XPChain: A Blockchain-Based Decentralized e-Recruitment Platform

Shaila Sarker

2015-1-60-034

Abdullah – Al – Haris Shakib

2015-1-60-123

Ashiful Arefin

2015-1-60-125

A thesis submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering

Department of Computer Science and Engineering
East West University
Dhaka-1212, Bangladesh

December 2019

Declaration

I, hereby, declare that the work presented in this thesis is the outcome of the investigation performed by me under the supervision of Amit Kumar Das, Senior Lecturer, Department of Computer Science and Engineering, East West University. I also declare that no part of this thesis has been or is being submitted elsewhere for the award of any degree or diploma.

<u>Countersigned</u>   <u>Signatures</u>

Amit Kumar Das   **Shaila Sarker**
Supervisor   2015-1-60-034

                                                                                       Abdullah – Al – Haris Shakib
                                                                                                       2015-1-60-123

                                                                                              Md. Ashiful Arefin
                                                                                                       2015-1-60-125

E-Recruitment system has emerged in the modern age since 1994 to amend the traditional recruiting system by making it faster, cost-effective, and flexible. Although the issue aroused from racism, nepotism, fraud, etc. these couldn't be mitigated entirely even with the help of modern technologies. This research study aims at creating a decentralized global platform for e-recruitment and make the recruitment process more secure as well as trustworthy to both the recruiters and the recruitees. It constitutes a ubiquitous trusted, experience point system that can present a globally unified perspective for employees, organizations and other stakeholders. This will also discuss how Blockchain technology is helping to secure the e-recruitment process from all the issues mentioned above. The study will provide a conceptual model along with a proof-of-concept. The XPChain implementation is a prototype proof-of-concept of the environment. XPChain stores employees' work experiences in terms of experience points. It is flexible enough to be used along with the organizations' existing HRM systems. This platform becomes more acceptable and robust as more people and organizations start to use it.

Acknowledgments

As it is true for everyone, we have also arrived at this point in achieving a goal in our life through various interactions with and help from other people. However, written words are often elusive and harbor diverse interpretations even in one's mother tongue. Therefore, we would not like to make efforts to find the best words to express my thankfulness other than simply listing those people who have contributed to this thesis itself in an essential way. This work was carried out in the Department of Computer Science and Engineering at East West University, Bangladesh.

First of all, we would like to express our deepest gratitude to the almighty for His blessings on us. Next, our special thanks go to our supervisor, "Amit Kumar Das", who gave us this opportunity, initiated us into the field of "XPChain: A Blockchain-Based Decentralized E-Recruitment Platform", and without whom this work would not have been possible. His encouragement, visionaries and thoughtful comments and suggestions, unforgettable support at every stage of our B.Sc. study were simply appreciating and essential. His ability to muddle us enough to finally answer our own question correctly is something valuable that we have learned and we would try to emulate if ever we get the opportunity.

We would like to thank "Shovon Paul" and "Jubair Islam Joy" for their overall support.

Last but not least, we would like to thank our parents for their unending support, encouragement, and prayers.

There are numerous other people too who have shown me their constant support and friendship in various ways, directly or indirectly related to our academic life. We will remember them in our hearts and hope to find a more appropriate place to acknowledge them in the future.

<div align="right">

Shaila Sarker
Abdullah – Al – Haris Shakib
Ashiful Arefin
December 2019

</div>

Table of Contents

List of Figures

Chapter 1

1.1 Recruitment

The term "recruitment" is used to define a process to find and hire the most qualified applicant for a specific job. It is an employee searching process. The process starts with identifying and publishing the qualifications and requirements for a particular job and ends with introducing a new employee to the organization.

In earlier days, the employers used to recruit employees starting with an advertisement in the print/broadcast media when there's a vacancy for any job. The interested candidates followed the recruitment circular and based on their eligibility and interest, they applied for the job. After the application deadline, the HR department checked the received applications and the CVs to perform some primary screening. Generally, the shortlisted candidates were invited via phone calls, postal mails, or emails to attend a face-to-face interview. Based on the performance of that interview and/or some evaluation the fittest employee was selected for the job. Besides, some companies used to hire some recruitment agencies to run the recruitment process. This method was very time consuming and inefficient.

1.1.1 E-Recruitment

In 1994, the internet evolved the recruitment process to become more efficient with electronic recruitment or e-recruitment [1]. E-recruitment system is a faster, cheap and efficient way of recruiting people for any company or organization. Here the whole recruitment process takes place on the internet. The job circulars are published on company websites, social media, online

job portals, etc. Nowadays, LinkedIn is such a popular online platform for professionals. This publishing process is much faster than the paper-based publications. The candidates and the recruiters can access the portals at any time and from anywhere with an internet connection. Portals can also filter the applications received for a circular. The applicants selected for an interview can receive emails or notifications automatically generated by the portal. The interviews can take place on any video conferencing platform such as Skype.

1.2 Background

Nevertheless, some issues remain regarding authenticity and credibility from both ends. The employer may prioritize or override the candidates discriminating based on religion, gender, race, color, nationality, personal favors, etc. The candidates can try to get on using forged certificates, documents, etc. This research study aims to mitigate these issues regarding favoritism or nepotism using Blockchain. Thus, both the recruiter and employee get rid of fraudulent due to corruption in

recruitments.

1.3 Blockchain

Blockchain is a tamper-proof, distributed digital ledger containing transactional data in a private or public P2P (peer-to-peer) network [2]. All the validated and confirmed blocks are connected and chained from beginning to the most recent block of the chain. In the Blockchain network, the member can view the transactions that are relevant to them. It is immutable as the alteration of the transactional data or blocks is impossible [3]. Data can only be inserted; no deletion or modification is possible. Hence it has credibility and authenticity. Distributed Ledger Technology is a database that contains the transactional records of a system. All the data are stored across several computers that are considered as nodes; thus, make a network. DLT helps to remove the necessity of intermediaries between users and for this, it is considered as trustless.

1.3.1 Trustless Trust System

Blockchain is considered to be a "trustless trust" system. Though the term sounds like an antithesis, the system is trustworthy in real [4]. As it follows a mechanism named 'consensus' which is achieved using a consensus algorithm. There are lots of consensus algorithms at work in different Blockchain implementations. Proof-of-Work (PoW), Proof-of-Stake (PoS), Delegated-Proof-of-Stake (DPoS), Proof-of-Authority (PoA), etc. are the most popular ones. Consensus algorithms are designed to reach an agreement between the Blockchain nodes about the validity of a block. Since all the data in the Blockchain network is replicated among the nodes, this is a crucial point. Proof-of-Authority has a much higher transaction rate comparatively. The system has to trust some validators for generating valid transactions. The primary beneficiary of the chain, the employees, are not actually in control of the network. Employees cannot transfer their experience points to others. Hence, when an organization generates a block and, it is broadcast to all the other nodes. The block is accepted by the other nodes only when the block contains valid data. The block expresses the acceptance with the creation of the next block having the hash of the previous one in the chain. It means, instead of depending on any third party Blockchain use consensus protocol for agreeing with the digital signatures, cryptographic hashes, and ledger contents to ensure the integrity of the transactions.

1.3.2 Digital Signature

Digital signatures are digital codes that are generated as well as authenticated by the public key encryption. These digital codes are attached to the documents or messages that are transmitted electronically to verify the sender's ID along with the contents in it. Messages are generally bit strings. Sometimes hash functions are used to convert arbitrary inputs into the proper format. The signatures are kept much shorter to save time. When all relevant prerequisites are satisfied the digital signatures are considered to be valid and it makes the recipient strongly believe in the messages sent by the claimed sender to them as there is no chance to alter the messages in transit [5].

Digital signatures are used for authentication, ratification, and integrity. Digital signatures are used for authenticating the sender of the messages. Valid signature helps to identify the user, who sent the message. When the source has been authorized through digital signatures the refusal of the ownership of the sent message will be meaningless. Ratification is considered as another important aspect in this case as an entity denial of a signed record is impossible. And there's no chance of emulating a valid signature by fraud. Integrity is ensured in such a way that there's no alteration of

the messages in transit while sending it to the recipients.

1.3.3 Decentralization

In a relational database, there's always a centralized author who has control over the database to change or modify any data and even has the allowance to delete the data. But in a blockchain, it is impossible to remove or alter any data by any centralized author. In a blockchain, each individual has control over the distributed ledger. Moreover, there are multiple copies of all the information in a Blockchain that almost mitigates the risk of data failure. If anyone tries to tamper with the data, their chain will be invalidated. Therefore, other nodes will not agree with that defected node.

1.4 Contributions

The significant contributions of the study are:
- To keep records of employees' achievements secured.
- To verify employee's academic and professional achievements.
- To create a decentralized or transparent and authentic e-recruitment system.

1.5 Organization of the Book

This research has been organized as follow: The Chapter 2 describes some related researches regarding E-Recruitment and in Chapter 3 the proposed platform for XPChain has been explained in depth. Chapter 4 represents the implementation details and Chapter 5 discusses about the limitations of the proposed method. Finally, Chapter 6 will conclude the study with mentioning some future and alternative initiatives regarding the proposed method.

1.6 Conclusion

This research study has been done to resolve the issues regarding corruption in recruitment systems. Such as favoritism or nepotism, racism or discrimination of employees by unfair means. Thus, the actual skills will be rewarded, the skilled person will be selected through the recruitment process and the company will be able to make more profit with the help of the experts recruited using XPChain.

Chapter 2

2.1 Introduction

It is tough to expand the literature review section for the research study since very few numbers of literature are available regarding this study. It is tough to find them. However, some of the available researches regarding this study have been reviewed in this chapter.

It seems that previously, some researches have been done to accelerate and optimize the recruitment system. Most of the studies have become successful in the discussion about the speed of recruiting employees. And others have adopted decentralized platforms as per the research requirements.

2.2 Literature Review

This research study will start reviewing the relevant literature with the discussion of the research named EduCTX from which the idea of the present study generated. EduCTX is a blockchain-based higher education credit transfer platform. The platform records students' acquired credits as tokens in the chain. The proposed solution was based on a distributed peer-to-peer network system, and they designed their proposed method in a very effective and efficient way. It was based on an open-source Ark Blockchain Platform. Though they have designed their proposed method but didn't implement it for a real-life environment [6].

A group of researchers in another research study related to this study has analyzed the success of using Facebook, the most popular SNS (Social Networking Site) in the recruiting system. Though they found a positive impact of SNS on the recruitment system, they couldn't solve the third-party involvement problem in the process [7].

Some other researchers have determined systematic freelance platforms regarding maximum gratified job requests with a proposed method of centralization of the schemes which achieve capacity in their research work. For ensuring freedom of the customers along with freelancers and decentralization operation, it has proposed simple schemes that are compatible with the operation of immediate crowd-sourcing platforms that achieve capacity approximately. When job requests go beyond capacity, it had a proposal of a scheme that was agnostic of the information, but fair and optimal to decline jobs without waiting [8].

Another study implemented a decentralized controlling system that is done on an experimental platform and dedicated to studying of knocking down in the industrial tubes. Having an order of 2x2 the plant was modeled as a multivariable system whose inputs were the applied current and voltage respectively in the actuators of the plant, and outputs were flowing along with pressure measurements that were obtained by sensors in the main tube. The Decentralized PID Control System was performed by a supervisory system that was developed in LabVIEW Software for verifying the impact regarding foul on the behavior of the experimental platform. Thus, it enabled performing predictive maintenance [9].

Some researchers have designed and evaluated a method for reducing multipath errors on Levenberg-Marquardt methods. The positioning of persons and objects can be done through a decentralized localization platform. Decentralized computation of position helps in shifting application-level knowledge into MS (Mobile Station) and in avoiding communication with remote devices such as a server. But limited computing capacity and power supply and restricted storage throw challenges in computing position on resource-constrained devices. So, the study proposed suitable algorithms for computing both optimized and unoptimized positions on Resource-Limited Mobile Stations [10].

Various literature has proposed different online recruiting systems. Among them, most of the systems were focusing on the selection and assessing the stage of the individuals and neglected the employees' search stage. Based on Massive Open Online Courses, the literature proposed a new way of e-recruitment. Created a real bank having profiles that made it an essential source for recruiting for the organization [11].

An article has a similar but not the same concept regarding this study, i.e., focuses on the implementation of such a system that measures competence for Computer Sciences. The system has used the model of item response theory. The results found by the system are represented to the students in the form of a dashboard. The teachers will be allowed to have necessary elements for monitoring their learnings by identifying causes blocking and checking achievements. The system can also help in amending the recruitment process by companies using it as a near-selection process of employees for jobs [12].

1.6 Conclusion

Reviewing other researches, the study came to a decision to resolve the issues those remained unsolved. And the study will include implementation details as a proof of concept. The whole concept consists of recruiting employees based on their earned experience points through the proposed system. Thus, a transparent and fair recruitment process will be done while selecting employee for any job vacancy.

Chapter 3

3.1 Introduction

This research study is all about recruiting an employee for a specific job by the employer, where the recruitment system has been decentralized using Blockchain. The name XPChain has been chosen for some valid reasons, i.e., it keeps track of an employee's professional experiences and achievements. In modern applications and games, users earn experience points (XP) as they reach milestones to keep track of the levels, abilities, and skills as well [13]. The proposed method is similar to this concept. Besides, the record is kept in a Blockchain. Hence, it has been named XPChain. The architectural design of the XPChain implementation is given in Figure 3.1.
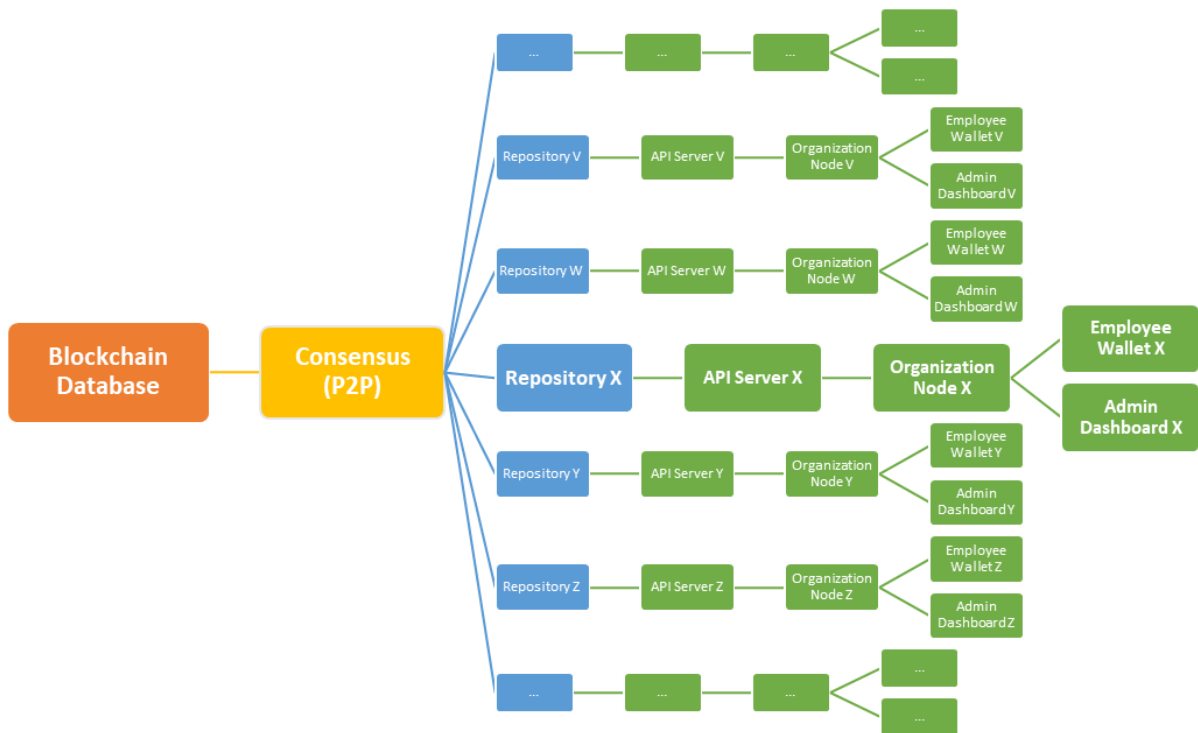

Figure 3.1 Diagram of Blockchain Incorporated XPChain Architecture

The XPChain platform recognizes employees' work experiences as tokens (XPToken) in the Blockchain. The organizations provide tokens, and employees cannot transfer XPTokens among themselves. However, organizations can transfer tokens among them for particular purposes. Organizations are the nodes in the network, and they hold the actual data in the network. The employees are passive users, and they use their respective organization's web services to keep track of their experience points (XPToken).

3.2 Organizations Joining to The XPChain Network

Since the system has to be trustless, the nodes have to be verified before being included in the network. Any existing member organization (hereinafter referred to as memOrg) can verify a new organization (hereinafter referred to as newOrg). When a newOrg is interested to join the XPChain network, they have to follow the steps:

- Contact a memOrg and get the necessary (Node and Crypto) scripts along with the memOrgs addresses.
- Using the Crypto script, newOrg will generate a new Public-Private Key-Pair and safely store the private key.
- Run the Node script and say "hello" to all the memOrgs to inform the newOrg's existence. The memOrgs acknowledge the greeting and registers the newOrg's web address and public-key as an unverified organization.
- The newOrg requests 1 XPToken from a memOrg, over a private channel.
- The memOrg verifies the new organization's existence and validity and transfers 1 XPToken to the newOrg's blockchain address.
- Over a private channel, the memOrg asks for reimbursement of 0.00X tokens. (X is supposed to be a secret)
- The newOrg transfers those as mentioned above (0.00X) amount of XPTokens.
- If the newOrg reimburses the correct amount of XPTokens, the memOrg adds the newOrg's information into the blockchain, signing it with the memOrg's private-key. Thus, the memOrg becomes the validator of the newOrg and initially transfers a significant amount of XPTokens to its address.
- When this is broadcast and accepted, all memOrgs add the newOrg as a new blockchain node and promotes it to a verified organization.
- Now, the newOrg is part of the network and can participate in all operations. All the steps mentioned above will be visually represented through a BPMN diagram inserted as Figure 3.2.

3.3 Employees Joining the Network

The employees are not actively connected to the blockchain. They need to be connected to an organization to get their experience points in the XPChain. Employees get connected following the steps below:

- The employee will acquire the Crypto script to generate their Public-Private Key-Pair. The public key will be used as the employee's Blockchain wallet address/identifier.
- The employee will safely store their private key. This key is crucial to authenticate their identity.
- The organization will provide a wallet account that only the employee can access by verifying their identity.
- The verification is done by the following:
  - The employee generates a message with their legal name, birth date and any national identification number (National ID or Social Security Number) in the following format: NAME_YYYYMMDD_ID
  - The message is digitally signed using the Crypto script with the employee's public key.
  - The employee will submit the message, and the signature to verify their identity.
- The organization will verify the identity with the message and the signature using the employee's public key.

- If validated, the organization will add a record to the XPChain mentioning the employee's public key, start date, and designation.
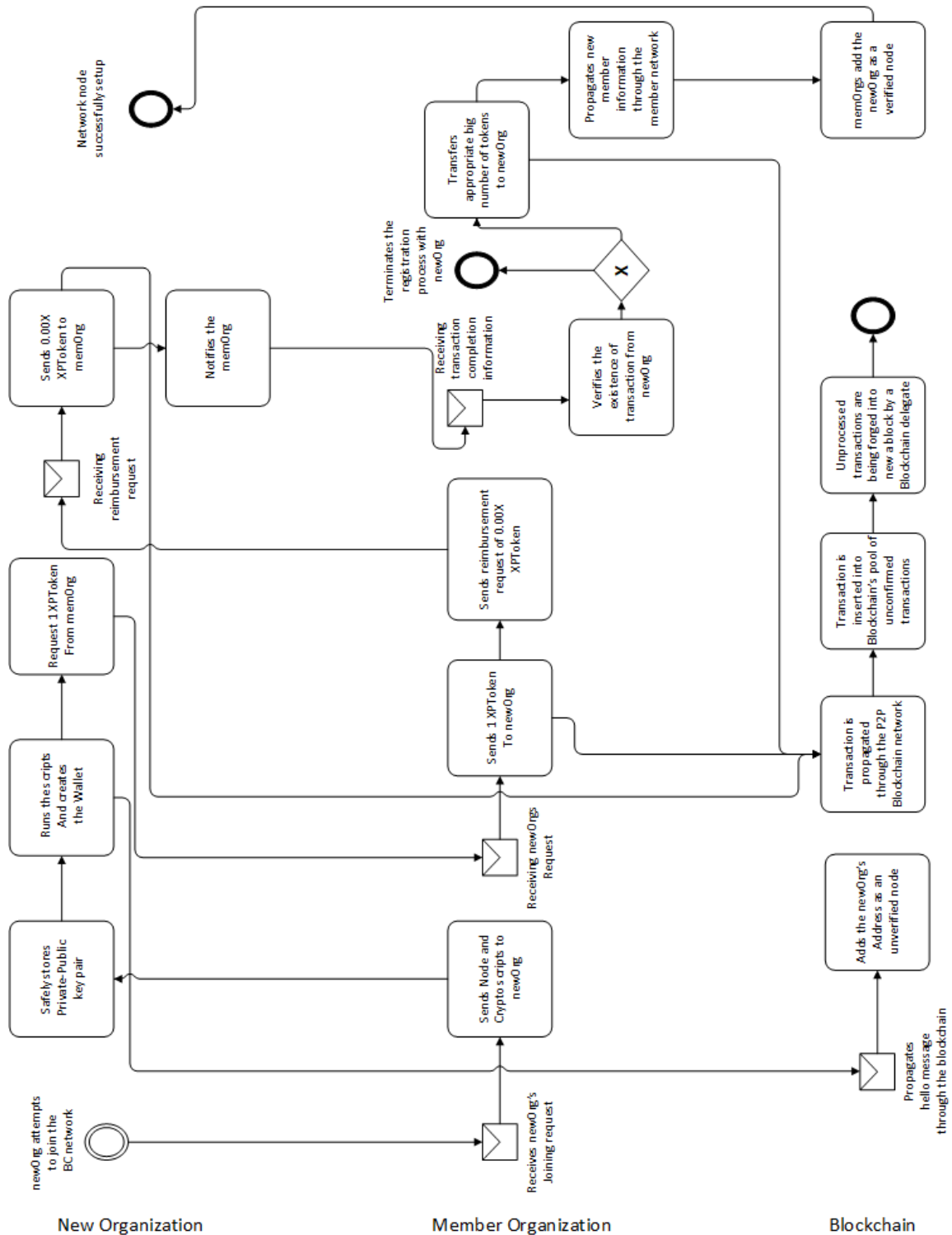

Figure 3.2 A process model of an organization's entry into the Blockchain network

The following BPMN diagram in Figure 3.3 is the visual representation of the steps mentioned above regarding the new employee's registration.
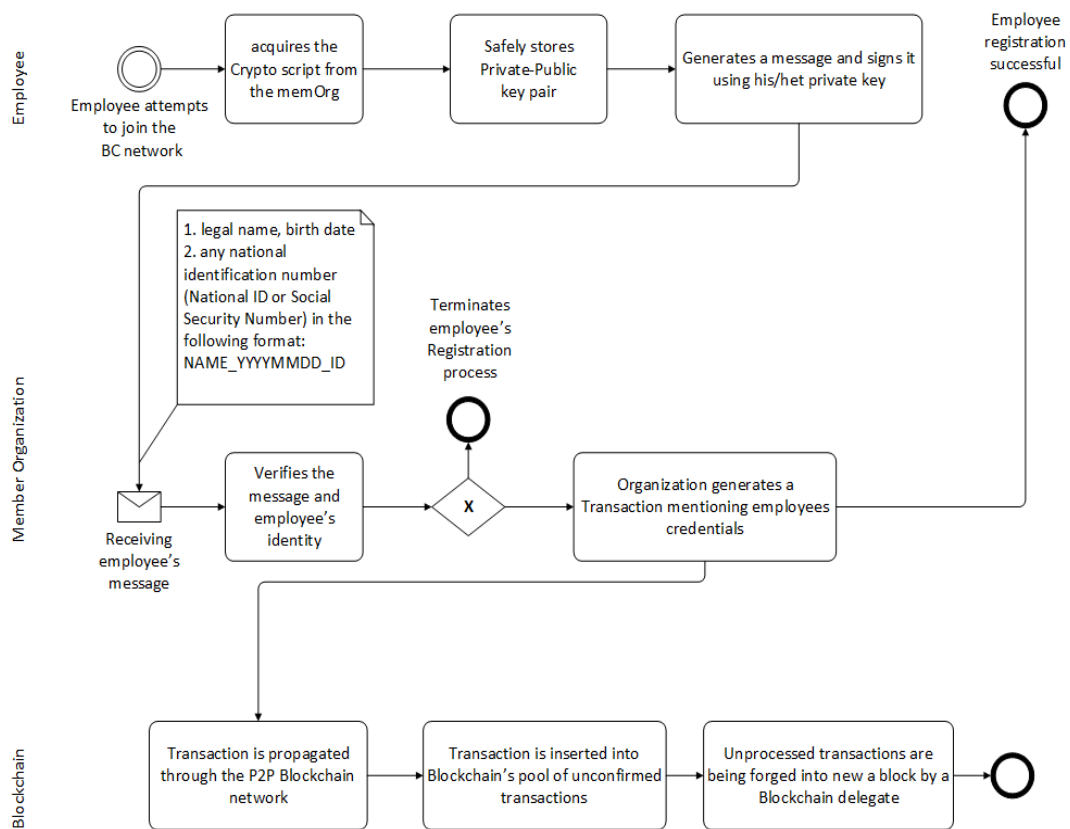
8

Figure 3.3 A process model of a New Employee's Registration into the Blockchain network

3.4 Employee Receiving XPTokens or Certificates

The real transactions in the XPChain are the transfers of XPTokens (experience points) and Certificates (or award, e.g. Employee of the Month). The employee receives some XPToken in the following steps (Figure 3.4):

- After a unit-of-work is completed, the employee adds a request to the organization's internal web site mentioning the details and a signature (with their secret private-key) for the details.
- The organization verifies if the request's validity and adds the unit-of-work to the blockchain if validated.
   - Organization can add the unit-of-work themselves. Nevertheless, the employee must add their signature before it can be added.
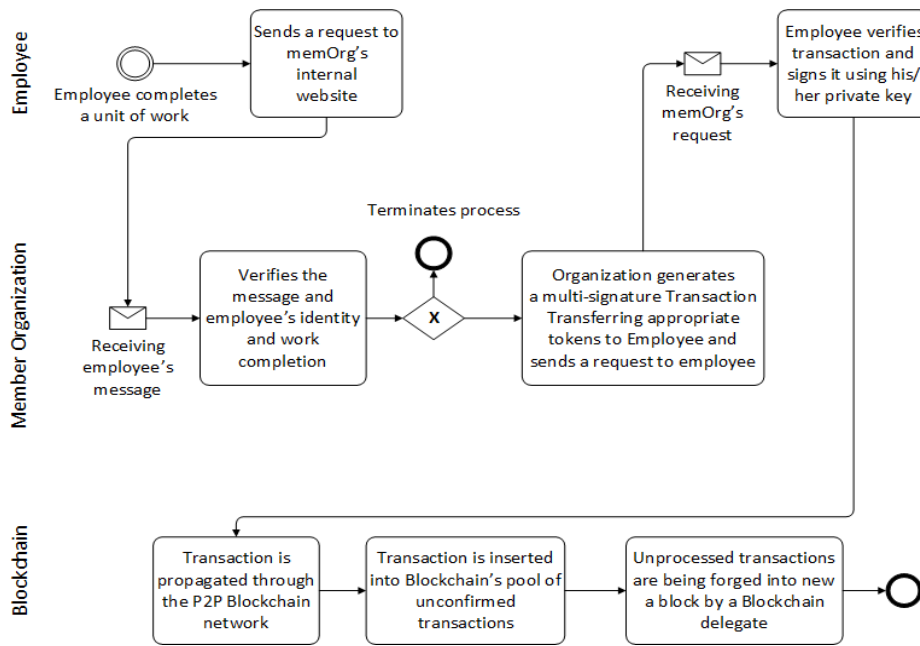   - The same rules apply for issuing certificates to the employees (Figure 3.5).

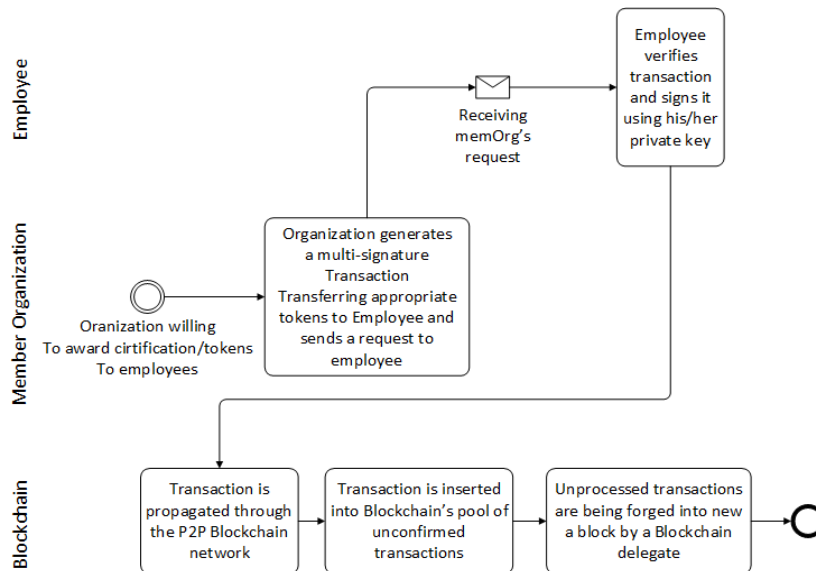*Figure 3.4 A process model of an employee receiving XPTokens*

Figure 3.5 A process model of an employee receiving certification

3.5 Employee Resigning from Organization

Employee's resignation from an organization is done similarly. It also requires the employee's signature to prove valid. An employee can be in multiple organizations at the same time, and there is no problem with that. These records are also persisted in the blockchain.

3.6 Recruitment

The recruitment process is similar to the existing e-recruitment systems. There will be a common portal for all organizations to offer job circulars with necessary details. The potential employees can visit the offers and notify the recruiters of their interested by sending their public key. The recruiters will search the XPChain database against that public key, and post the list of selected public keys in their public website/portal. The selected people will identify themselves privately and proceed with the rest of the recruitment process (Figure 3.6).
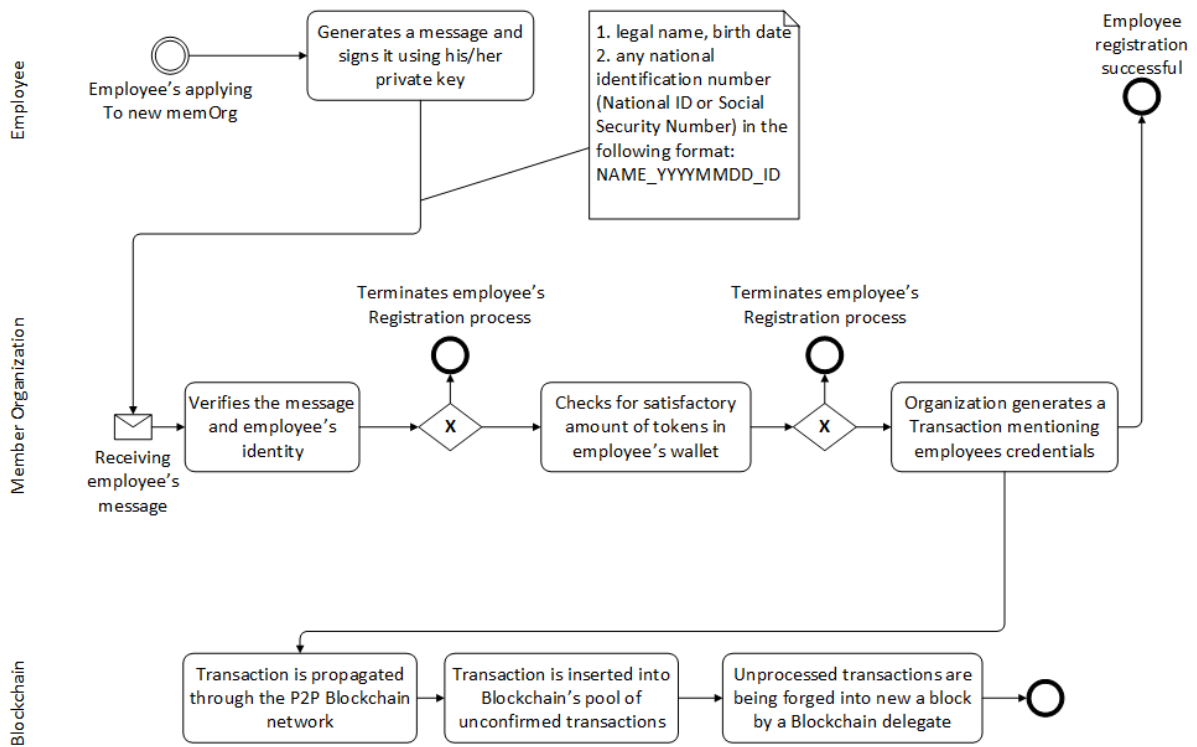
Figure 3.6 A process model of an employee being recruited to a new member organization

3.7 Conclusion

All the steps mentioned in this chapter, regarding the use of Blockchain technology in e-recruitment system will help to verify the achievements or experience of an employee that were recorded in the distributed ledger initially. The recruiter will have to simply focus on the experience points or XPTokens earned by the employee to recruit him/her for the vacancy in a specific job.

Chapter 4

4.1 CryptoTool

The CryptoTool application of the implementation provides a secure way to generate Public-Private key pairs. The tool can be executed locally on the client's machine, so the private key doesn't have to leave the computer in any way. Besides, the tool also facilitates the user with the ability to generate and verify signatures locally. Figure 4.1 shows the homepage of the CryptoTool application.

For the public-private keypair generation, **.NET**'s RSACryptoServiceProvider class is used, which lives in System.Security.Cryptography namespace. A class library (Crypto) is developed to provide the functionalities to the CryptoTool and the Server application for code reuse. The proof of concept CryptoTool application is developed with the WindowsForms application platform on .Net Core 3.0. It has a Console Application counterpart. Therefore, CryptoTool is cross-platform. The CryptoTool application's interface is included in the screenshots:
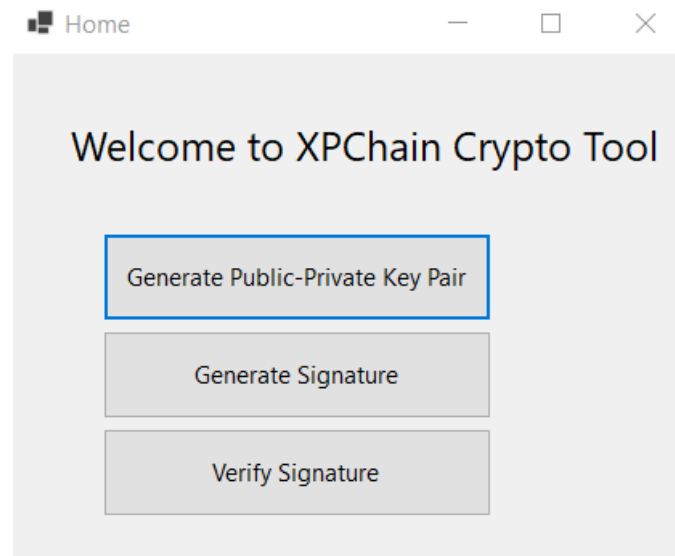

Figure 4.1 Home Page of Public-Private Key Pair Generating Crypto Tool

The "Generate Keys" page can generate RSA style public-private keypair (Figure 4.2). It also writes a text file with the name "Keys.txt" to help the user preserve the keys easily.

Figure 4.2 Graphical User Interface for Generating Public-Private Key Pair

For "Signature Generation," page on Figure 4.3 offers two fields for the message and private key input. After providing the message and private key, upon clicking the Generate Signature button, the tool generates the digital signature that can be copied to be used elsewhere.

Figure 4.3 Graphical User Interface for Generating Digital Signature

The last functionality of CryptoTool is signature validation. It provides three fields: message, public key, and signature. After providing the proper message, public key and signature, click the Verify Signature button verifies if the signature is valid (Figure 4.4) or not.
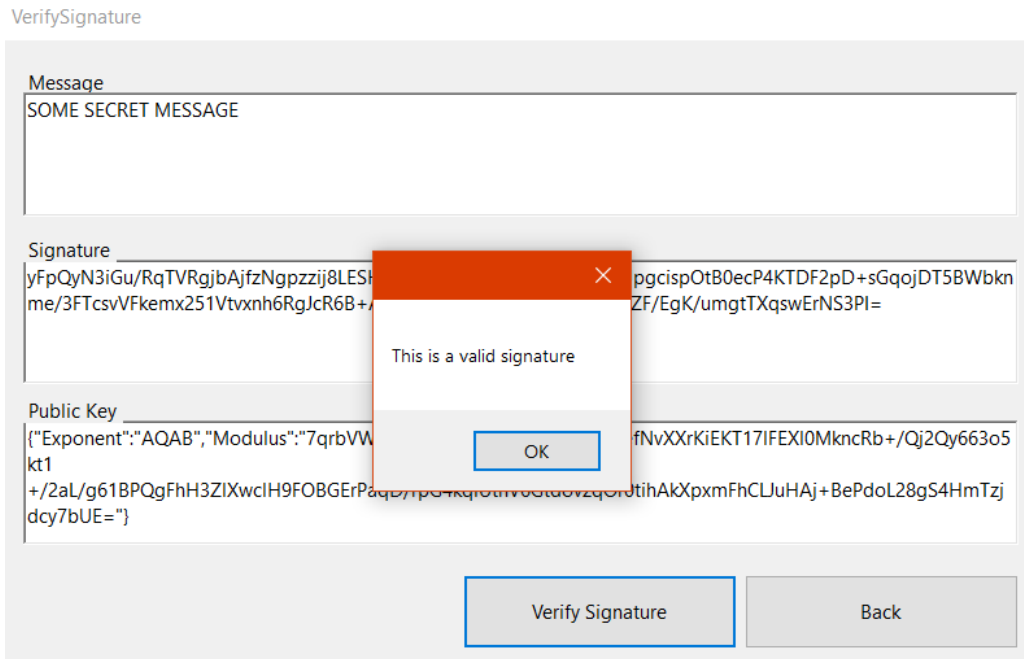
Figure 4.4 Graphical User Interface for Verifying Digital Signature Page (Valid Message)

4.2 XPChain Server

The server application executes on the organization machines and acts as Blockchain nodes. It provides necessary functionalities to add and manage related data to the XPChain platform. Each server can have admin, and employee user accounts local to the organization. Admins can access all the local data and perform appropriate operations.

The server application is developed using Visual Studio 2019. It uses the Razor Pages model and targets .Net Core 3.0 framework that is opensource and cross-platform. The figure below (Figure 4.5) shows the homepage of the application.
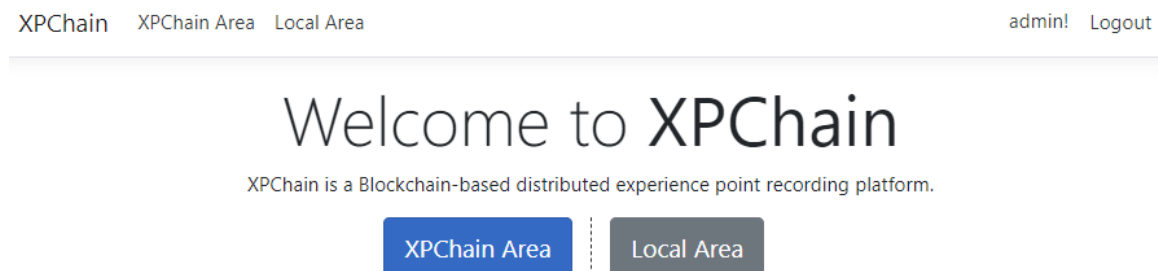

Figure 4.5 Blockchain Based Decentralized Network: XPChain's Home Page

There are two areas shown on the homepage: the XPChain area, and the Local Area. Data in the local area are exclusive to the organization. The local area page provides the following options (Figure 4.6):

Figure 4.6 Organization's Separate Local Home Page for XPChain

There are two areas shown on the homepage: the XPChain area, and the Local Area. Data in the local area are exclusive to the organization. The local area page provides the following options (Figure 4.7):

Figure 4.7 Form for Adding New Employee to The Local Area of XPChain Server

Before adding any data (except Projects) to the Blockchain, it has to be added to the local area. The data is once validated and verified in the local area, and then when the admin feels ready, they can

publish/deploy it in the XPChain. Before entering into XPChain, each data block is verified by the other nodes in the network for the consensus.

The process of adding a new employee is shown below:

1. Admin logs in and navigates to Local Area > Employees > Add New (Figure 4.8).

Local Employee Details

Shakib Haris

Username	shakib
Email	shakib@comx.com
Phone	6582358565
Address	Dhaka, Bangladesh
Designation	Junior Software Developer
Date of Birth	01-Oct-96
Join date	01-Jan-14
Identification Number	1996100101
Public Key	{"Exponent":"AQAB","Modulus":"8s1r6/vo2 dhqwTn4snb5phVCYDhEnmJ0GI3oMRs82r8wU7E5 Hw2bYwKMC8Jv/n0j3v8ocdXEKK55womKwyj0C9o SFasfJ6bm9/t3KLcOaPttzRGqFrkC96tRL9obO8 ETFw81qwqwoHhWdx37ZtfUvGU7WASZp898AqkFR 3r0l0U="}
Identification Signature	
Verification Signature	
Deployed to XPChain	No

Verify

Figure 4.8 Employee's Local Information View before verification by employee (from employee's account)

2. Admin fills up the form with the proper information of the employee, including the employee's public key.
3. Adding the employee also adds a new account for the employee. The employee is notified via an email and provided with a temporary password that the employee can change after login.
4. An employee can view their data on the local area, and are provided with a Verify button (Figure 4.9). Clicking on the button redirects to the page on Figure 4.10.
5. On employee verification page, the employee is presented with an identification message (i.e., NAME_BIRTHDATE_ID converted to base64 format) and a verification message (i.e., Organization Public Key, Employee's Public Key, Designation, and Start Date converted to base64 format). The employee copies the message, signs the message with their private key using the CryptoTool, and enters the signatures into the corresponding fields. Upon submission, the signatures are validated and on success, presented with the updated information.

6. Now, the admin can see a new deploy button on the employee's information page. This indicates, all necessary information for the employee is collected and can now be published in the XPChain.
7. After deploying, the admin is presented with a page that indicates, and the employee has been published to the Blockchain network.
8. The block view in the XPChain is shown in Figure 4.10.

Figure 4.9 Employee Verification form (only available from employee's account)

Block Details

5dcfa2efd1118503e81cf732

Hash	4zIpt4wdPH0vJ9jKZOojM/m/Jn21vjPWgqjEDzT UHcc=
Previous Block Hash	nIV4Eyk9XVr5iQZr3Rdc6wJ3jFszZ9HEkiy3SOi pF+0=
Created at	Saturday, November 16, 2019 1:19:11 PM
Block Owner	{"Exponent": "AQAB", "Modulus": "z+oFX+qNOkYP8pXFOGTX/KCOtxMrfOs+SFFlRP ACGvHeUOTEkD51nQ0EBkgdmPswIUNuF+sBQnGl0 JI6TMFJiAdLFIj/yQbsXnupw6ALBAmIUkiRkmBG B8vdCvmmy8Mb9PYGuxNCRSR9fNY12WvFVp1Su8v /D/2hfWEvj0wYxAk="}
Type	Employee
Signature	wB/6l+oVuW6jmtjemQS/+1CkxUghY0q5mUQ3EXg 0pRGZwa4JafW6bkb9OrUvBAw1P3lcrIThrFIWeU 85klJN8XuiX6EoMns5X0Lb2ezOg7KrEcKAaX8/3 Ln/N2IfxFxCPdV3J+2kZfcYDrsOGGdq28RIwpnF WSo5d4gjiYo6Blg=

Block Data

```
{
  "Organization": "{\"Exponent\": \"AQAB\", \"Modulus\": \"z+oFX+qNOkYP8pXFOGTX/KCOtxMrfOs+SI
  "PublicKey": "{\"Exponent\":\"AQAB\",\"Modulus\":\"8s1r6/vo2dhqwTn4snb5phVCYDhEnmJ0GI3oMRs
  "Designation": "Junior Software Developer",
  "StartDate": "2014-01-01T00:00:00+06:00",
  "EmployeeSignature": "a7kvfsUioKaiyzCCYS1qAHn4bh00r2svD2zfwB7Xnk1CWVQOc3T9wHH+ABP7vrNFdjQ0
  "IdentificationSignature": "ADQw8uSqNJT9SdRgiahg22vNemu3wGhwIbEqG2ViDX74gr6xXzGpsxgAveodwc
  "Id": "5dcf9e11d1118503e81cf726"
}
```

Figure 4.10 Employee Information in XPChain's distributed database in block form

New Local Unit of Work

Project	XPChain Server
Executor	Shakib Haris
Tags	Unit-Test Moq xUnit
Experience Points	15
Description	Developing unit tests for the server application.

Save

Figure 4.11 Form for Adding New Unit of Work in Organization's Local Database

The other data are published similarly. The Figure 4.11 shows the form for adding a new Unit of Work locally. Figure 4.12 shows a newly added undeployed unit of work in the local database of the organization. Then, Figure 4.13 shows newly deployed unit of work in the XPChain block list. Lastly, Figure 4.14 shows the newly added unit of work's block information.

Local Units of Work

ID	Project ID	Executor ID	Tags	XP	
5dcfa653d1118503e8 1cf737	5dcfa3d1d1118503e8 1cf733	5dcf99e5d1118503e8 1cf71b	BackEnd	10	View
5dcfa98ad1118503e8 1cf73f	5dcfa5c7d1118503e8 1cf735	5dcf99e5d1118503e8 1cf71b	BackEnd	15	View
5dcfaea608ed5d03e8 d69fdb	5dcfa8e9d1118503e8 1cf73d	5dcf9cb5d1118503e8 1cf722	Design	20	View
5dcfd6d73153c603e8 183c22	5dcfa7e5d1118503e8 1cf739	5dcf9a65d1118503e8 1cf71c	API-design node express	10	View
5dcfd7113153c603e8 183c23	5dcfa891d1118503e8 1cf73b	5dcf9ac2d1118503e8 1cf71d	signalr websocket	20	View
5dcfd7da3153c603e8 183c24	5dcfa3d1d1118503e8 1cf733	5dcf9c09d1118503e8 1cf720	web-api REST	15	View
5dcfd8403153c603e8 183c25	5dcfa891d1118503e8 1cf73b	5dcf9d65d1118503e8 1cf724	Front-End HTML CSS JS	12	View
5dcfd88a3153c603e8 183c26	5dcfa8e9d1118503e8 1cf73d	5dcf9daed1118503e8 1cf725	Class-Library C#	20	View
5dcfdafa3153c603e8 183c27	5dcfa7e5d1118503e8 1cf739	5dcf9daed1118503e8 1cf725	Class-Library C#	20	View
5dcfdb173153c603e8 183c28	5dcfa3d1d1118503e8 1cf733	5dcf9daed1118503e8 1cf725	Class-Library C#	20	View
5dcfddee3153c603e8 183c30	5dcfa3d1d1118503e8 1cf733	5dcf9e11d1118503e8 1cf726	Unit-Test Moq xUnit	15	View

Figure 4.12 List of Units of Work in Organization's Local Database with a new Unverified Unit of Work

5dcfdd403153c603e8183c2e	...VrpJdYU+id4=	...znK+kP1LQes=	...p1Su8v/D/2hfWEvj0wYxAk="}	UnitOfWork	Saturday, November 16, 2019 5:28:00 PM	View
5dcfdd623153c603e8183c2f	...snKxZaTtc7E=	...VrpJdYU+id4=	...p1Su8v/D/2hfWEvj0wYxAk="}	UnitOfWork	Saturday, November 16, 2019 5:28:34 PM	View
5dcfdf053153c603e8183c31	...0MofGzFa9+k=	...snKxZaTtc7E=	...p1Su8v/D/2hfWEvj0wYxAk="}	UnitOfWork	Saturday, November 16, 2019 5:35:33 PM	View

Figure 4.13 Snip of a Block List in XPChain's Distributed Database (Last one being the new Unit of Work from Figure 4.12)

Block Details

5dcfdf053153c603e8183c31

Hash	m0yMr43jomWIX+JuEbaKVcAgZ3cSs+jD0MofGzFa9+k=
Previous Block Hash	ml+4Mha/DCgSS5GrfH48UVQiqp1L+S4FsnKxZaTtc7E=
Created at	Saturday, November 16, 2019 5:35:33 PM
Block Owner	{"Exponent": "AQAB", "Modulus": "z+oFX+qNOkYP8pXFOGTX/KCOtxMrfOs+SFFlRPACGvHeUOTEkD51nQ0EBkgdmPswIUNuF+sBQnGl0JI6TMFJiAdLFIj/yQbsXnupw6ALBAmIUkiRkmBGB8vdCvmmy8Mb9PYGuxNCRSR9fNY12WvFVp1Su8v/D/2hfWEvj0wYxAk="}
Type	UnitOfWork
Signature	UBquXPrYnOqRBlrG+NMffsqOF6IlAeUW3JBN66AaN0RWaVFLt/GHFi4+BZD1gHQGJH8TEoYQ5b9Mir6bgOe4FUdE6Zoc64t4UHImQwf+OfBZDdsj0mPUunN43gCw+G52oR8Ibb1QFPAxlYQt8wbp2mxRgiRFkt9WcRsf4D1k8yc=

Block Data

```
{
  "Organization": "{\"Exponent\": \"AQAB\", \"Modulus\": \"z+oFX+qNOkYP8pXFOGTX/KCOtxMrfOs+Sl
  "ProjectId": "5dcfa3d1d1118503e81cf733",
  "Executor": "{\"Exponent\":\"AQAB\",\"Modulus\":\"8s1r6/vo2dhqwTn4snb5phVCYDhEnmJ0GI3oMRs8
  "Tags": "Unit-Test Moq xUnit",
  "Description": "Developing unit tests for the server application.",
  "Xp": 15.0,
  "Payload": "eyJFeHBvbmVudCI6ICJBUUFCIiwgIk1vZHVsdXMiOiAieitvRlgrcU5Pa1lQOHBYRk9HVFgvS0NPdHl
  "EmployeeSignature": "OohQhR4g9+ugusMUbM2bYyJPiqJvKoxFJI450WxyaseGJcjdnKaLl90YEcU4jyE0nURA
  "Id": "5dcfddee3153c603e8183c30"
}
```

Figure 4.14 Block View of the Unit of Work (mentioned in Figure 4.12) in XPChain's Distributed Database)

This is how the XPChain server application works for its users. The source code is publicly available at https://dev.azure.com/brotal/xpchain.

4.2 Conclusion

This chapter has represented the Graphical User Interface of XPChain platform. The screenshots have shown the steps through which the record of an employee has been inserted into the Blockchain using verification processes or PoA consensus algorithms. Using the system, the employer can recruit employee in a faster and secured way.

Chapter 5

5.1 Introduction

Although the adoption of blockchain technology in the e-recruitment process has created a new dimension to it. Now the issues regarding nepotism, racism, gender, and religious discrimination have been minimized. However, the anonymity holds until the primary selection process. This can be further optimized by eliminating the primary selection and go straight to offer appointment letters to the best candidates.

5.2 Scalability

Scalability is considered as the core problem in blockchain technology. In Bitcoin and Ethereum, because of having consensus mechanisms that require each participating node for verifying the transaction, which limits the blockchain network from processing the total number of transactions. Transactional patterns become transparent for being recorded on the public ledger. For immutability and being append-only, the blockchain stores data indefinitely. Hence, the data storage imposing a significant cost on a network which is decentralized and where every full node store more and more data into infinity. Consequently, storage remains a massive hurdle for any realistic application which uses the blockchain network.

5.3 51% Attack

There is a concept named "51% attack" in which telling a lie becomes the truth. It is considered an unavoidable security flaw. An unsuitable consensus mechanism may create a failure in the process. Blockchain Technology needs supercomputers or powerful hardware resources for running transactions, which may lead to massive energy consumptions. It happens due to spending a large amount of computational power to solve the computations to process and verify the transactions. Our implementation uses PoA that minimizes this problem by a considerable margin.

5.4 Conclusion

Although the system will have some lack due to the limitations of Blockchain technology, but on the contrary it will use the benefits of the technology such as trusted, temper evident and credibility etc.

Chapter 6

6.1 Conclusion

The XPChain platform proposes a blockchain-based global work experience platform. It takes advantage of the blockchain's trusting nature to create cooperation among the planet's established organizations and helps employees keep track of their work-experiences and easily prove their expertise in their respective fields. So, fraudulent can be removed in a certain way. Thus, the proposed method made the e-recruitment system more efficient in behavior. The Blockchain-based platform is considered to be accepted globally without any distrust, and the solution founded towards fraudulent, nepotism, and racism while recruiting employees is up-and-coming.

6.2 Future Work

However, our prototype proof-of-concept is using a dummy blockchain network made from scratch that can be replaced by established implementations like ARK or Ethereum. The PoA consensus can be also replaced with DPoS or similar algorithms. The XPChain does not consider any penalties for the wrongdoings, which also can be incorporated for a more realistic use case.

[1] Chignell, B. (2019). The Evolution of Online Recruitment. [online] CIPHR. Available at: https://www.ciphr.com/features/the-evolution-ofonline-recruitment/ [Accessed 09 Oct. 2019].

[2] IBM Developer. (2019). Blockchain Basics: Introduction to Distributed Ledgers. [online] Available at: https://developer.ibm.com/tutorials/clblockchain-basics-intro-bluemix-trs/ [Accessed 09 Oct. 2019].

[3] Armstrong, S. (2019). Move over Bitcoin, the blockchain is only just getting started. [online] Wired.co.uk. Available at: https://www.wired.co.uk/article/unlock-the-blockchain [Accessed 10 Oct. 2019].

[4] Cloud Technology Partners. (2019). Blockchain: You Want Me to Trust a "Trustless Trust" System? – Cloud Technology Partners. [online] Available at: https://www.cloudtp.com/doppler/blockchain-you-want-me-to-trust-atrustless-trust-system [Accessed 15 Oct. 2019].

[5] Paul, E. (2019). What is Digital Signature- How it works, Benefits, Objectives, Concept. [online] Emptrust.com. Available at: https://www.emptrust.com/blog/benefits-of-using-digital-signatures [Accessed 9 Nov. 2019].

[6] M. Turkanovic, M. Hölbl, K. Koši ´ c, M. Heri ˇ cko and A. Kamišali ˇ c,´ "EduCTX: A Blockchain-Based Higher Education Credit Platform," in IEEE Access, vol. 6, pp. 5112-5127, 2018.

[7] Golovko, D. and Schumann, J., "Influence of company Facebook activities on recruitment success." in ELSEVIER, vol. 104, pp. 161-169, 2019.

[8] A. Chatterjee, L. R. Varshney and S. Vishwanath, "Work Capacity of Regulated Freelance Platforms: Fundamental Limits and Decentralized Schemes," in IEEE/ACM Transactions on Networking, vol. 25, no. 6, pp. 3641-3654, Dec. 2017.

[9] T. Rodrigues de Melo, J. Jo da Silva and J. S. da Rocha Neto, "Implementation of a Decentralized PID Control System on an Experimental Platform Using LabVIEW," in IEEE Latin America Transactions, vol. 15, no. 2, pp. 213-218, Feb. 2017.

[10] Z. Kasmi, N. Guerchali, A. Norrdine and J. H. Schiller, "Algorithms and Position Optimization for a Decentralized Localization Platform Based on Resource-Constrained Devices," in IEEE Transactions on Mobile Computing, vol. 18, no. 8, pp. 1731-1744, 1 Aug. 2019.

[11] H. Lynda, T. M. E. Amine, B. Farida and B. Tassadit, "E-recruitment support system based on MOOCs," 2017 International Conference on Mathematics and Information Technology (ICMIT), Adrar, 2017, pp. 234- 238.

[12] A. Aajli and K. Afdel, "Towards a new approach of measure of skills applied to an adaptive

assessments system used in e-learning and erecruitment," 2013 ACS International Conference on Computer Systems and Applications (AICCSA), Ifrane, 2013, pp. 1-4.

[13] Quora.com. (2019). Why do role-playing video games have the XP system to level-up characters' skills and traits? - Quora. [online] Available at: https://www.quora.com. [Accessed 8 Nov. 2019].

Appendix

P2P	Peer to Peer
DLT	Distributed Ledger Technology
PoW	Proof-of-Work
PoS	Proof-of-Stake
DPoS	Delegated Proof-of-Stake
PoA	Proof-of-Authority
XP	Experience Point
EduCTX	Higher Education Credit Transfer Platform
SNS	Social Networking Site
memOrg	Member Organization
newOrg	New Organization
BC network	Blockchain Network