government and studies the Saudi Arabia case study in 2020. The manuscript presents the usage of Blockchain and the other applications in demand that can help any nation for e-governance in various aspects of the multiple dimensions.

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