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Blockchain-Based Electronic Coupon Service for Safety and Convenience

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Abstract-E-coupons are commonly utilised as e-commerce expands because of their simplicity and mobility. Most electronic coupon systems have a central server where all coupon data is stored. E-coupon systems, however, often face security difficulties due to their centralization. Forged data on an e-coupon server, for instance, makes it impossible to determine which customer should get credit for a purchase, and a previously used coupon may be used several times beyond its expiration date (i.e., double-spending). To address this problem, we offer a novel e-coupon service that enhances the service's security by using a blockchain network. First, we'll be creating a server that can connect to the blockchain and provide the e-coupon service. Second, we design a blockchain-based smart contract that safeguards both the electronic coupon's business logic and its information. We built our version of the planned service on the Ethereum network.Experimental findings reveal that, compared to an already available e-coupon service, our proposed service offers much improved security with just a little performance hit.

Keywords— E-coupon, blockchain, smart contract, security.

I. INTRODUCTION

Electronic coupons (e-coupons) are becoming more popular as a promotional strategy with the expansion of the e-commerce sector [1, 2]. E-coupons' electronic nature makes them not only easy for customers to use, but also efficient for coupon providers like retailers and marketers. E-coupon suppliers, for instance, can simply track how many people have downloaded and used their discounts thanks to the unique digital codes they provide. In addition, e-coupons can be easily managed by customers from their smartphones or computers. The research Global Mobile Coupons Market 2016-2020 [3] predicts that the worldwide mobile coupon industry would develop at a CAGR of 73.14% between 2016 and 2020 as a result of the benefits of e-coupons.

While there are many advantages to using an electronic coupon and the market for them is growing, there are still obstacles to overcome. Most e-coupon services keep track of their coupons in one central location. In order to ensure that an electronic voucher is legitimate, it is checked against a central database. However, due to the centralised nature of the information, an administrator can easily manipulate it to facilitate forgery and fraudulent use of an e-coupon. Double spending is possible with electronic coupons, and the discount rate can be tampered with by an attacker. PennLive reports that the true annual cost of e-coupon crime in the United States is between $300 million and $600 million [4].

Hsueh et al. [5] propose an e-coupon system using a hash chain that integrates blockchain technology to improve the safety of digital coupons. When it comes to guaranteeing the authenticity of e-coupon data using blockchain technology, our research is in accordance with the existing literature. In contrast, we safeguard both the activities (such as the management of e-coupons, etc.) and the e-coupon information by developing a secure smart contract.

To address these concerns, this article proposes a blockchain-based e-coupon service.

Specifically, we've developed a server that can provide e-coupon service and exchange data with a blockchain network. Second, we create a blockchain-based smart contract for e-coupons to ensure the security of transactions (i.e., business logic code [6]) and e-coupon details. Also, for the benefit of our customers, we have implemented an automated blockchain deployment of an electronic coupon smart contract.

For the safety of electronic coupon data and business logic code (i.e., downloading, giving, and redeeming an e-coupon), we apply and execute the proposed service on the Quorum blockchain system [7]. The experimental findings show that the proposed service is more secure than the current ones, with just a little performance penalty. The following are some of our main contributions:

We look at the current mechanism for processing e-coupons, paying special attention to its applicability to security and e-coupon trading.We propose a novel service that automatically installs an e-coupon smart contract on a blockchain network, allowing for safe electronic coupon exchange.

In this paper, we show that our proposed e-coupon service is safer than the current options.

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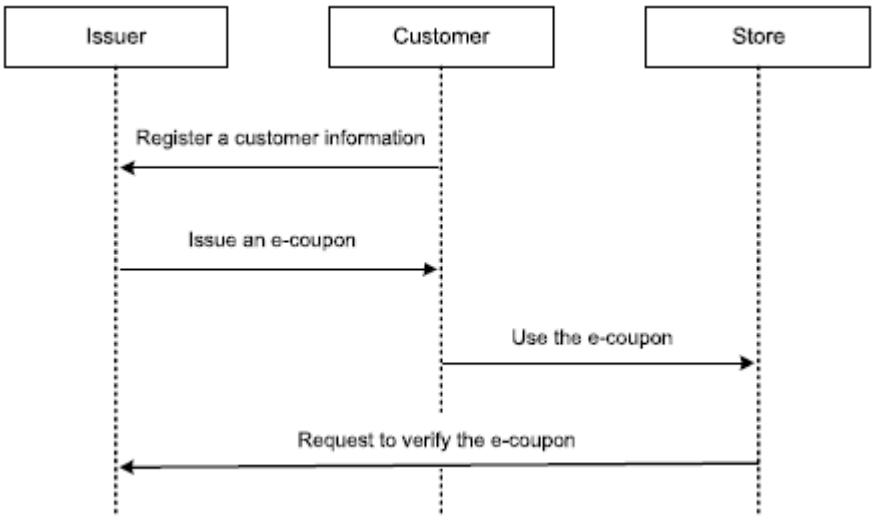

FIGURE 1. Example of centralized e-coupon service.

II. RELATEDWORKS

E-coupon use has increased [8][10] as smartphone penetration and e-commerce have grown.

E-coupons offer several advantages over conventional paper coupons, including the ease with which coupon providers may gather and manage coupon information (such as the quantity of coupons, the number of downloads, client lists, and whether or not coupons have been utilised).

Customers may access and manage their e-coupons from any computer or mobile device [11]. As can be seen in Figure 1, most e-coupons are made available via a central server for handling the e-coupon information, since this allows for more efficient management and collection of data. The following is the procedure that must be followed in order to redeem an electronic coupon using the services that provide them: 1) A consumer must first register with an e-coupon issuer before they may access the issuer's website and download an e-coupon.

A client may get a discount by downloading an electronic coupon from the issuer to their computer or mobile device.

Thirdly, when a client redeems an electronic coupon, he or she transmits the coupon to the retailer (or the electronic coupon provider, in this case).

Fourth, the retailer will ask the e-issuer coupon's to confirm the coupon's legitimacy.

Moreover, the issuer checks this electronic coupon against their database to ensure its legitimacy.

Verifying an e-coupon is the most vital step in the process of e-coupon services because e-coupons that have been faked or manipulated by hostile activities may cause significant financial loss.

Message-digest algorithm 5 (MD5), message authentication code (MAC), and one-way hash function are all proposed in prior publications [2, 12][15] as techniques to authenticate e-coupons and prevent their fabrication. Nevertheless, they do not provide methods to safeguard against tampering with data stored in a centralised location. In other words, electronic coupons cannot be forged during data transmission; but, the aforementioned methods may be used to counterfeit electronic coupon information saved in an electronic coupon database. Moreover, an e-coupon server administrator may change any e-coupon information for their personal benefit. Thus, the purpose of our research is to roll out a new e-coupon service that prevents illegal forging of e-coupons and data manipulation on the e-coupon server. In order to do this, we develop a blockchain-based electronic coupon service.

If you're concerned about the safety of your distributed system's data, then you should look at blockchain technology [16], [17]. Most blockchain systems, in order to solve these problems, keep a chronological chain of the blocks shared by all users. There is a block header and a block body that make up the block. The transactions themselves may be found in the body of the block. The Merkle tree [18] root, which was constructed from the block body's transactions, and a hash of the preceding block are both included in the block header. If a new block is to be added to the chain, it must be appended to the end of the chain, which is itself linked to the preceding blocks by their hashes. Because of the sequence of previous transactions, the blockchain's recorded transactions can neither be

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altered nor removed. Byzantine fault tolerance (BFT) [19] and direct transactions between users are therefore possible in a blockchain system.

Ethereum is a widely-used blockchain platform that facilitates the creation of smart contracts, making it a key component of many other blockchain-based systems.

Essentially, a smart contract is a legally binding agreement in digital form [20]. The blockchain records the business logic code and status value (the outcome of a smart contract), allowing smart contracts to function reliably across all Ethereum nodes without the mediation of a trusted third party [21], [22]. Thanks to the smart contract's anonymity, transparency, immediacy, and top-tier security features, users can build DApps with all of these desirable characteristics. It's true that smart contracts improve security, but they're not perfect. For instance, users may find it challenging to manually construct a smart contract, which can limit the smart contract's applicability. Hence, we take use of the robust security of blockchain and implement an e-coupon smart contract mechanically to provide a service that is both safe and widely applicable.

III. PROPOSED SYSTEM ARCHITECTURE

We propose a new secure e-coupon service that makes use of blockchain technology and smart contracts to improve the safety and usefulness of electronic coupons. By the use of blockchain technology, we guarantee the authenticity of the e-coupons and the business rationale behind them. The big picture of the electronic coupon service we offer is shown in Figure 2. An application, an e-coupon server, and a blockchain based on Ethereum make up the e-coupon service in its entirety. The programme is quite similar to already existing apps, with the exception of the signing and sending of transactions to the blockchain. The electronic coupon server acts as a broker, providing the application with access to blockchain-stored member data and electronic coupons. e-coupon transactions are verified and recorded on the blockchain, which is based on the Ethereum platform. Moreover, e-coupon smart contracts run on the Ethereum virtual machine (EVM), a sandboxed virtual computer automatically encased inside each entire Ethereum node, able to execute the contract bytecode. To boost the blockchain's efficiency in its e-coupon service, we give some thought to its underlying architecture. For instance, the Ethereum blockchain employs a tree structure to record the history of a smart contract's transactions (i.e., account storage trie).

Consequently, the tree size grows in proportion to the number of states being kept. This may lengthen the time it takes to look up state data in a tree. As a result, the scheme's efficiency may suffer while storing or retrieving e-coupon status data. Nevertheless, we provide separate smart contracts for each e-coupon vendor, and each tree under a given smart contract is responsible for maintaining its own set of e-coupon-related state data. This technique optimises the storage and retrieval of e-coupon status data by decreasing the tree depth.

In addition, we automate the creation and deployment of e-coupon smart contracts, which simplifies management of the electronic coupon and lowers development costs. The proposed e-coupon service achieves this by providing e-coupon providers with a smart contract template. By configuring the e-coupon information (i.e. the quantity of the coupon, the coupon's validity period, the coupon type, the discount amount, etc.) with this template, e-coupon providers can easily create a coupon smart contract and automatically deploy the smart contract to the blockchain without writing a new smart contract. Hence, it may ease the burden on e-coupon suppliers and cut down on the expense of developing the smart contract.

As each block added to the blockchain is cryptographically linked to its predecessor, blockchain is an append-only database that does not allow for deletion or edit actions. To alter the data in a block, for instance, the consensus algorithm must be used to update the hash value of all blocks that follow it. This means an adversarial attacker has to compromise a number of blockchain nodes to achieve any meaningful effect. In order to successfully alter or erase data, the attacker has to have a significant advantage over the defenders. The blockchain's use of these methods ensures that all information is accurate and secure (i.e., e-coupon information). As the business logic (i.e., the e-operational coupon's logic) is likewise kept in the blockchain, the smart contract on the blockchain can guarantee that it is accurate. Our proposed e-coupon service uses blockchain and smart contracts to increase security while requiring just a little amount of extra processing time from users.

The guarantee of non-repudiation in an e-coupon service is that neither the e-coupon supplier nor the e-coupon recipient may dispute the legality of the e-issuance, coupon's use, or gift. We use digital signatures and a blockchain to ensure that our transactions cannot be disputed. To redeem an electronic voucher, a user must first create a transaction and then digitally sign it. Validity of a signed transaction is verified by the smart contract. A signed transaction is included to the blockchain ledger if and only if it is legitimate. An electronic coupon's issuer, recipient, and redeemer may all be traced back to a signed transaction. The blockchain's use of a consensus method involving numerous nodes also makes it impossible to alter the recorded transaction. It means it's unfeasible for an attacker to try to forge a transaction without having access to much more computer resources than the other nodes.

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This means that blockchain may be used to track down the original signer of a transaction and keep that particular transaction's details unchanged. This means the user who signs the transaction cannot later claim that it was never completed.

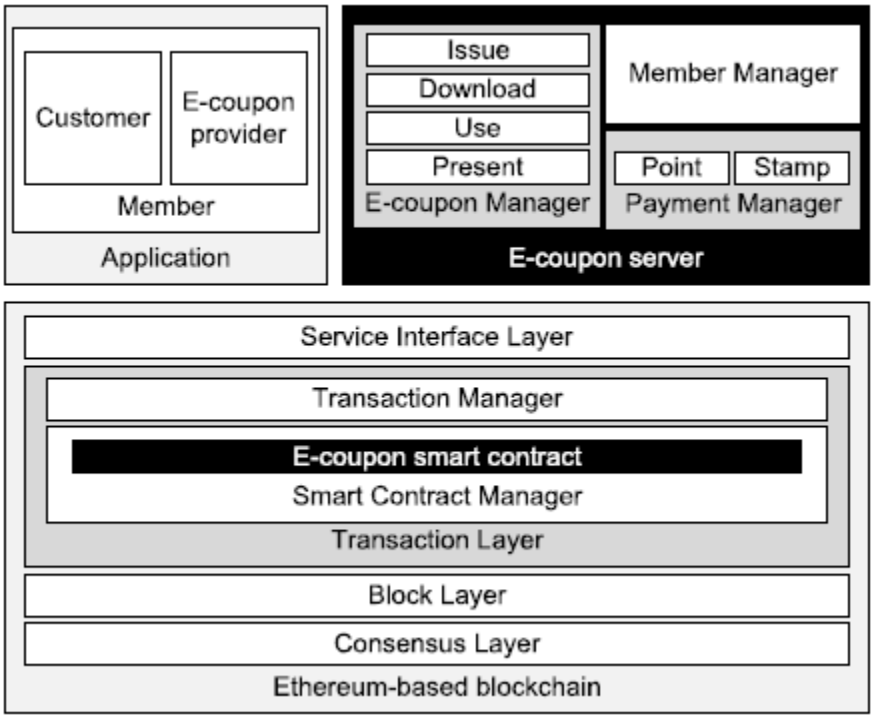

FIGURE 2. Overall architecture of the e-coupon service.

IV. RESULTS AND DISCUSSION

The Proposed e-coupon service output screens are shown in Fig.3.

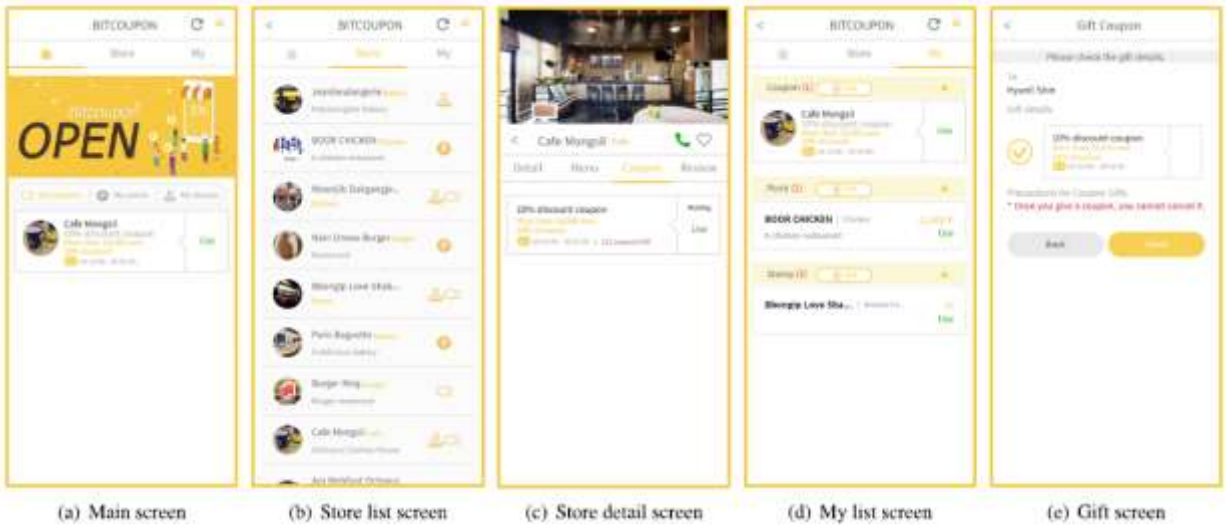

Fig.3 Proposed e-coupon service.

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The proposed smart contract mechanisms form the basis for a proof-of-concept (PoC) service, which is depicted in Figure 3. Screenshot of the main, list of stores, store detail, e-coupon list, and gift e-coupon screens. See Figure 3(a) for an example of the home screen with the e-coupons displayed. The electronic coupon can be seen in the "My coupons" submenu. The reserve e-coupon is displayed in the My points and My stamps tabs. As can be seen in Figure 3, the first thing a customer does when attempting to download an electronic coupon for a discount is to receive a list of stores (the "e-coupon provider") (b). The customer can then access the downloadable coupon via the store detail screen (Figure 3). (c).

A customer's electronic coupon data is displayed in Figure 3(d). The buyer can also click a "gift" button to share the e-coupon with others. Customers confirm the gifting of an electronic coupon to another customer on the screen depicted in Figure 3(e). Once a customer shares an electronic coupon with another, they cannot take it back. In addition to these capabilities, our service also includes a number of others that are not shown in Figure 3. Customer registration, requesting an e-coupon, receiving an e-coupon, collecting points or stamps, and verifying e-coupon use are all examples. Smart contracts further allow users to maximise efficiency by exchanging e-coupons for desired coupons.

V. FUTURE SCOPE AND CONCLUSION

We looked into services that compile e-coupon data and make it accessible from one location. We discovered that server-stored e-coupon data is vulnerable to manipulation by malicious attackers or administrators. We address this concern by unveiling a novel e-coupon service that tightens up security by making use of e-coupon smart contracts within a blockchain infrastructure.The proposed service has been built and tested on the Quorum blockchain, and its performance has been measured against a synthetic benchmark. Our experiments show that the proposed service successfully protects against the manipulation of e-coupon information while incurring only a minimal performance penalty. Enhancing blockchain functionality is a future priority.

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