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Cryptocurrency based Payment channel for Edge/ IoT devices

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Abstract: ***Due to the potential applications in a range of industries, blockchain-based cryptocurrencies have recently gained a lot of attention worldwide. One of these applications is in the domain of the Internet of Things. With B-IoT i.e. merging Blockchain with IoT, we aim to utilize the power of cryptocurrencies without jeopardising payment security, privacy, or long transaction period. On the other hand, traditional payment modes and methods are hampered by relatively lengthy complex process fees making them vulnerable to physical cash exchange thefts. This makes the process of transferring assets complex.***
By developing a payment channel network, we propose an entirely new and unique model to address these concerns by allowing nodes to build payment channels between themselves without needing to write to the network and benefit us from payment networks like blockchain. Payment channel networks have an exceptional set of characteristics regarding routing complexity. In this study, we describe a detailed analysis of a payment channel network design that will help us make the transaction process through the edge and IoT systems a lot faster and more accessible. Furthermore, there are various references which show that using edge-IoT devices to connect nodes greatly improves the success and efficiency rate.
Index Terms: Cryptocurrency, Blockchain, Edge and IoT devices, Payment channel network, Security, Ethereum.

I. INTRODUCTION

Our goal is to construct a payment channel network approach that uses a normal weight strategy to maintain channel balance across the network. For this purpose, we make use of technologies such as Blockchains, IoT, Cloud Edge Computing and some reliable Cryptography concepts. Internet of Things (IoT) has been welcomed in diverse disciplines at an influential pace over the last decade as it carries numerous potentials and conveniences. Generally, resource-constrained IoT systems and devices transmit data from their detectors to isolated or remote servers via wireless linkage and connection settings in such applications. With their advanced abilities, we can witness applications where an IoT device may need to do financial transactions.
When a smart home assistant like Alexa, Siri, or Google Assistant is used to place an order for a Pizza, for example, it will go through a step-by-step process to record the customer's initial Pizza requirements, such as the size of the pizza, the toppings and seasoning needed additional ingredients, and so on. After this is completed, the Home assistant will inquire about payment options, such as cash-on-delivery or online. If the online payment option is chosen, the intended Pizza order will be placed based on a successful digital currency transaction. To achieve this, Blockchain technology is used.

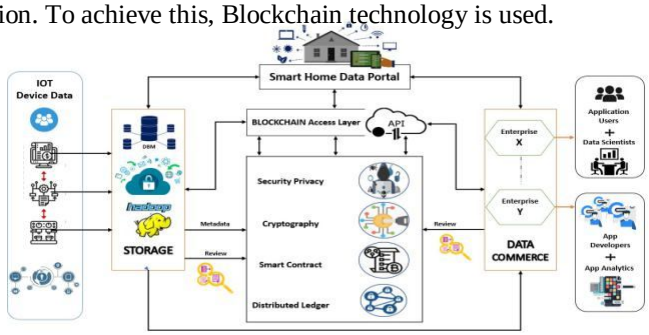

Fig. 1. B-IoT Application System

We are attempting to implement this model, in which IoT devices are used in a variety of real-time applications; in such an environment, an On-Board Unit (OBU) acting as an IoT device on a component, say your smart home assistant, may be required to make automated payments as and when required. Micro-payments are also required in various situations, such as automatic vehicle charging, parking payment, sensor data selling, and so on.

A. Approach

The fundamental requirement of this project is dedicated to building a secure transaction mode while initiating a payment from any Edge networked device. To achieve this objective we reviewed several solutions from different research papers as a part of the literature survey. Then we compared each paper to find a relevant and reliable solution for it. From our Literature survey, we came up with an all-new approach that can help us achieve our expected target which is by creating a decentralized application for e-commerce purposes.

B. Workflow

We have proposed a structured design and cross-functional framework which includes creating a decentralized application or portal to channel payments using Blockchain Technology. This will help us to use cryptocurrency instead of hard cash i.e. normal currency even when doing an online payment from dedicated payment applications like Google Pay, Paytm, Bhim UPI, PhonePay etc. On creating this application we check its operation and functions as we initiate the payment.

Once we have accomplished the task of creating a D-app we then set up the network of Edge devices. Integrating the Blockchain Decentralized application over an edge network will allow us to efficiently complete a transaction with an automated device. Hence we run our designed technology over the B-IoT platform.

II. LITERATURE SURVEY

A. Reviewing Past Paper works

This Literature Survey consists of the summarization of the research on blockchain and blockchain used in IoT applications in recent times. The research references were mostly surveyed from various papers, journals and magazines available on IEEE Explore, Google Scholar, and Web of Sciences, as well as from other online sources such as developer communities and web pages to give an up-to-date summary of the technologies in the blockchain. The following are the important aspects of the blockchain in IoT technologies.

The IoT features and the process of security analysis in IoT are the focus of the majority of security challenges in IoT and edge applications, which impacts the performance and the efficiency. A big number of devices, decentralised networks, high throughput, low cost, mobility, large data creation in IoT devices, and connection instability have all been identified as unique features in the IoT network and applications. These articles [4] [10] [1] [7] describe in detail the issues in the security of IoT applications that includes communication channel attacks, denial of service (DoS) attacks, sensor data attacks, software attacks, and network protocol attacks, by conducting relevant research on IoT security.

Several published research papers ranging from the year 2017 to 2021 were examined while conducting an in-depth analysis of Cryptocurrency Based Payment Modes for IoT Applications. From a theoretical perspective, some studies such as [9] [7]6 [8] [3] tried filling the loopholes in IoT's amalgamation with cryptocurrency using some advanced technologies such as Decentralized applications and Payment channel networks.

In these papers [2]56, we have critically reviewed the existing integration approaches and cryptocurrency designs that strive to enable micropayments among consumer devices. We identify and discuss solutions under three main categories such as direct integration, payment channel network and new cryptocurrency design. The first approach utilizes a full node to interact with the payment system. We evaluate the pros and cons of each of these approaches and then point out future research challenges. Our goal is to facilitate micro-payment adoptions.

We have studied the opportunities in cryptocurrency in terms of the security of its technology, low transaction cost and high investment return. The discussion revolved around law and regulation, high energy consumption, the possibility of crashes and bubbles, and network attacks. The improvement and future work on cryptocurrency include improving the security protocol, working on the proof of activity, using the by-product of proof of work and applying the knowledge management system.

Recent papers [5] [6] clarify that the PCN i.e. payment channel network establishment is a better way to solve the scalability challenge of blockchain-based cryptocurrencies for micro-payments, it has its challenges related to operational efficiency, management and routing, etc. One of the main characteristics of these payment channel networks is the way their channel capacities are consumed which raises new challenges in terms of insufficient balances in channels during routing.

A payment channel network (PCN) is one of the solutions proposed to address these problems of virtual currencies. It leverages the smart-contract concept to avoid writing every transaction on the blockchain. Instead, the transactions are done off-chain. Applying the PCN concept in the IoT domain will bring new opportunities for the users and the businesses.

There are many benefits of using blockchains in IoT applications, but it also comes with its own set of challenges. [7] [1] [3] IoTs, in recent years, have had emerging advancements in the technologies that power them. These advances have been in the area of communication technologies such as 4G/5G communications, Authentication and Security Schemes such as RFID and NFC, and Cyber-Physical Systems (CPS). Adding blockchain to IoT introduces issues that affect scalability, processing power and time, storage, privacy, and the overall throughput of such implementations. Finally, the survey is taken in the direction of future research, opportunities to build the gap which resides between the IoT requirements and limits of the blockchain technologies in the current research works. The possible direction of the research includes improvements in consensus algorithm and identification of IoT/edge devices, editable blockchain, and simplified verification of payment. [5]

B. Conclusion of Literature survey

We have critically reviewed the related research works and the solutions they've proposed with an aim to integrate loT using the Blockchain concept with existing cryptocurrencies and design models that claim to be loT friendly. Past research only focused on solutions under three main categories which are Direct system integration, Payment channel networks (PCN) and IOT cryptocurrency designs. With direct integration, we can utilize a gateway to communicate with the blockchain, while payment channel networks(PCN) is an effective method to increase the number of transactions is defined for lower the fee rates and with IoT, cryptocurrency designs the focus is more set on standardising the methods requiring fewer computation fees. We opt to go with the best of all three methods we perform the direct implementation of our build D-app with an IoT network using the features of APIs and then using the integrated platform for connecting with several Edge and IoT devices available on the network. In this way, our approach proves to be an advanced, secured and unique platform for carrying out various payment activities.

III. PROPOSED WORK

When a customer chooses to pay with cryptocurrencies in-store, online, or through an app. They pay the fair market value of the digital currency at the moment of the transaction. Payments are made using cryptocurrency. The funds are added to your provider's account and paid into your specified account at intervals determined by your service contract. To do so, we'll need to create the D-App and develop the D-App's front end and back end. Connect the D-App to the API. Using the solidity programming language, Metamask and ganache

A. Software Requirements

Solidity is a statically-typed curly-braces programming language designed for developing smart contracts that run on Ethereum. Remix is a browser-based compiler and IDE that enables users to build Ethereum contracts with Solidity language and debug transactions. Metamask Ethereum Wallet is a software cryptocurrency wallet used to interact with the Ethereum blockchain. It interacts with Ethereum D-Apps and Smart Contracts without running a full Ethereum node. Ganache is a personal blockchain for rapid Ethereum and Corda distributed application development. We have used Ganache across the entire development cycle; which enables you to develop, deploy, and test your D-Apps in a safe and deterministic environment. Ganache is used for setting up a personal Ethereum Blockchain for testing your Solidity contracts in an Ethereum simulator that makes developing Ethereum applications faster, easier, and safer.

B. Application Interface

We compile all the contracts using the truffle console. Once it gets compiled resulting in no errors, we migrate these contracts to our personal blockchain, Metamask. On successful compilation, migration, and running of the source code, our smart contract will get tied to our Metamask Wallet and help us to deploy it over the network. This will open the application in the Web browser under the name Ease.com. On this Ease.com web page, there are two modules defining the services of our Decentralized application. 1. Listing Module 2. Purchase

1) *Listing Items:* There is a provision for listing the name of the item required say a burger or some pizza. We can also add the price of the required product in ethers under the 'Product price component'. This will help us to list all the required items in Purchasing Item module. As we list our items it'll get mapped in the Purchasing item table.
2) *Purchasing Items:* In this module, we can purchase the selected items with the help of the 'buy' button. In this Purchasing Item module, there is a table consisting of elements such as the name of the item, price of the item, etc. The list under this module is registered as and when we add the Name and price of the required item using the Listing Item module. Once all the items have been listed, we can buy any item that appears on the list.

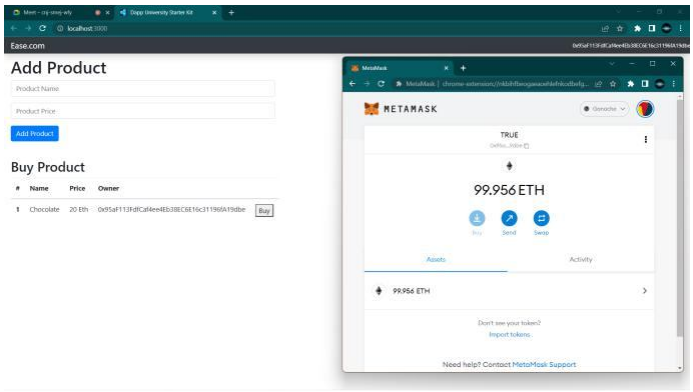

Fig. 2. Ease.com Application Interface

Using the 'Buy' button available in front of each item, the process gets redirected to a Metamask Wallet that we have. Using the smart contracts for transactions from our decentralized application.

The Wallet once it is opened prompts us to confirm the transaction initiated with our application. This ensures transaction security. Once this transaction is confirmed, Meta-mask will check the number of available ethers in the wallet with the one that is required to complete a purchase. After this, the Wallet will deduct the equivalent of the item price in ethers. Thus in such a decentralized and secure way, we can purchase the item we want.

Now that we have created a method to make payments possible. The very next step is to create a method to make it convenient to use by enabling this feature is specially designed Edge and IoT devices. For this, we believe that we need to make an identification method using AI i.e. speech recognition and similar tools to control and manage these blockchain-enabled IoT and Edge devices. This part of the project is still in the research phase.

IV. CONCLUSION

We analysed the existing integration approaches and cryptocurrency ideas for allowing micro-payments between consumer electronics. We discovered three main categories: direct integration, payment channel network, and new cryptocurrency design.

We looked at and analysed existing solutions in three categories: direct integration, which uses a gateway to interface with blockchain, and payment channel networks, which is an efficient approach to enhance transaction volume. We discovered five components that should be considered while designing an IoT infrastructure. IoT device kinds, application types, blockchain types and nodes, data and storage, and security are among them. Blockchain-based IoT necessitates an energy-efficient architecture, as well as security and scale-ability. IoT devices should have scale-able storage options as well as the computational capacity needed to hash transactions.

We present a decentralised IoT workflow management solution in which blockchain is used to define the rules for data transfer and access. To store the encrypted data set, we use a secure execution mechanism and only record the hash map information in the blockchain. As a result, our solution provides enhanced data sharing transparency and custom data access management for the huge volume of data created by IoT devices.

Our study sheds light on how IoT changes are progressing as a result of blockchain technology, as well as the considerations that businesses must make as they shift their business models. With the enhancement of the security components used in the suggested scheme, the system performance could be increased even more in the future.

V. FUTURE SCOPE

Having understood various concepts and potentials of Blockchain and IoT systems in and out, it is certain that by integrating such innovative technology with industries, businesses and commercial markets one can achieve long term benefits with increased profit rates and cost-effectiveness. Eliminate Paper transactions (Go paperless towards sustainability). using Digital Currencies may help us in Secure Transactions making services more accessible using intelligent/smart automation techniques.

B-IoT will enable IoT for digital payments with its traceable nature. B-IoT will also provide fast calculations. This increase in computing power is the result of B-IoT. Thus for a very valid reason, An efficient solution for making successful payments in IoT systems using blockchain systems proves to be an ideal business model.

In future, our main objective is to achieve an identification method for edge and IoT devices like Alexa/Siri edge devices and make digital currencies (Ethereum or similar cryptocurrencies) faster, more secure, and compatible with smart devices. After implementing this in a Home Automation system like Amazon Echo, we would intend to integrate this proposed solution into other applications or devices that one uses in their everyday life. This would include several transport automobiles like cars, buses, etc

Another possibility where this project can be implemented is in commuting that is in transport stations where on travelling from one station to another the payment for a single day fare can be effectively done using our technology. This will help in making the transactions easy and secure

The uses cases of this project are tremendous. We believe that the introduction of this technology to the outer world, it will not only make our lives simpler but also help us to safeguard ourselves from great thefts and losing a fortune by making the use of cryptocurrencies.

VI. ACKNOWLEDGEMENT

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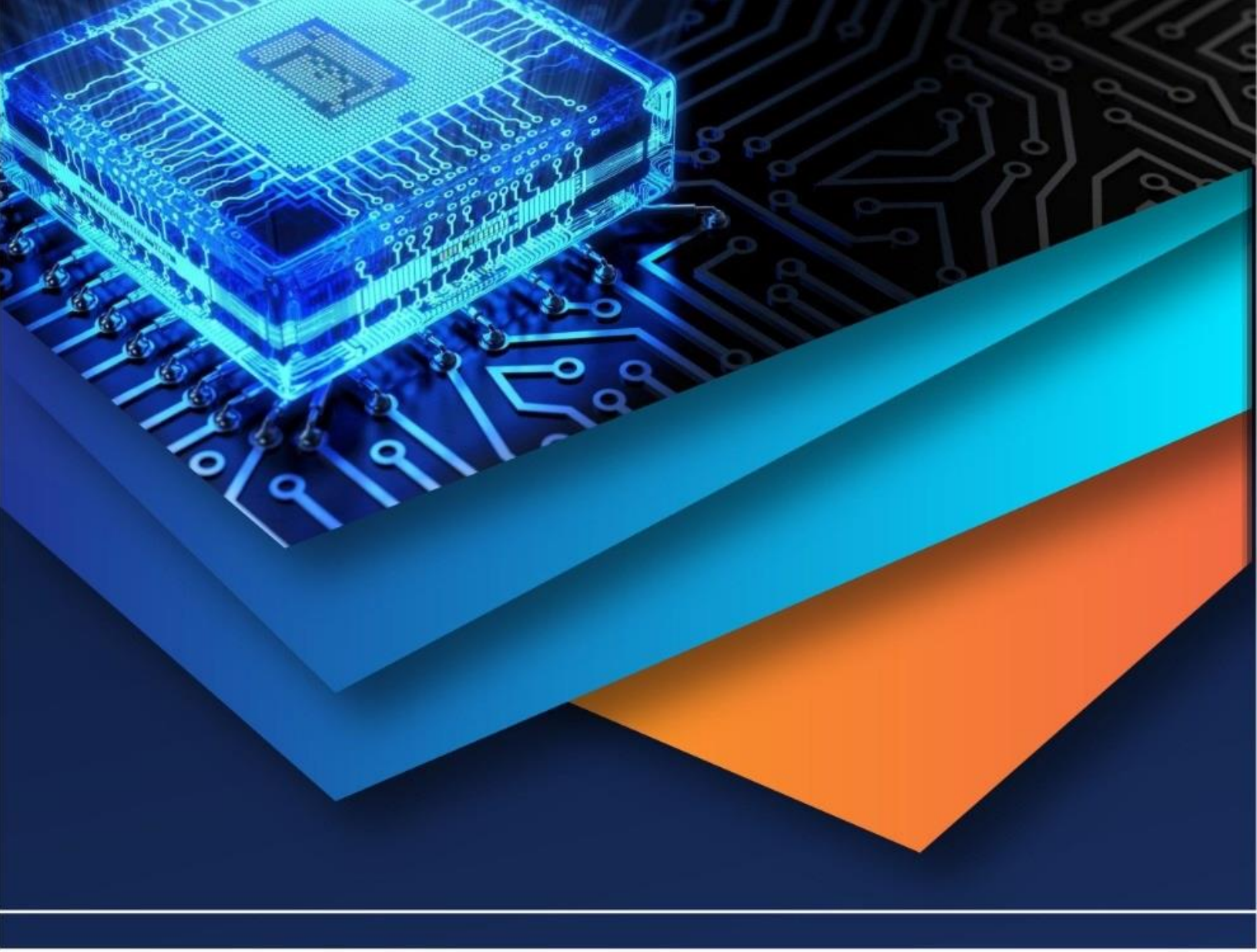

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