People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research

Larbi Tébessi university - Tébessa

Faculty of Exact Sciences and Natural and Life Sciences
Department: Mathematics and Computer Science

End of studies thesis
For obtaining the MASTER diploma
Field: Mathematics and Computer Science
Faculty: Computer science
Option: Networks and information security

Subject:

Protection of personal data in Smart Grid using Blockchain and Edge Computing

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Defense date: 21/06/2021

2020/2021

Abstract

The deployment and development of smart networks is related to the development of network technologies in terms of the communication process, how to exchange data, and the method of protecting them in an ideal manner. Threats, this work sought to use the permission Blockchain Model in Smart Networks (PBEM-SGN) combined with advanced computing technology (Edge computing) to protect privacy and energy security that achieved optimal security to ensure that the edges of the network are really secured.

Résumé

Le déploiement et le développement des réseaux intelligents sont liés au développement des technologies de réseau en termes de processus de communication, de mode d'échange de données et de méthode pour les protéger de manière idéale. Menaces, ce travail visait à utiliser le modèle de blockchain autorisé dans les réseaux intelligents (PBEM-SGN) combiné à une technologie informatique avancée (Edge computing) pour protéger la confidentialité et la sécurité énergétique qui a atteint une sécurité optimale pour assurer la santé des utilisateurs

ملخص

ان نشر الشبكات الذكية و تطورها متعلق بتطور تقنيات الشبكة من حيث عملية الاتصال,كيفية تبادل البيانات.و طريقة حمايتها بطريقة مثالية.يعتبرالامان و الخصوصية من اكثر النقاط التي تسبب مخاوفا لدى اي شبكة,لكن بالمقابل تم تقديم خدمات مرنة و فعالة لمواجهة هذا النوع من التهديدات.حيث سعى هذا العمل الى استعمال نموذج Blockchain المصرح به في الشبكات الذكية (PBEM-SGN)اتحادا مع تقنية الحوسبة المتطورة (Edge computing) لحماية الخصوصية و امن الطاقة التي حققت الامان المثالي لضمان صحة المستخدمين.

Dedications

I dedicate this modest work to:

My dear parents, of whom I am and I would be fully grateful for having supported me throughout my journey, may God keep them and protect them.

My dearest sisters: wafa, bouthayna, roufayda, aya.

And my friends:rabie and samiha.

Thanking

I would like to thank all the people who contributed to the success of my internship and who helped me .

First of all, I would like to thank my project director M.Ali Abdelatif Betouil, professor at the University of Tebessa, for his patience, his availability and above all his judicious advice, which contributed to my reflection.

I thank my dear parents, who have always been there for me. I thank my sisters wafa, bouthayna, roufaida, Aya for their encouragement.

I always thank my grandmother Mahbouba for wishing me a good luck.

Finally, I thank my friends Rabie mohcene, Samiha redjel, who have always been there for me. Their unconditional support and encouragement has been a great help.

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Work plan :

General Introduction

In the current time, we live in terrible technological forces that provide almost all of humanity's needs; a person can completely depend on the machine to get his needs in a smart and fast way.

One of the currently popular fields is the field of renewable energies, which has swept a large place among traditional energies that can be used in urgent cases and this is the main reason for its establishment.

In order to preserve its position in the area, the researchers developed it and improved its level in all respects, they went with its content to artificial intelligence to make it a smart network(Smart Grid) that is more accurate and fast to meet consumer demands, which has met with great success in economic return, make it a requirement for many consumers, but the success of any system is not complete without securing its information and exchanges from any external attacks, which is why it has been suggested to rely on the principle of blockchain to protect the network.

Blockchain technology is very effective in protecting privacy and achieving the principle of transparency among members of the system, as it has become applied in many fields and is deservedly required by customers in order to protect their personal data or money or such as "Bitcoin"

And by this, we have noticed that the latter one will be an effective addition if it is used to protect smart networks(smart grid). This is what has been demonstrated by previous studies that have reached successful results in terms of security.

The link between smartgrid technology and blockchain technology is a strong binary to protect network data.

In the same time we will not say that this combination will achieve an ideal system. For example, the consumers by nature desire easy and speed to obtain his demands

this usually motivates him to choose a specific system,that is why the idea of introducing "edge computing" technology, which is a picture emerged

Miniature of cloud computing, but the difference between them is that edge computing is on the side of the consumer and that's what makes the data.

Closer to it. That is, the response will be immediate because the consumer's order will become a direct download of the information only.

The combination of these three forces makes the system safe, efficient, and destination for many consumers and clients.

for our suggestion ,we want to enhance the principle of transparency, which is one of the most important features of the blockchain technology, at a point where I saw that any energy source has the right to protect its production capacity from premature deterioration by adding a new element under surveillance, which is TNT(Total Number of Transaction）.

In this work ,we have covered five chapters:

Chapte1: some definitions of blockchain technique.

Chapter2: the general principle of Smart Grid.

Chapter3 :general view of Edge Computing.

Chapter4: related work.

Chapter5: proposed work.

General conclusion

Chapter (1)
Blockchain

Blockchain

1: Introduction:

Imagine a "very large notebook which everyone can read for free, on which everyone can write, but which is impossible to erase and indestructible". It is blockchain a technology for storing and transmitting information[1], transparent and secure.

We believe that the possibilities brought by this technology are immense and could revolutionize the way we think and manage our activities, but how can this promising technology be adopted? What is his level of maturity? Does it involve risks? Can we measure the benefits against the investment it represents?

2: Definition:

A Blockchain is a digital storage and information transmission technology that evolves in a transparent and secure manner, and of which a flagship application is Bitcoin.

It constitutes an ideal database [2] for transactions. It contains the history of all the exchanges made between its users since its creation. In particular, it has particular properties: once the information enters the Blockchain, it is almost impossible to alter.

3:Blockchain structure:

Blockchain is a group of units(blocks) connected to each other by tight links(data structure), each unit contains specific information[3], necessary, reliable and linked in an organized and strategic way, Indicating which block was the previous block is generally referred to as referencing.

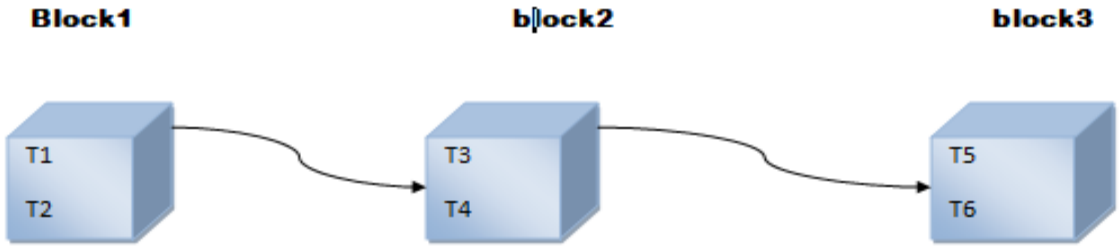

Figure 1.1: Blockchain structure

3.1: types of blockchain structure:

3.1.1: centralized blockchain :

It's like a star shape, whereby customers are centered [4], in a circular motion around a central point(it's not a leading point).

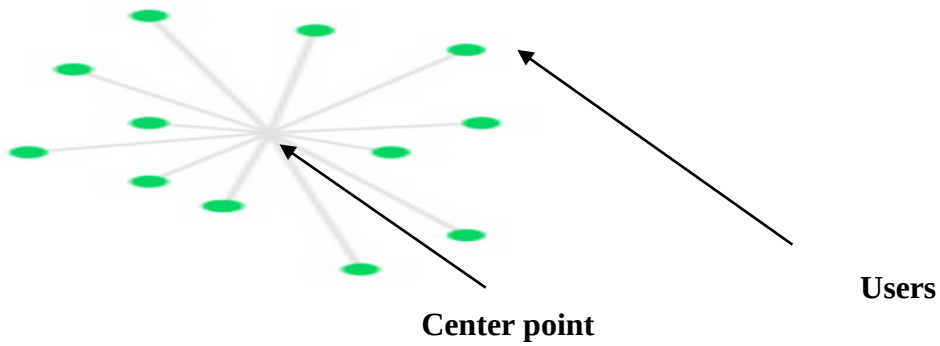

Figure 1.2: Centralized blockchain

3.1. 2: Decentralized blockchain:

It is the opposite of the first type, in which customers [5], are randomly centred.

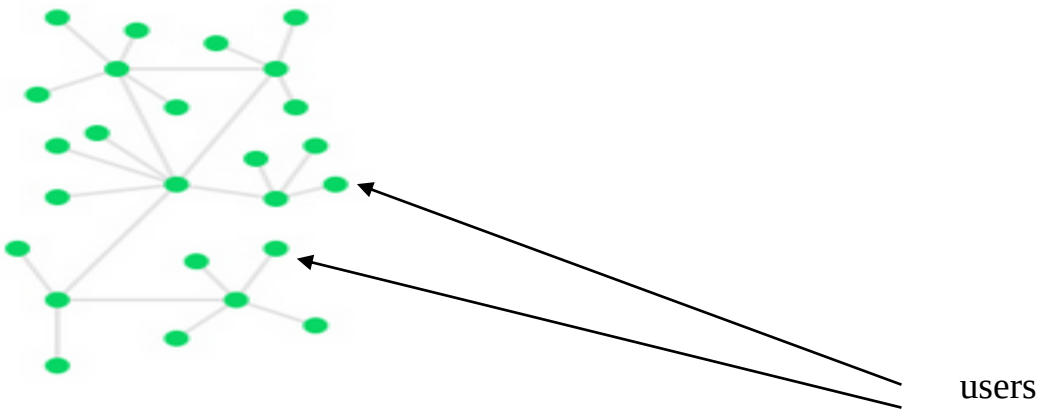

Figure 1.3: Decentralized blockchain

3.1.3: Distributed ledgers:

3.1.3.1: public blockchain:

Users are anonymous. it mean a secret[6], identity.

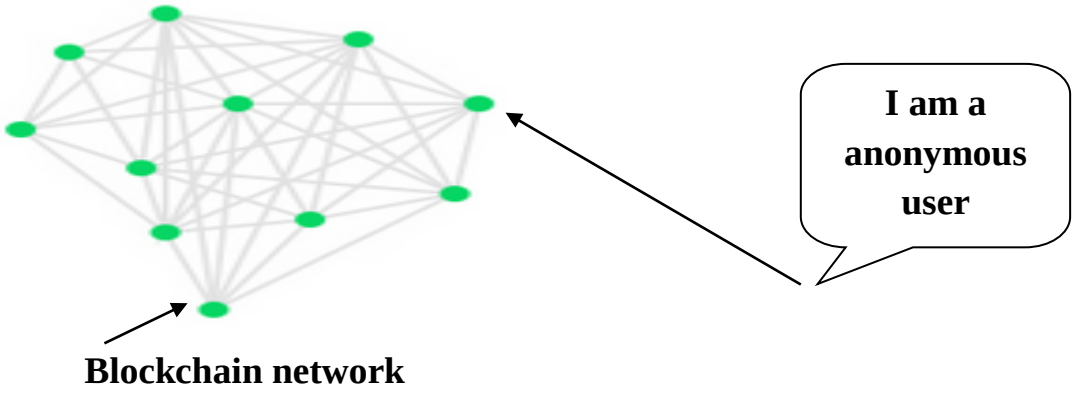

Figure 1.4Public blockchain

3.1.3.2: private blockchain:

Users are note anonymous because[7], the system is private.

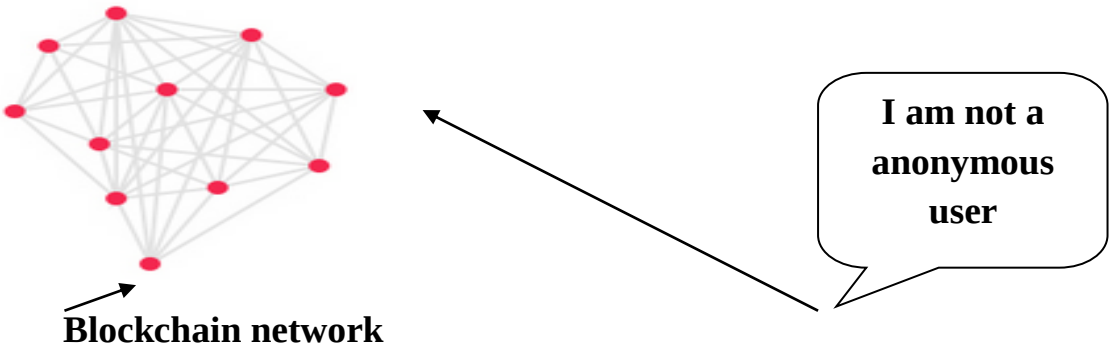

Figure 1.5Private blockchain

4:The difference between databases and Blockchain:

4.1:Data bases structure:

It is a very effective data structure [8] and it is an excellent way to store the largest possible number of data. But it is often operated depending on a central entity(Bank) that decides who can add data to the database(centralization), and also has the ability to modify or delete the data, but this type of data storage It would not be a good idea to store your money.

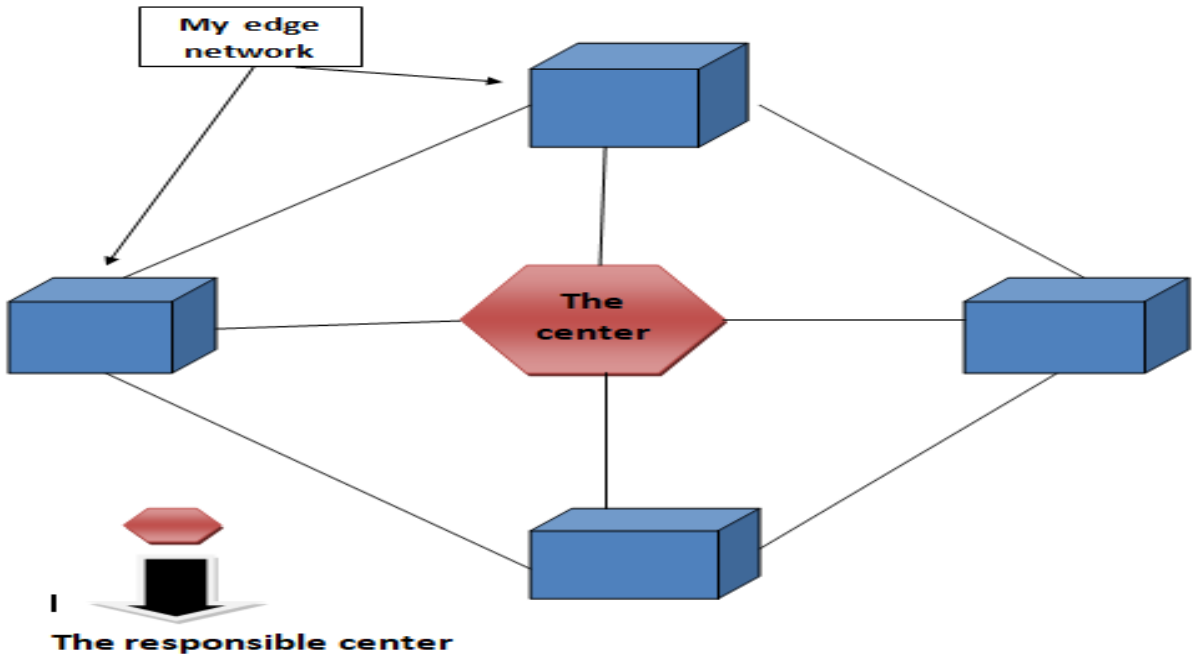

Figure 1.6: Data bases structure

4.2: Blockchain structure:

It is a less effective method of databases, as it is operated by a large number of entities, as there is no trust between these peers[9], and the beautiful thing is that they do not need to trust each other, as each peer keeps a copy of the data and does not have the power to modify it, and the communication between them takes place constantly to keep abreast of new events in Block, which is the last one is a transactions.

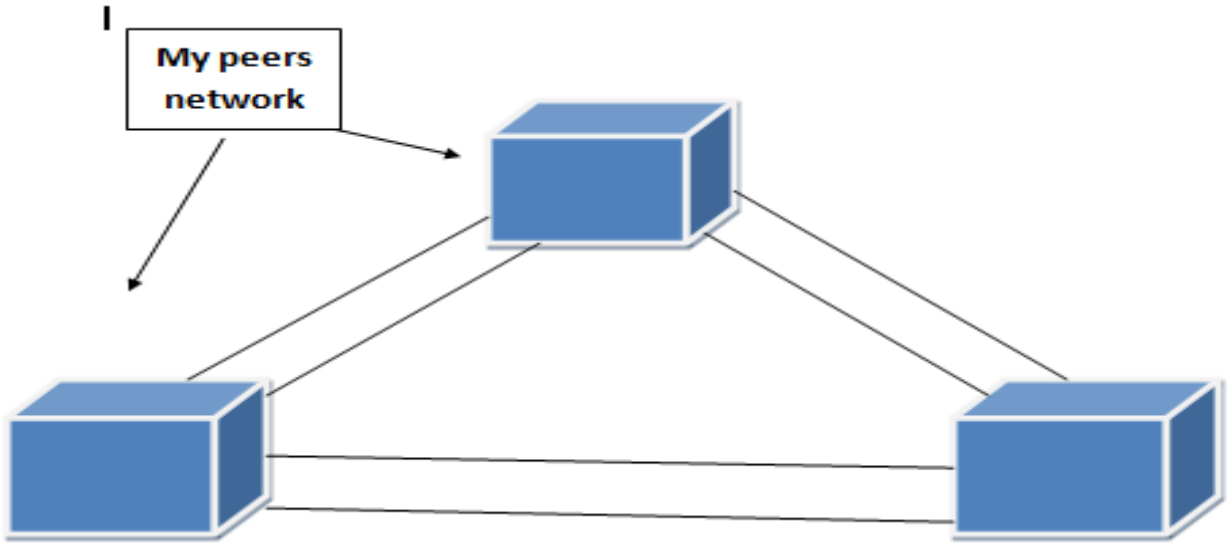

Figure 1.7: Blockchain principle

5:How does a Blockchain work?

Blockchain job is to store[10] information and transfer values without interference from any central entity, and this process is as follow:

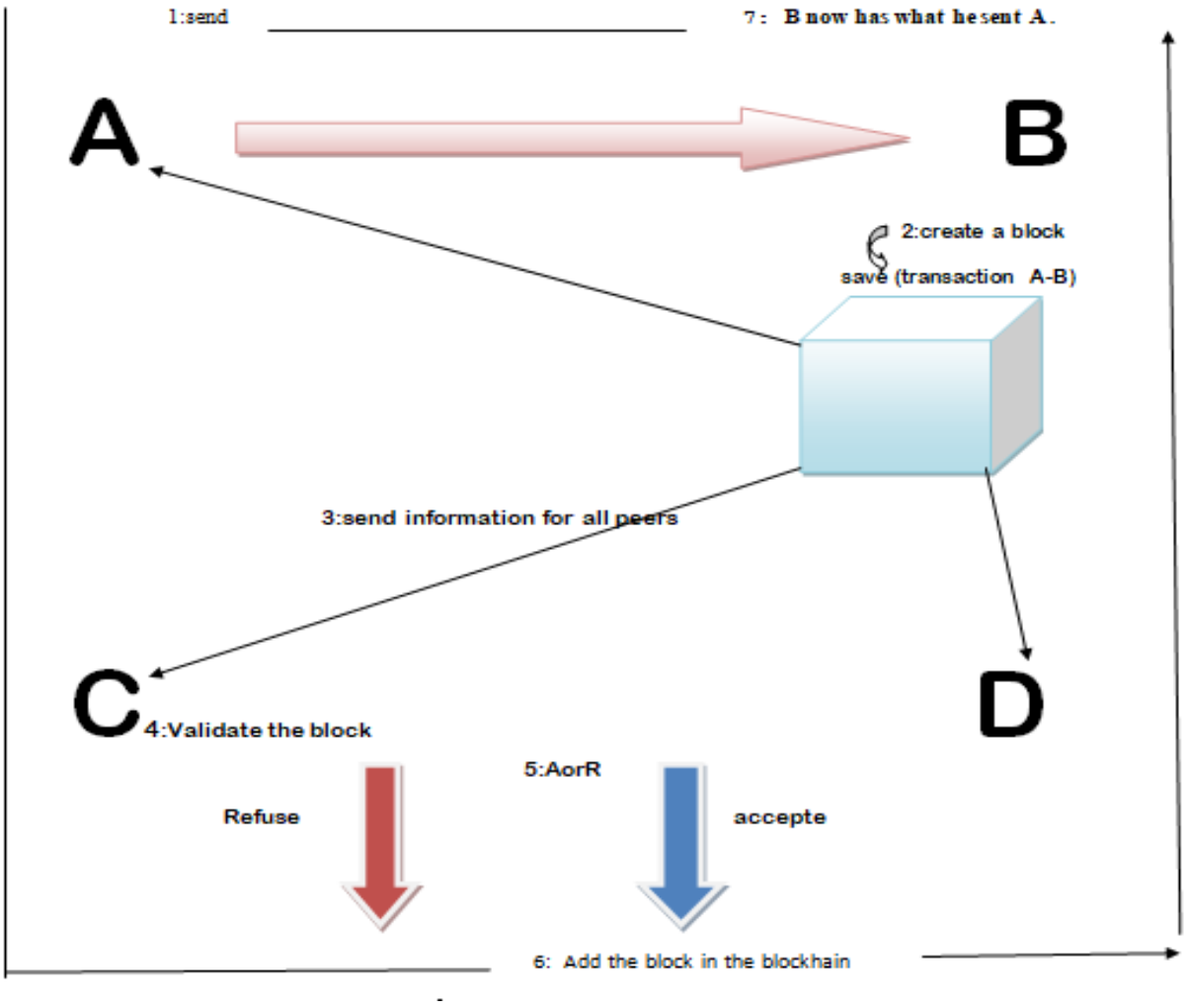

Figure 1.8: How does a Blockchain work

6:Field of use of blockchain:

Blockchain technology has been used in several fields and in different regions to determine how we can benefit from this technology that records [11] transactions in a manner that is not tampered with.
and here we present some of these cases:

6.1: Identify connected objects and verify diplomas

We can maintain some anonymity over the Internet, but there is a difficulty in identifying all objects connected to the network.This is inconvenient if the company wants to securely identify everyone connected to its network, This is what made the USA[13] Department of Homeland Security grant money, which is estimated at 199 thousand dollars, for the establishment of a time stamping system for Internet of things stations in Blockchain ,And this is done by registering the identification number and the manufacturer. And updates are available Knowing that it can be managed with a classic database, but block technology is achieved Difficulty infiltrating any intruder claiming to be one of the connected devices because the latter cannot modify the records.

6.2: List diamonds with Everledger

In the diamond trade, there must be a tracking system that will stand the test of time.
EVERLEDGER makes use of blockchain technology to prove the origin of the diamond and determine the owner of the diamond[14]. It uses two types of chains:
The first is private: here is the recording of information on diamond dealers that they do not wish to share on a large scale.
The second: public blockchain of bitcoin, wherever built its first database on the Iris block developed by Monax

6.3: Walmart tests food traceability with IBM's blockchain

It is a completely different field that has been explored in China and the goal of it is tracking HARM.Walmart[15] is testing ABM's blockchain technology to record the source of every piece of meat sold in China, where and how it was processed The temperature of its storage and its expiration date. as it was recently opened American retail stores Collaboration Center for Food Safety(WFSCC) to work with IBM company to improve food safety using Blockchain technology.

7: advantages of blockchain:

7.1: Decentralization

A blockchain is a collection of nodes interconnected. None a central structure that controls these nodes. each node owns a complete copy [16]of the data. and for this any change must be approved by the decentralized network this ensures that the changes take place it is in the interest of the majority.

7.2: Hard technology:

Despite the emergence of many new technologies, Blockchain is still there and strongly. Every time we see that a specific company[17] wants to implement blockchain technology in order to achieve digitization of all files Sensitive to them, as it improves the profits of startups and protects them from any breaches, In this way, it has enhanced the efficiency of investments.

7.3: hightly secure system:

Most business people turn to blockchain technology[18] due to the data security that achieving it for them, and thus blockchain technology has won the confidence of the largest investors and customers in the world.

8: Some Blockchain limits:

Although Blockchain is a powerful and effective technology, but it is not without some negative points (technological limits) we can call it a performance problems. Among these problems we mention:

8.1: electrisity

Bitcoin clients usually execute a large number of transactions. For this reason, the cost of electricity may be greater than the profit of Bitcoin, which is a loss for entrepreneur users of this technique.

8.2: The last user

There is a blocchain security issue usually at the end of the chain, because if the last user loses his private key and the transactions are executed without his consent, the data will not be changed.

8.3: Transparency

Transparency is not completely perfect today, because most companies do not like fully transparent sales and exposed to all of its competitors in the market.

8.4:Blockchain creator

There are conditions that a blockchain creator must adhere to In agreeing to lose control of it because this power enables him to destroy the system at any point, and he cannot make any profit from it, because the profit must be made to the peers that belong to the chain only.

9: Conclusion:

Blockchain is a very advanced technology that has become an effective part in
Most of the Domains, and that it is because it Check security[20] of the informations
in sensitive data that require trust and transparency among its clients. On the other hand, this technology can increase transparency and create organizations new, more open and cooperative, with the aim of promoting the public interest of its users.

Chapter (2)

Smart Grid

Smart grid

1. Introduction:

We always hear the term Power Generator, but some people don't know what is the responsible for providing energy to your home or business area, and it consists of transmission lines, substations, transformers, and other elements, this what happens when you turn on the light switch or turn on your computer, and this one the so-called normal electrical grid. As technology developed, these networks were relied upon in order to create smart networks to take advantage of more power, efficiency and speed of [21] electric energies.

The two-way communication between a device and its client is what makes technology a digital technology. It is the one that realizes the concept of the smart grid, such as the Internet. Therefore, the realization of the principle of the smart grid with the power of electric energies, it will produce digital power to meet electrical demands in a fast and efficient way.

2. Definition:

Smart grids are electrical networks that use computer technologies modern and advanced to modify and facilitate the flow of electricity between suppliers and consumers [22]. It represents a real force for the introduction of the industry in a time of reliability efficiency and speed transfer of energy , as it exploits every production of renewable energies In consumption, for example when it is sunny day that is solar energy can be used transfer it to the consuming interests at night in an accurate and effective manner. Where this technology allows for utilities and customers to exchange information about energy use in real time. Therefore, efficiency is guaranteed Security in the production and distribution of energy.

3. How a Smart Grid Work:

Smart Grid[23] is a link between two basic components they are the consuming interests and the source of renewable energies. This consuming sends a request to the grid and accepts a Real-time response via power transmission lines fast and smart way.

An essential element must be present to complete the process of this system, which is an installation a Smart Meters in homes and companies instead of traditional meters, because this one Digital [24] devices are capable of carrying out two-way communication, and transmitting information between producers and consumers. the smart grid can take advantage of it to better predict From the consumer and responding to his request in a faster way.

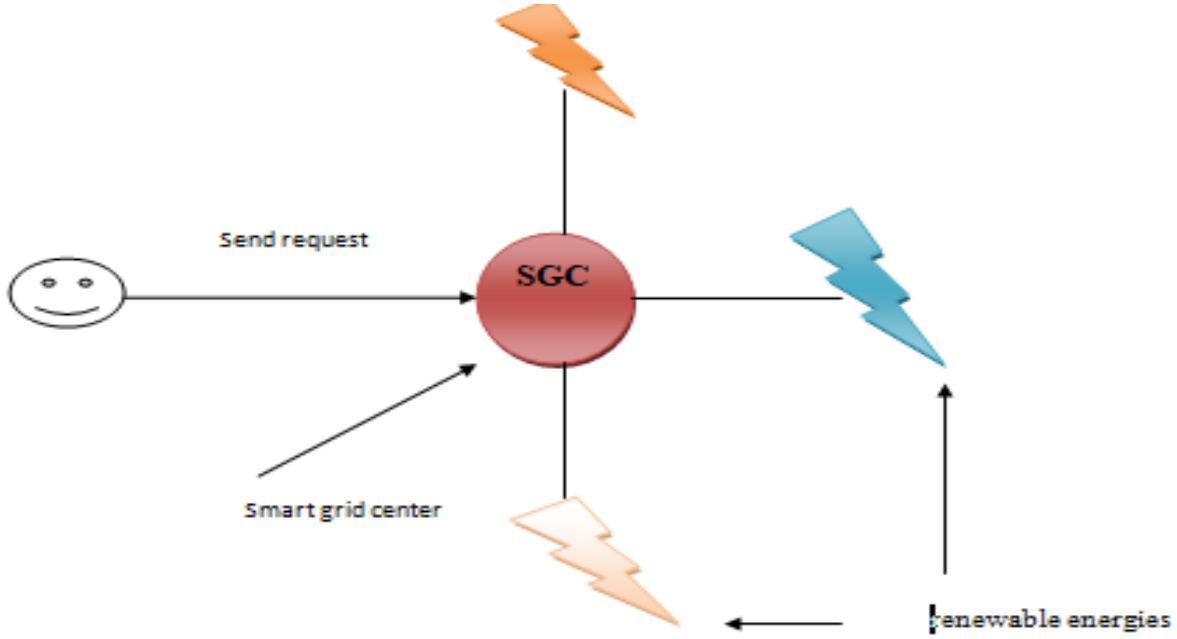

Figure 2.1: How a Smart Grid Work

4.advantages of Smart Grid:

1: Energy savings through reducing consumption:

Where this feature allows us to know the value of consumption by the energy meter at any time, users will always be aware of their[25] consumption actual. Thus, monitoring will be done better.

2: Better customer service and more accurate bills:

This feature provides an accurate billing service, as it is not based on estimates Rather, it always reflects the real consumption of each month and thus we have improved customer service And we got rid of the errors of the manual energy meter in the old systems.

3: Accuracy in gathering a larger number of data :

Smart grids can collect much more data than a manual energy meter reading system. This is because it performs a more realistic analysis of the data. It takes all variables into account. And with that you have achieved the parallel between production and consumption.

5.Limits of Smart Grid:

However, the cost of investments is still high. In fact, smart grids must be implemented throughout the network and involve all beneficiary members to be effective another obstacle is the diversity of actors, because they have to develop different communication systems. In addition, the data collected is complicated to manage and store, due to the large amount of information to be processed.

Finally, information about schedules or activities of consumers and producers is confidential. Data protection standards must be applied, making it a complex and delicate system.

6. Conclusion:

Given the size of successful projects around the world, which are developing every day. With the development of technology, so the term smart grids[27] is not considered just a phenomenon It is a modern technology, it is a great innovation in the field of electrical energies resulting from energies renewable, which combines network intelligence, which provides the latest systems and accuracy in controlling and monitoring each from the producer and the consumer.

Chapter (3)

Edge computing

1. Introduction:

For more than a decade, centralized cloud computing has been an excellent technology to store data and manage resources efficiently, but with the increase in the use of the Internet of things, the number of devices connected to the Internet increased and this is what statistics proved, in 1992 the number of connected devices reached 1 million and continued to increase until it reached 18.4 Billion[28] in the year 2014 as a result of the use of smart devices, and this confirms the impossibility of addressing all data, because processing it will require more time, and thus there will be a delay in responding. To solve this problem, advanced computing emerged, which is edge computing that attracted attention the last period.

2. Definition:

Edge computing [29] is a storage technology that is positioned close to input data or end users. This is what gives it the advantage of high transition between all sites and quick response to the user and this is what distinguishes it from central computing.

3. Architecture of edge computing:

The edges are the near edge of users [30] like a personal edge.

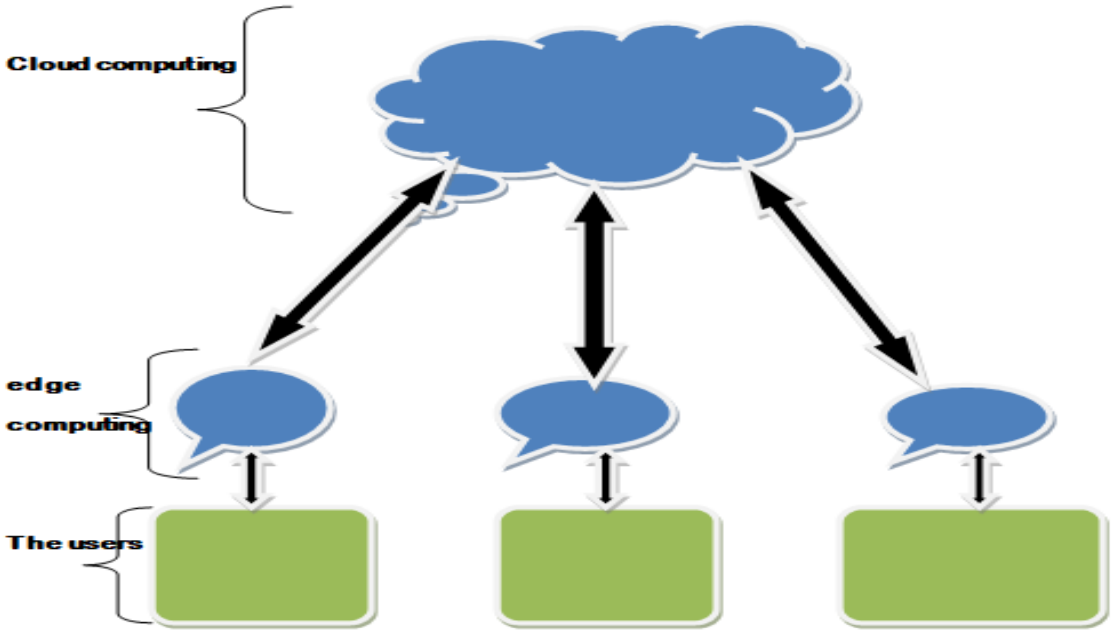

Figure3.1:forme of edge computing

4.How to work the Edge computing:

Edge computing is[31] centralized between large clouds and users to be near the source of the data instead of relying on the larger clouds to do all the work. This computing places enterprise applications close to where the data is generated. The reason[32] is that the cloud computing and IOT enhanced the role of this technology, which provides advanced services close to Artificial intelligence.

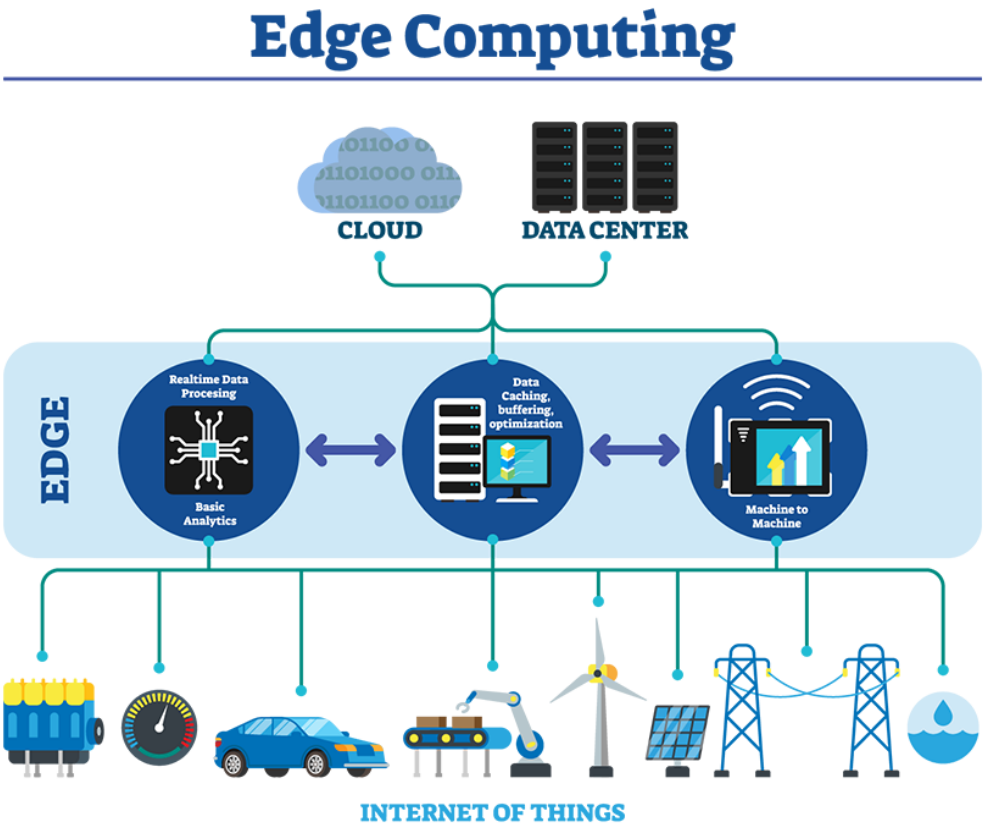

Figure 3.2: How to work the Edge computing [33]

5:Some benefits of edge[34] computing:

1.speed:

Speed gives vitality to any system. because slow data transmission generates consumer frustration.

2. Security:

The security of information in cloud computing cannot be questioned, but the centrality of the latter makes it more vulnerable to attack. But distributed storage on the edges makes network destruction more difficult.

3. Reliability

The availability of advanced computing devices for the Internet of things, and advanced data centers close to the user. It makes them a reliable choice in terms of reducing of network problems in the exchange

6. Conclusion:

Edge Computing has recently proven its efficiency due to its great ability to process data edges, reduced response times, improved[35] reliability, and that's what makes it this technology is a solution to many of the technical problems caused by the development of the Internet of things .

Chapter (4)

Related work

1. Introduction:

The great importance of this type of networks (smart grid) that we previously talked about, it has made a lot of competition in improving [36] this technology in all respects to utilize it in the best possible way and to make more use of it in developing the production of the renewable energies and facilitating dealings with the consumer. Making it one of the most sought-after technologies currently, due to its keeping pace with the speed of the times and modern technology. For this reason, many methods, models and algorithms have been worked on to improve all aspects of this technology.

2: Access control method:

2. 1.1Lin et al:

Data privacy protection is one of the most important things in cloud computing, because privacy leakage [37] directly affects the use of computing services,this method(Lin et al) protect privacy, the user can register data by choosing one of these two modes: direct or indirect, and this mode(indirect) is the most data protection. where a chart is Fuzzy presented for all stages of users with data encryption.

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2.2 Seol et al:

The exchange of electronic health records (EHR) between medical institutions has become a very complex system and devoid of security systems. for this, these records may be exposed to security threats, and thus private patient data[38] may be exposed . Several methods have been suggested to protect it, the data is by applying a secure method to access the patient's records. However, this has not been achieved access control systems that rely on encryption and digital signatures. a cloud-based EHR model to be adopted has been proposed in the manner of an electronic signature when sending a records from the sender to the receiver(exchange just a necessary informations to treat the patient).

2.3 Liu et al:

Sharing resources and cooperating in operations in IOT technology is what is called it manufacturing internet of things (MIOT). Therefore, the exchange of resources is a very important matter that must be secured and its protection[39] that's what this technology is working on, it provides an access control model for a share these resources are in order to achieve safe participation, meaning that it contains only the concerned elements which has actual roles in the system.

2.4 Chatterjee et al :

The exchange of information and the use of communication technology is increasingly in the medical sector. Therefore, remote medical information exchange technology telecare medicine information[40]system' (TMIS) has been relied upon, which allows for improvement the exchange process between the medical sector and patients to develop health care in terms of services and costs where it is possible patients have access to healthcare information in a safe manner[41], because the process is completely confidential, as it works to hide the identity of the user and the confidentiality of the directive and change the password traffic is effectively automatic without connecting to the remote server.

2.5 Zhang et al:

Cloud vehicle networks are a very successful model for improving communication services between vehicles; this technology [42] has been adopted to facilitate the process of assigning tasks to clouds to reduce the time transportation cost. Thus, we have achieved efficiency in terms of carrying out tasks in a faster manner and more adapted to Mobile Edge Computing.

3: Models:

3.1 model design:

This model was proposed to enhance cooperation between Blockchain technology and Edge computing by connecting edges and transactions [43] by smart contracts. We find that there are two types of nodes: the edge nodes and the super node (responsible for all edges), are the ones that validate the rest of the edges in the system to perform electrical transactions accurately and safely.

Presentation of this process:

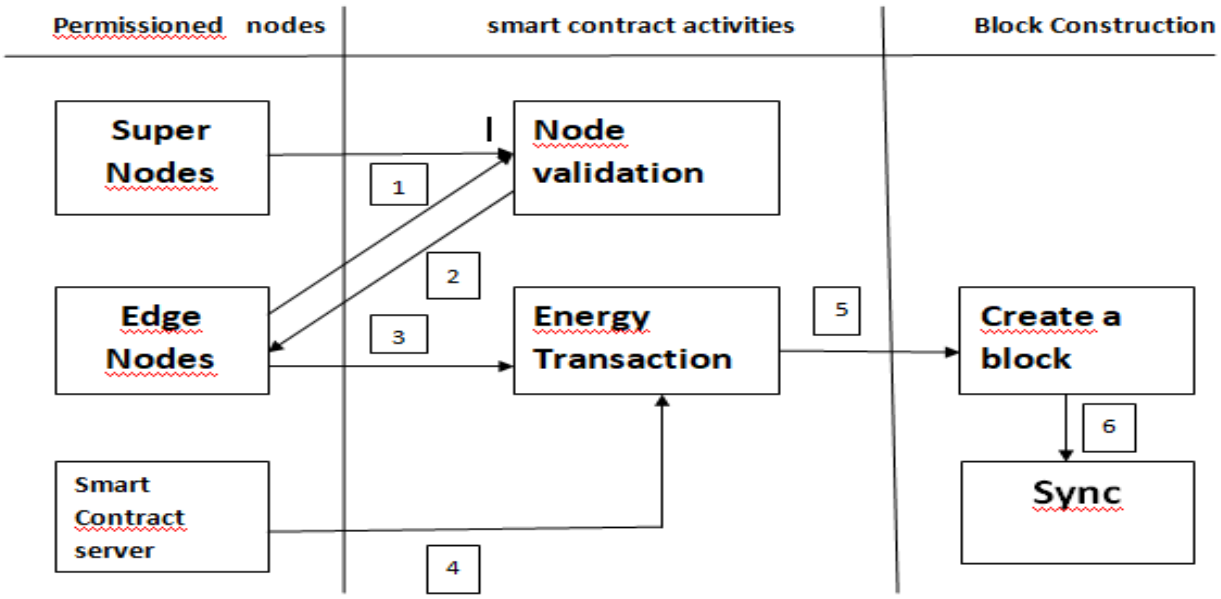

Figure4.1: layered activities in permissioned blockchain system

1→validation,
2→confirmation the validation
3→service Request**,**
4→strategy
5→go to create the block
6→synchronization

3.2 Threat model:

The energy production of the edge nodes is upon the request of Super Nodes, and this communication between them allows the attackers [44] to be a part of the system, by positioning itself at one of the edges, and dealing with consumers in a straightforward manner. Combating

these breaches is one of the priorities of the PBEM-SGN model, depending on the model RIDEM (Resisting Illegally Distributing Electricity Model).The default is that the attacker can access with a valid signature in the Edge group and interact with users.

3.3 Permissioned Blockchain System:

This system relies on the use of a authorization layer, which is the one on which users depend to access the system, by this, we have reduced the attack on the system. That is, there are almost no hackers in the form of users of [45] the system. The role of the above-mentioned authorization layer is to combine the traditional access methods with a special method , which depends on the responsibility of super node on the authorization of other nodes (edge nodes) and this is the goal of this model.

To protect sensitive information moving between nodes(super and edge), Covert channel authorization technology has been applied, which provides a class of mechanisms internal reception(jitter bugs) that transmits data secretly and hidden in cables or connectors, it can transfer sensitive data without prejudice to the host or software. So, the possibility of data leakage here is very small.

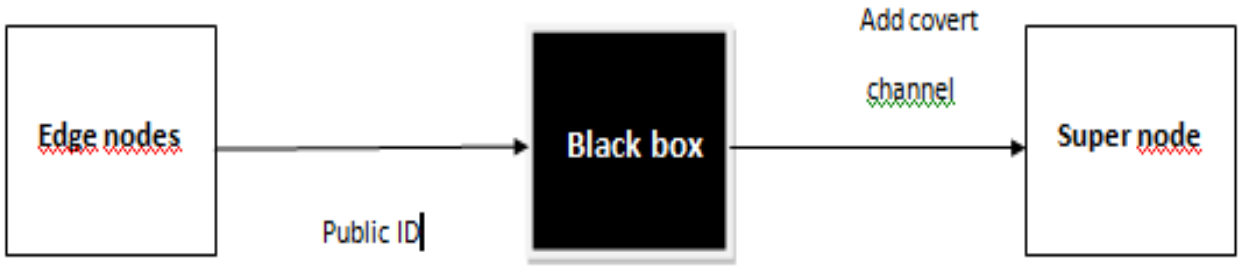

Figure4.2: covert channel authorization

3.3.1How to add covert channel with[46] jitterbug?

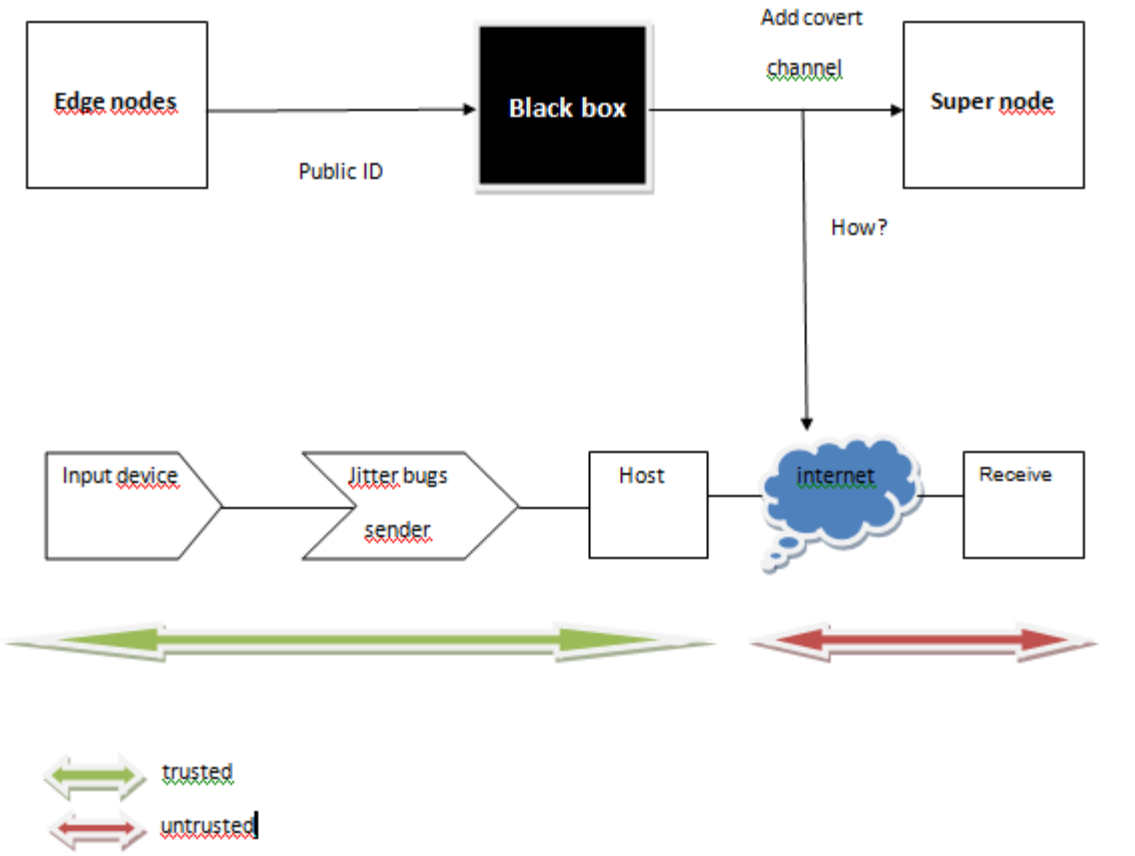

Figure4.3: creation of covert channel

3.4:Edge-enabled Energy Optimization Sector:

The accuracy and speed of response is one of the basic principles that any system must adopt to achieve better results. For this reason, work has been [47] done on the problem IETO (Instant Energy transaction Optimization) in smart energy networks, in order to ensure real-time response

service for consumers.For this, edges are created (definition 2.1) near of the order center which guarantees them the proximity of what they requested of them and thus upon retrieval the energies are faster in terms of response, as they do not need to wait for the response from the source.

Simple Diagram :

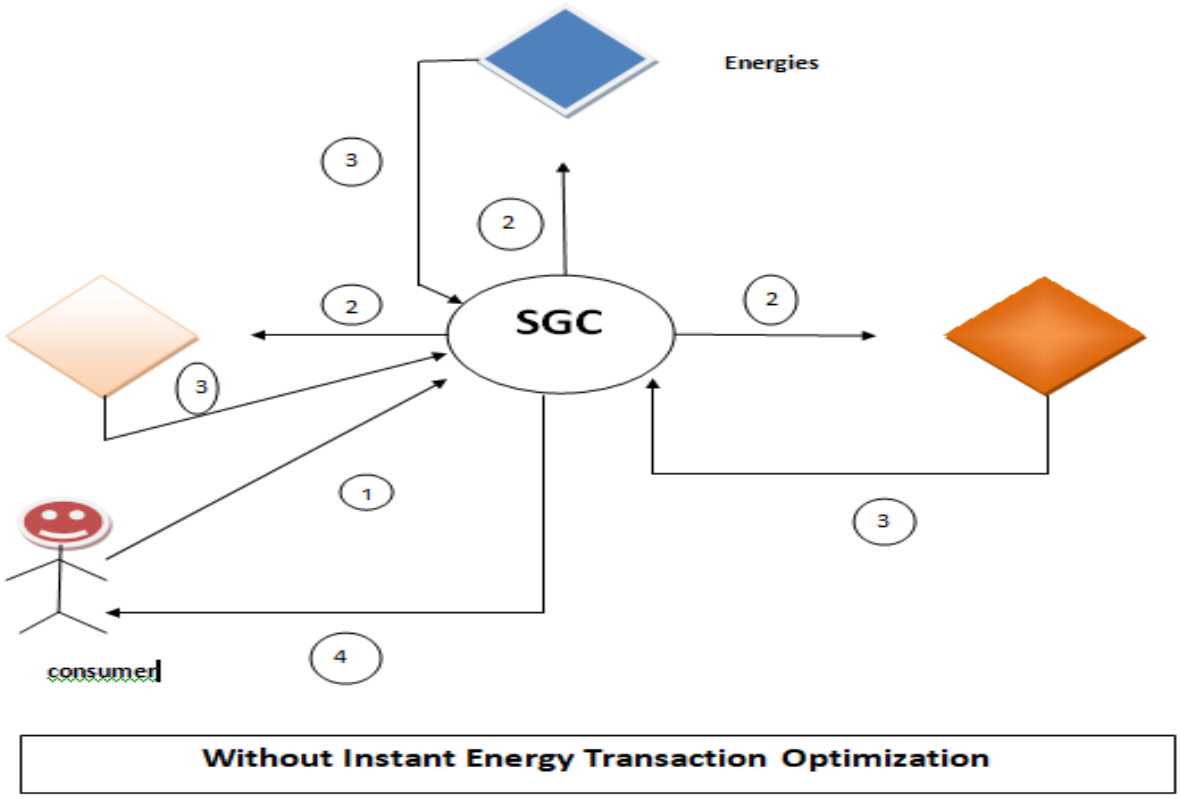

Figure4.4: energy sector without optimization

1: consumer request

2: order from the center for all the energies

3: send production

4: send production for consumer

Notes in this case:

-The step number (3) need a lot of time

-we have not a real time option

The solution:

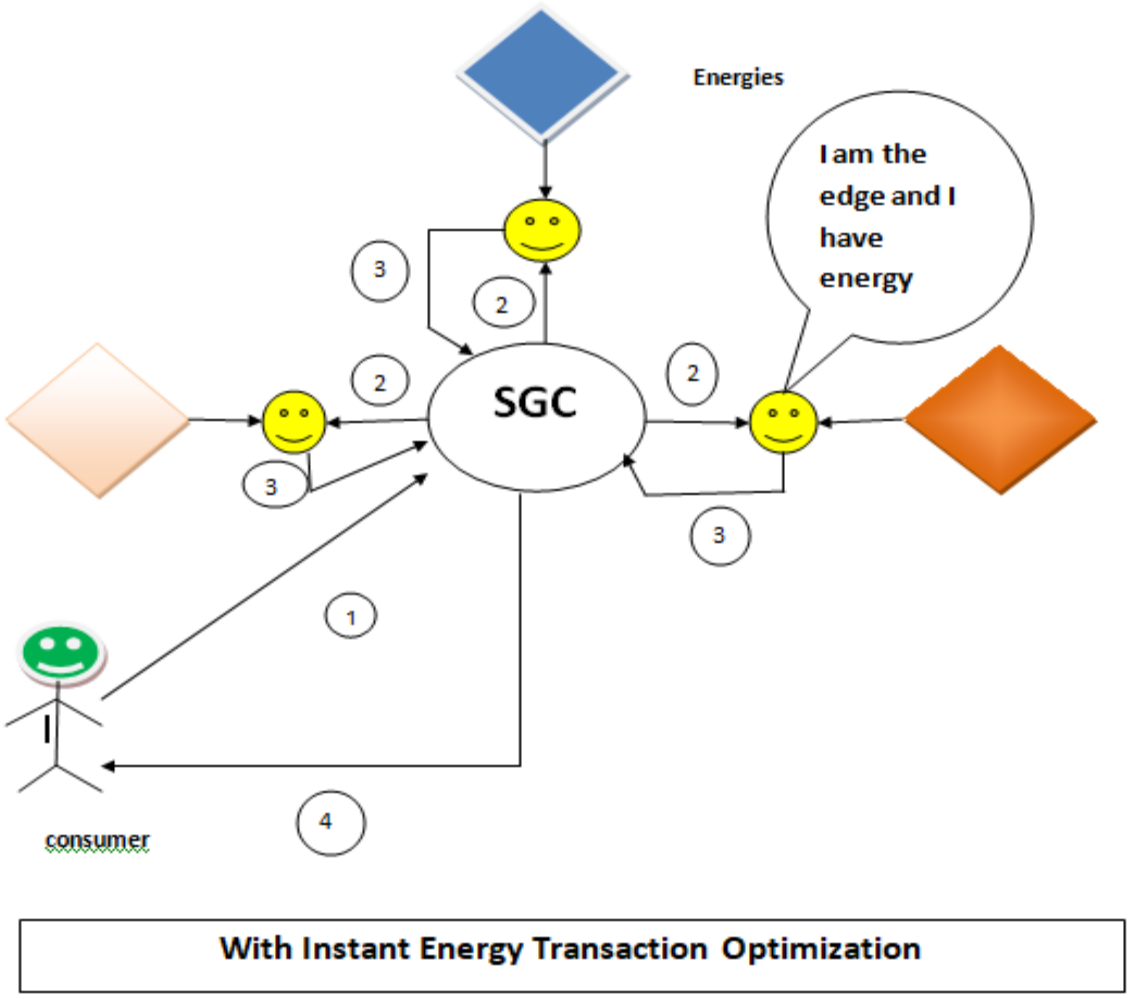

Figure4.5: energy sector with optimization

Notes in this case:

-the step number (3) need less time than the first case

-almost we have the real time option

4: algorithms:

4.1: Edge Nodes Identity Validation Algorithm(ENIV):

When we talk about the identity of members (edges) of a sensitive system that requires a high degree of security, there is a permanent investigation of identity of everyone [48] who wants to enter it and prevent anyone who is an outsider, so we will necessarily talk about signatures in cryptography .However, it is necessary to continuously check the effectiveness of the elements of the system. In this algorithm, it has been completed the application of this technology by Super node . The idea is applied by a group of signatures that guarantees its credibility.

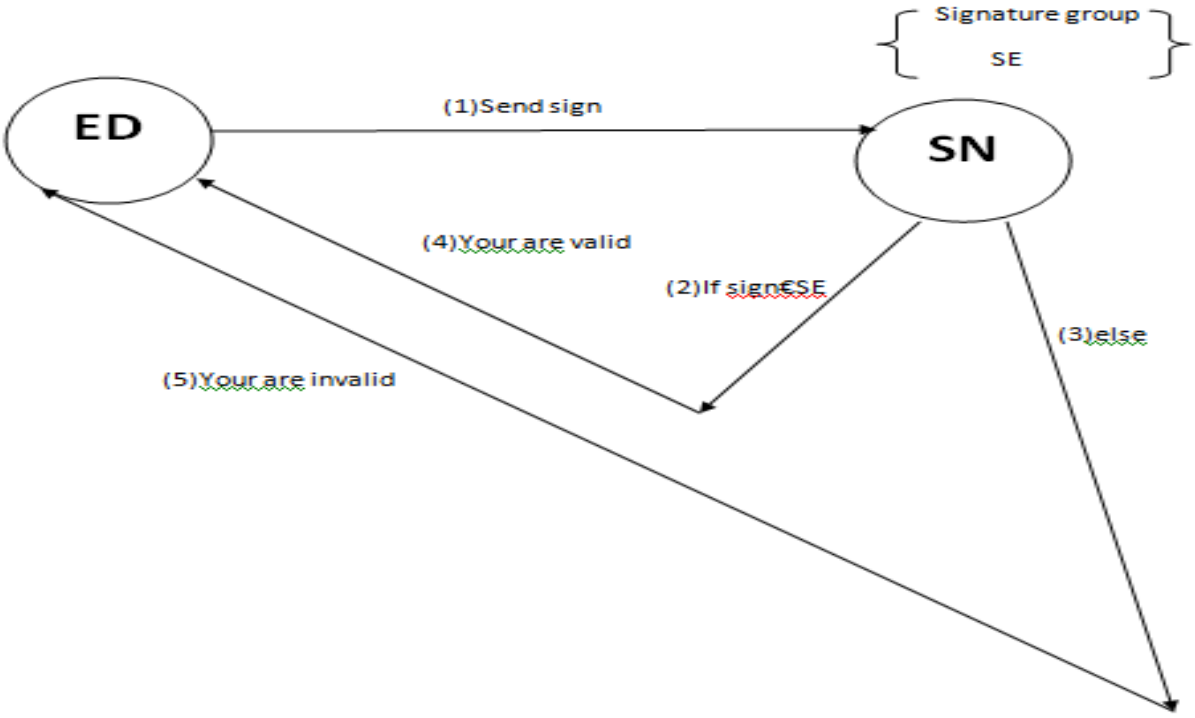

Figure4.6: the ENIV principle

4.2: Energy Transaction Block Creation Algorithm (ETBC):

This algorithm was adopted in order to effectively investigate the principle of the smart contract in creating blocks to record all transactions[49] in a network is strategic. There are two parts to this process. First, an energy storage strategy is created in the blocks to make transactions

Second, these blocks record the estimated time and energy costs transmitted from the edge nodes, these details help in stimulating the previously mentioned RL(Reinforcement Learning) model.

In this algorithm, 3 steps of block creation are represented:

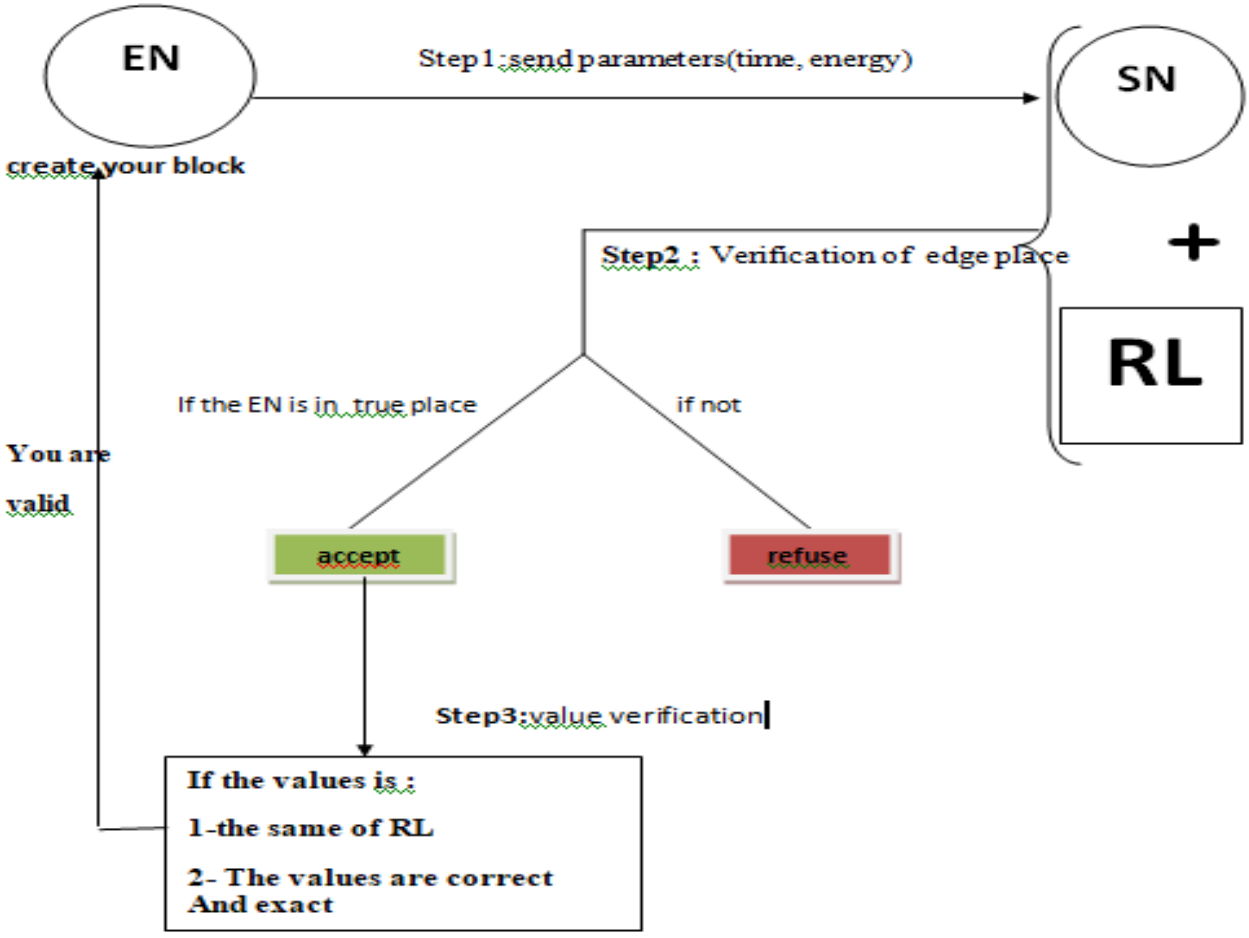

Figure 4.7:the ETBC Principle

5. Comparative study [50]:

5.1 Methods:

Table 1related methods to protect data

Methods	Role
Lin et al	Protect the data privacy in the cloud
Seol et al	Guarantee patients privacy.
Liu et al	Guarantee the security of data sharing for "IOT"manufacturing.
Chatterjee et al	Protected secure information exchange in telecare of user.

5.2Models:

Table 2: related models to secure transaction of energy using edge computing and blockchain system

Model	Role
Model Design	cooperation between Blockchain technology and Edge computing(super node and edge nodes)
Threat Model	Resist illegal distribution models
Permissioned **Blockchain System**	Confidentiality of information sharing **(**covert channel)
Edge-enabled energy optimization	Optimization of power transmission

5.3Algorithms

Table 3related algorithms to validate identity and block creation

Algorithm	role
Edge nodes identity validation	Identification of edges using Cryptography (signature)
Energy transaction block creation(ETBC)	Verify that the block is in the true location in smart grid.

6. Conclusion:

A lot of ideas, models and technologies were reached in order to achieve the principle of complete security on smart Grid Blockchain was created for such purposes. I suggest relying on it to enhance the security of information exchanged in the network. According to my knowledge, all of these technologies protect the network from external threats, but there is a main advantage of Blockchain, which is

full transparency among network members(edges), meaning that there is no process that is ambiguous for a edges of the smart grid.

After my research into what previous research and work noticed that there is a case that loses transparency in its content, and if we really want to apply Blockchain technology on the smart grid, we cannot ignore this point, which we will deal with in details in the next chapter

Chapter (5)

Proposed work

1: Introduction:

We talked previously about the multiplicity of methods and models for protecting smart grids using blockchain technology. The researchers agreed on its effectiveness in protecting information from external attack. As well as transparency [51] between network members, this achieves clarity between them from the beginning of sending the request to the end of obtaining the results. According to my knowledge, in there is a process of inspecting the concept of transparency in its meaning, which we thought it necessary to activate in order to ensure that members (energies) have more confidence in the system (smart grid).

2: The problem?

How can each member of the network protect himself in terms of production and make sure that no harm occurs to him because of permanent dealings with him only?

3: Our solution:

My idea is to add a parameter to the elements of the blocks. This is called ‘’the total number of transactions’’ (TNT). Before choosing the person who will be chosen to receive the consumer order. Smart grid Center (Super node) [50] is testing this parameter (TNT). The member with the least number of transactions is the one to whom the request is directed. By this, we have achieved the principle of transparent equivalence between all energies.i use the idea of model Design and Edge-enabled Energy Optimization Sector model [51] to configure the edge computing method.

4: our idea diagram:

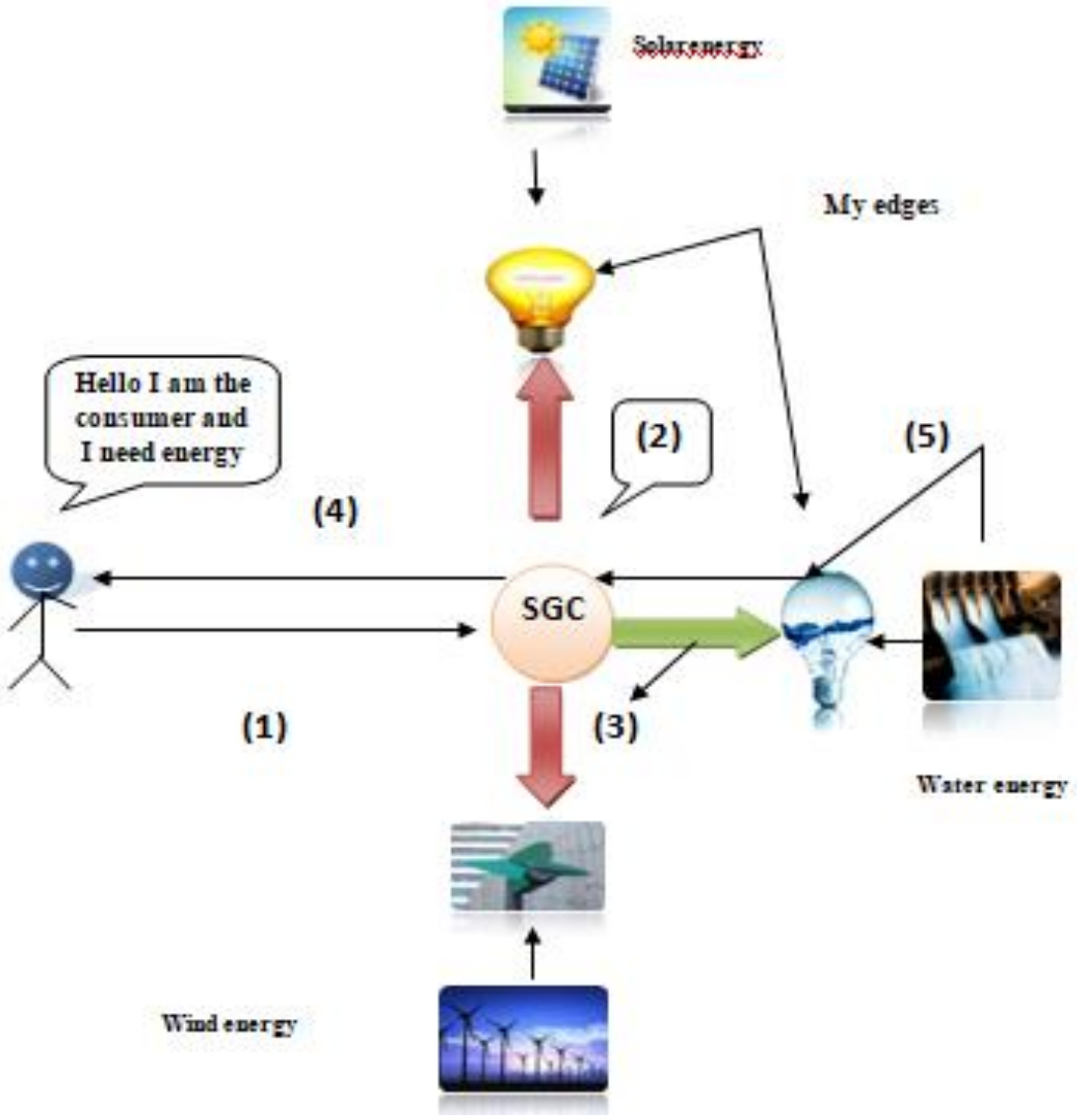

Figure 5.1:optimisation of transparence

5: Explanation of diagram:

In the first step (1):

The consumer sends an energy request to the smart grid center (SGC)

C send RC(energy)-→SGC

After logging in to the network:

LC=IN(email,Password)

The customer's order has been sent to the network center(SGC)

In the second step (2):

The smart grid center(SGC) examines the values of TNT and on the basic of it decides to whom to send the consumer's order:

If (TNT(WATER)<TNT(Wind)<TNT(SOLAR))

Then:

The third step(3) is lanced

because"water energy is win"(TNT=1)

If the EdgeW (water energy) has a required energy:

EdgeW>=RC

Then:

The fourth step (4) is start:

Send the required energy to the consumer.

Send RC to the C

else

The center(SGC) verify another edge to get energy:

If EdgeWi>=RC OR EdgeS>=RC

then The fourth step (4) is start

1:The energy source(water energy) is create his production copy (ID,EnergyP,timeE,TNT) (Block):

The TNT parameter has updared(+1)

TNT=2

2: make it accessible from all sources

The energy center access to the ather energy block

the step number four (4) is lanced:

Send RC to the C

The EnergyP of water energy has updated (EnergyP(1000)-RC(600)=energyt(400)

The sixth step (5):

EdgeW charged with energy:

EdgeW=100%E

and lances the step number four (4)

Send RC to the C

6:Our implementation:

6.1: the softwares used:

6.1.1:php:

PHP[52] is a free programming language, mainly created to produce dynamic web pages through an HTTP server

6.1.2:xamp

XAMPP [53] is a groupe of software allowing to set up a local Web server, an FTP server and an electronic mail server

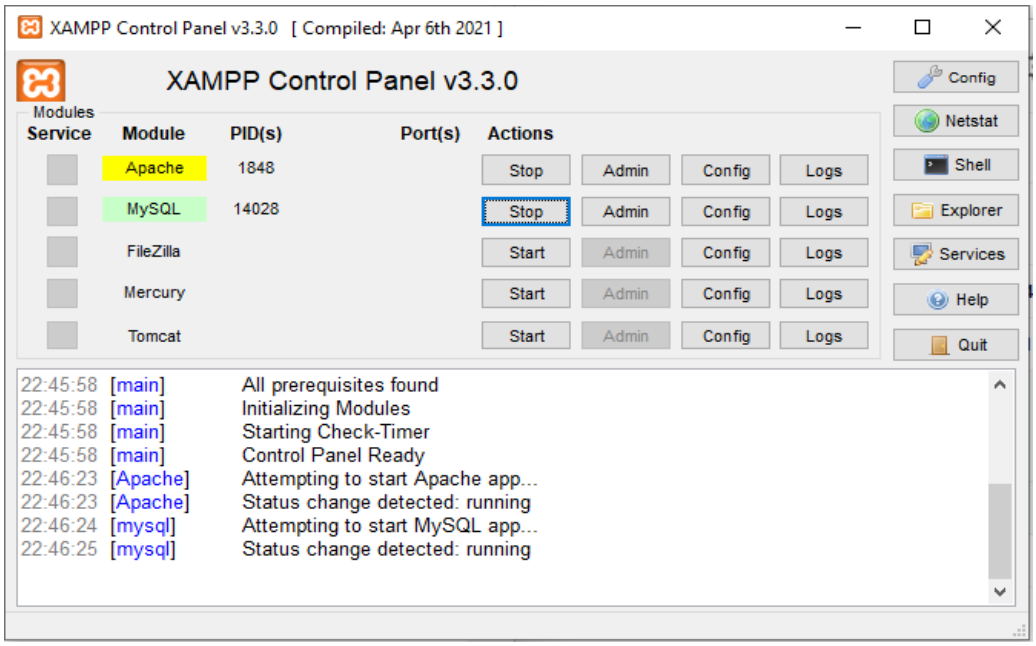

Figure 5.2:PHP exemple

6.1.3:html

HTML[54] is the standard markup language for Web pages. you can create your website with HTML because it is easy to learn.

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">

    <link rel="stylesheet" href="https://stackpath.bootstrapcdn.com/font-awesome/4.7.0/css/font-awesome.min.css">

    <link rel="stylesheet" type="text/css" href="style.css">

    <title>ORDER</title>
</head>
<body>
    <div class="container">
        <form action="" method="POST" class="login-email">
            <p class="login-text" style="font-size: 2rem; font-weight: 800;">mssg</p>



            <p class="login-register-text"> the order has been sent<a href="index.php">----go back</a>.</p>
        </form>
    </div>
</body>
</html>
```

Figure 5.3:HTML form

6.1.4:css

CSS[55] is the language we use to style an HTML document

```
* {
    margin: 0;
    padding: 0;
    box-sizing: border-box;
    font-family: 'Poppins', sans-serif;
}

body {
    width: 100%;
    min-height: 100vh;
    background-image: linear-gradient(rgba(0,0,0,.5), rgba(0,0,0,.5)), url(bg.png);
    background-position: center;
    background-size: cover;
    display: flex;
    justify-content: center;
    align-items: center;
}
```

Figure 5.4: CSS example

6.1.5:bootstrap:

Bootstrap[56] is a collection of tools useful for creating the design (graphics, animation and interactions with the page in the browser, etc.) of websites and web applications. It is a set which contains HTML and CSS codes, forms, buttons, navigation tools

```
<link rel="stylesheet" href="https://stackpath.bootstrapcdn.com/font-awesome/4.7.0/css/font-awesome.min.css">

<link rel="stylesheet" type="text/css" href="style.css">
```

Figure 5.5: PHP example

6.2 :the execution :

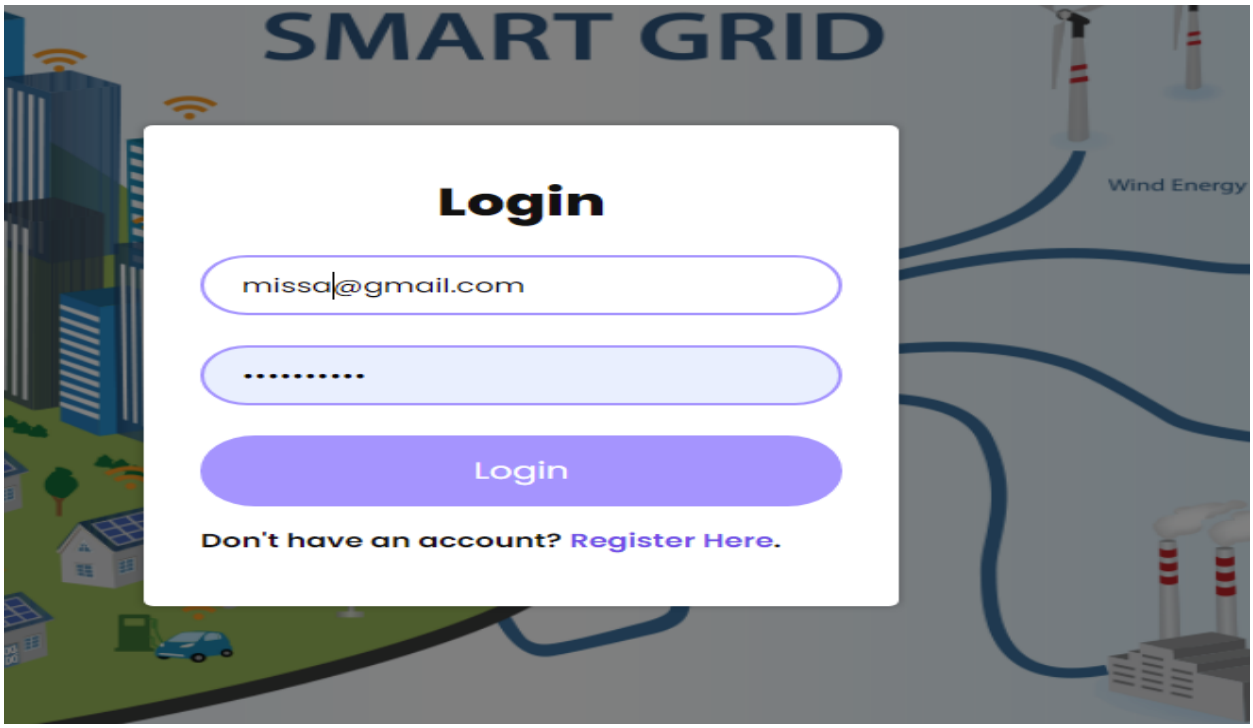

Figure5.6:the consumer order

1 :first , The consumer records his connection to the network(smart grid)

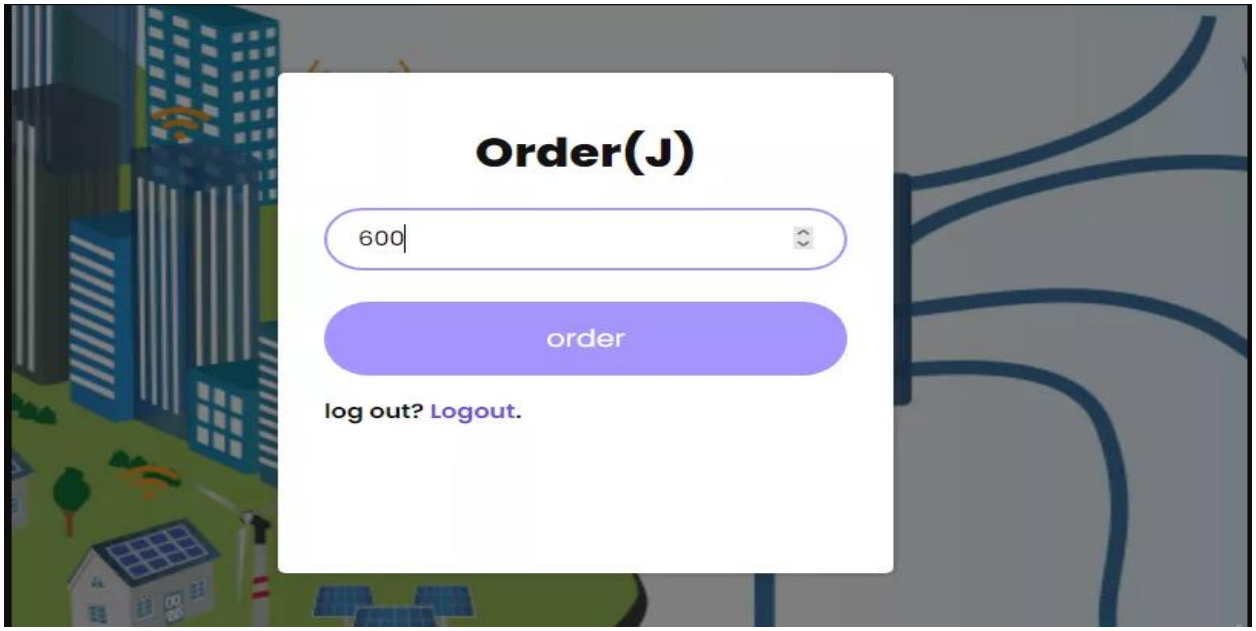

Figure5.7:consumer login page

1:In this step the consumer enters the amount of energy he needs.in this example the required energy(RC)=600j

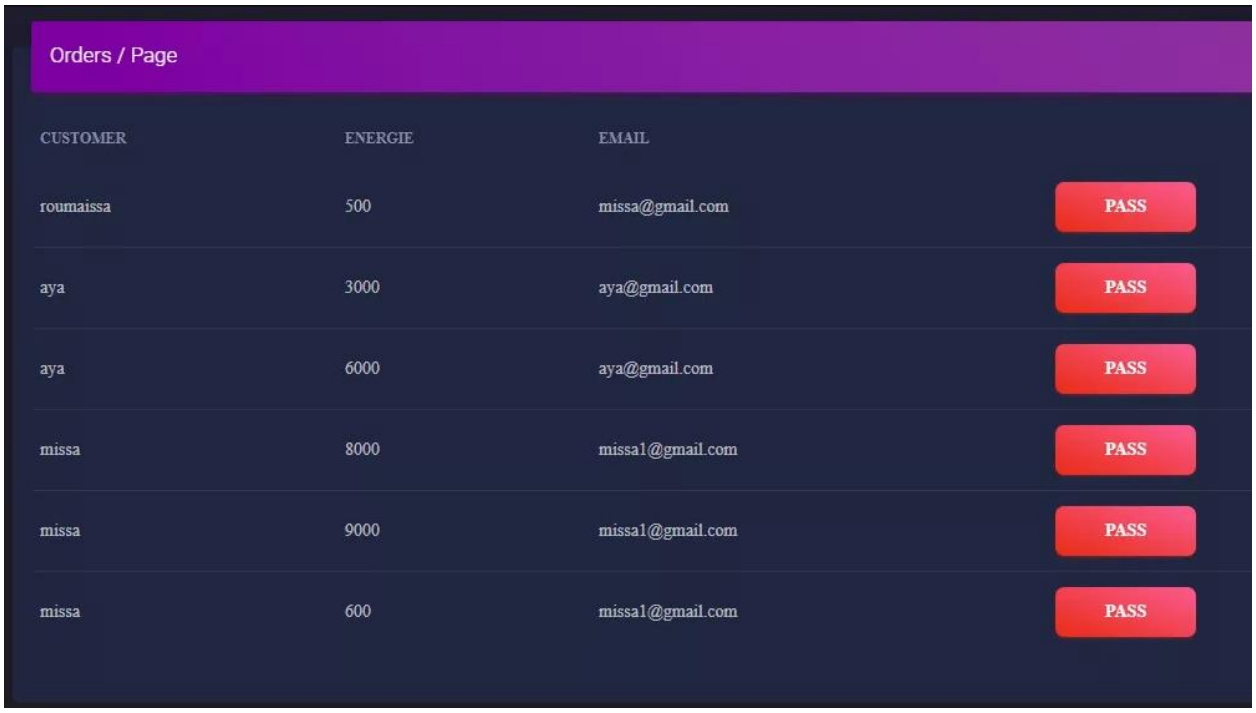

Figure5.8: the order is in the network

The customer's order has been successfully delivered to the network center (SGC).

the values of TNT before the consumer request are:

Figure 5.9:the first TNT values

When the button'PASS' is clicked,the TNT(total number of transaction)test is started:

```php
<?php
include("../config.php");

session_start();

error_reporting(0);

$sql = "SELECT tnt FROM `energy` WHERE name='water'";
$result = mysqli_query($conn, $sql);

if (mysqli_num_rows($result) > 0) {

  $row = mysqli_fetch_assoc($result);

   $id1=$row["tnt"];


}
//tnt energy -winder
$sql = "SELECT tnt FROM `energy` WHERE name='winde'";
$result = mysqli_query($conn, $sql);

if (mysqli_num_rows($result) > 0) {

  $row = mysqli_fetch_assoc($result);

   $id2=$row["tnt"];


}
//tnt energy -soler
$sql = "SELECT tnt FROM `energy` WHERE name='soler'";
$result = mysqli_query($conn, $sql);

if (mysqli_num_rows($result) > 0) {

  $row = mysqli_fetch_assoc($result);

   $id3=$row["tnt"];


```

Figure 5.10: get the TNT's values

```php

//energy total edgew
$sql = "SELECT energyt FROM `edgew` WHERE 1";
$result = mysqli_query($conn, $sql);

if (mysqli_num_rows($result) > 0) {

  $row = mysqli_fetch_assoc($result);

   $en1=$row["energyt"];


}
//energy total edgewi
$sql = "SELECT energyt FROM `edgewi` WHERE 1";
$result = mysqli_query($conn, $sql);

if (mysqli_num_rows($result) > 0) {

  $row = mysqli_fetch_assoc($result);

   $en2=$row["energyt"];

}
//energy total edges
$sql = "SELECT energyt FROM `edges` WHERE 1";
$result = mysqli_query($conn, $sql);

if (mysqli_num_rows($result) > 0) {

  $row = mysqli_fetch_assoc($result);

   $en3=$row["energyt"];


}
//select RC
$rr=($_SESSION['username']);
$sql1 = "SELECT energie FROM orders where 1";
$result1 = mysqli_query($conn, $sql1);
$row = mysqli_fetch_assoc($result1);
$rc=$row["energie"];
```

Figure 5.11: edge total energy

```php
$rc=$row["energie"];




//$rc=300;
if($id1<=$id2)
    $min=$id1;
else
    $min=$id2;
if($id3<=$min)
    $m=$id3;
else
    $m=$min;

if($m==$id1)
    {
    if($en1>=$rc)
        {
            $ene=$en1-$rc;

            $id1=$id1+1;

               $sql1 = "UPDATE energy
                     SET tnt = ' $id1' where name='water'";
               $result1 = mysqli_query($conn, $sql1);

               $sql1 = "UPDATE edgew
                     SET energyt = '$ene' ";
               $result1 = mysqli_query($conn, $sql1);

         }

    elseif($id2<=$id3)
        {
            if($en2>=$rc)
          {
            $ene=$en2-$rc;
            $id2=$id2+1;
```

Figure 5.12: the TNT value test

```
        $sql1 = "UPDATE energy
            SET tnt = '$id2' where name='winde'";
        $result1 = mysqli_query($conn, $sql1);

        $sql1 = "UPDATE edgewi
            SET energyt = '$ene' ";
            $result1 = mysqli_query($conn, $sql1);
           }
        }

     else
       {
        if($en3>=$rc)
        {
        $ene=$en3-$rc;
        $id3=$id3+1;
        $sql1 = "UPDATE energy
            SET tnt = '$id3' where name='soler' ";
        $result1 = mysqli_query($conn, $sql1);

        $sql1 = "UPDATE edges
            SET energyt = '$ene' ";
            $result1 = mysqli_query($conn, $sql1);
         }
        }

}

elseif($m==$id2)
    {
    if($en2>=$rc)
        {
            $ene=$en2-$rc;

            $id2=$id2+1;

               $sql1 = "UPDATE energy
                    SET tnt = ' $id2' where name='winde'";
```

Figure 5.13: update of total edge energy

```
                $result1 = mysqli_query($conn, $sql1);

                $sql1 = "UPDATE edgewi
                    SET energyt = '$ene' ";
                $result1 = mysqli_query($conn, $sql1);

         }

    elseif($id1<=$id3)
        {
            if($en1>=$rc)
          {
            $ene=$en1-$rc;
            $id1=$id1+1;

        $sql1 = "UPDATE energy
            SET tnt = '$id1' where name='water'";
        $result1 = mysqli_query($conn, $sql1);

        $sql1 = "UPDATE edgew
            SET energyt = '$ene' ";
            $result1 = mysqli_query($conn, $sql1);
           }
        }

     else
       {
        if($en3>=$rc)
        {
        $ene=$en3-$rc;
        $id3=$id3+1;
        $sql1 = "UPDATE energy
            SET tnt = '$id3' where name='soler' ";
        $result1 = mysqli_query($conn, $sql1);

        $sql1 = "UPDATE edges
            SET energyt = '$ene' ";
            $result1 = mysqli_query($conn, $sql1);
         }
        }

}
```

Figure 5.14: search energy in other edges

```
205
206
207
208  else
209      {
210      if($en3>=$rc)
211          {
212              $ene=$en3-$rc;
213
214              $id3=$id3+1;
215
216                 $sql1 = "UPDATE energy
217                       SET tnt = ' $id3' where name='soler'";
218                 $result1 = mysqli_query($conn, $sql1);
219
220                 $sql1 = "UPDATE edges
221                       SET energyt = '$ene' ";
222                 $result1 = mysqli_query($conn, $sql1);
223
224           }
225
226      elseif($id1<=$id2)
227          {
228              if($en1>=$rc)
229            {
230              $ene=$en1-$rc;
231              $id1=$id1+1;
232
233          $sql1 = "UPDATE energy
234              SET tnt = '$id1' where name='water'";
235          $result1 = mysqli_query($conn, $sql1);
236
237          $sql1 = "UPDATE edgew
238              SET energyt = '$ene' ";
239              $result1 = mysqli_query($conn, $sql1);
240             }
241          }
242
243       else
```

Figure5.15: search energy in other edges (2)

```
244          {
245           if($en2>=$rc)
246           {
247           $ene=$en2-$rc;
248           $id3=$id2+1;
249           $sql1 = "UPDATE energy
250               SET tnt = '$id2' where name='winde' ";
251           $result1 = mysqli_query($conn, $sql1);
252
253           $sql1 = "UPDATE edges
254               SET energyt = '$ene' ";
255               $result1 = mysqli_query($conn, $sql1);
256            }
257           }
258
259  }
260
261  ?>
262  <!DOCTYPE html>
263  <html>
264  <head>
265      <meta charset="utf-8">
266      <meta name="viewport" content="width=device-width, initial-scale=1.0">
267
268      <link rel="stylesheet" href="https://stackpath.bootstrapcdn.com/font-awesome/4.7.0/css/font-awesome.min.css">
269
270      <link rel="stylesheet" type="text/css" href="style.css">
271
272      <title>ORDER</title>
273  </head>
274  <body>
275      <div class="container">
276          <form action="" method="POST" class="login-email">
277              <p class="login-text" style="font-size: 2rem; font-weight: 800;">mssg</p>
278
279
280
281              <p class="login-register-text"> the order has been sent<a href="index.php">----go back</a>.</p>
282          </form>
283      </div>
284  </body>
285  </html>
```

Figure5.16: update the TNT's value

The order of consumer is ready for sent and Energy block is created:

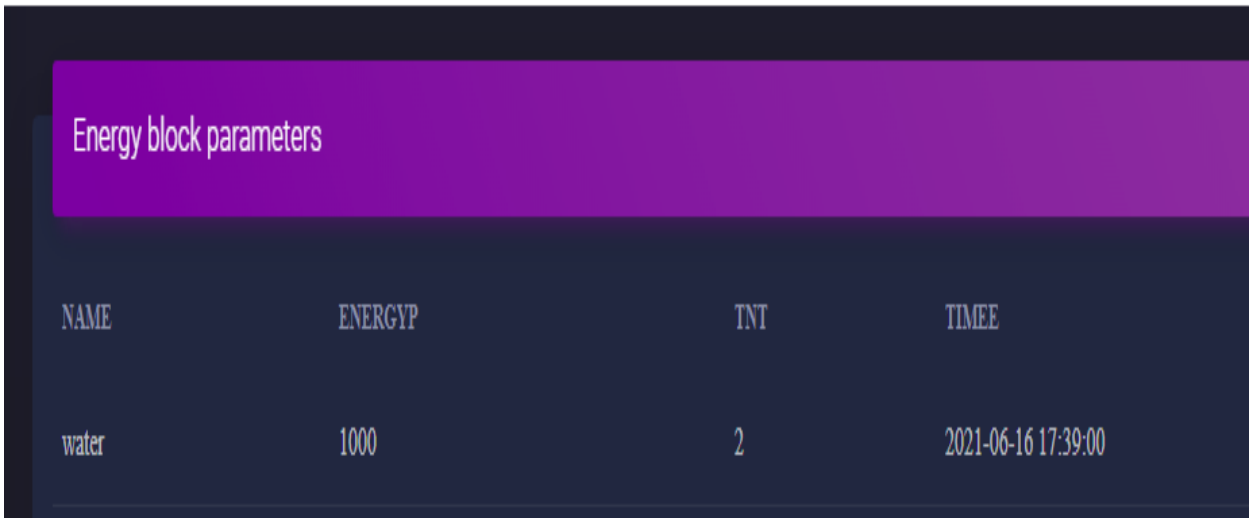

Figure 5.17: the parameters block of energy

-the block is accessible for all peers(energies) after:

-this access URL:

Figure 5.18: the access URL

- his energy declaration:

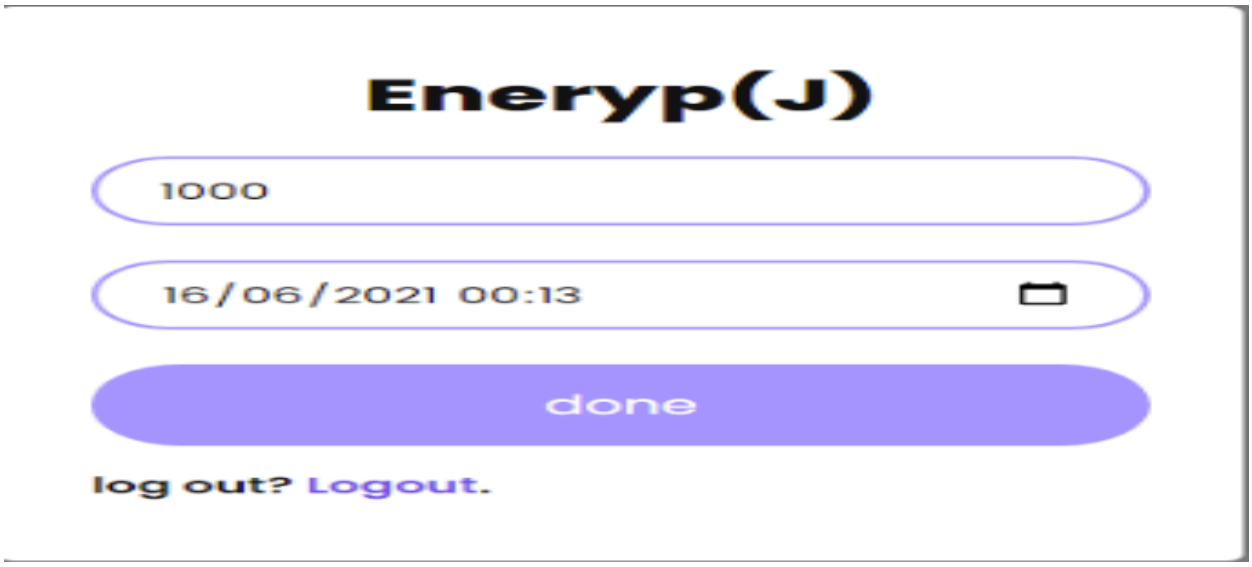

Figure 5.19: energy and time declaration

-The water energy can see all other energies blocks

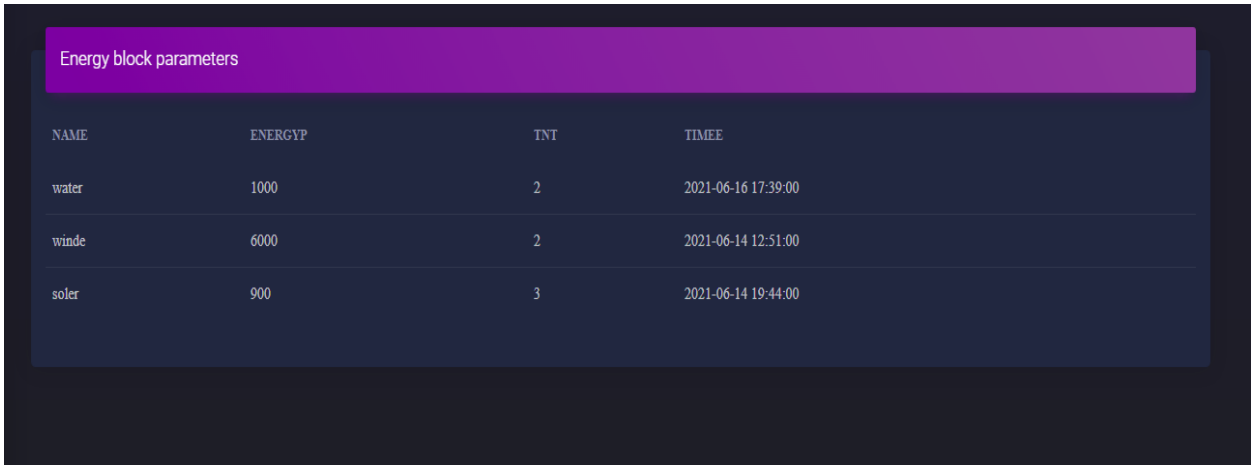

Figure 5.20: the block is accessible for all energies

The energy is updated now

Figure 5.21: update of energy to energyt

7. Conclusion:

In terms of this work, we tried to embody more the principle of transparency in a process that lacks the latter, according to my knowledge of previous researchs.To further maintain the continuity of production and ensure that the source produced does not fall into any damage that could negatively affect on the functioning of the network and on transactions with the consumer.

General conclusion:

This memorandum focused on treating the problems of preserving privacy in smart grid. For this reason, the most conservative technology on data privacy has been adopted currently, which is blockchain technology to ensure the security and effectiveness of the network's performance. Many models and techniques have been used to promote this principle, authorization between nodes(super node/edge node), traditional access systems such as a cryptographic in addition to edge computing technology that made transactions faster and easier. RL (Reinforcement Learning) to ensure the perfection of the system in terms of customer satisfaction.

When we say the security term, we cannot remove the idea of a blockchain from our minds. So we wanted to expand this principle more and more by adding a new element under surveillance, which is TNT (Total Number of Transaction）.

In order to always maintain the security position of the smart grid system:

- Other models of reinforcement learning can be worked on in this domain

-we can use another resource allocation techniques like multi agent system, to make the smart grid more practical.

-we can replace the TNT value with the inequality metrics like(roobinhood index…)

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