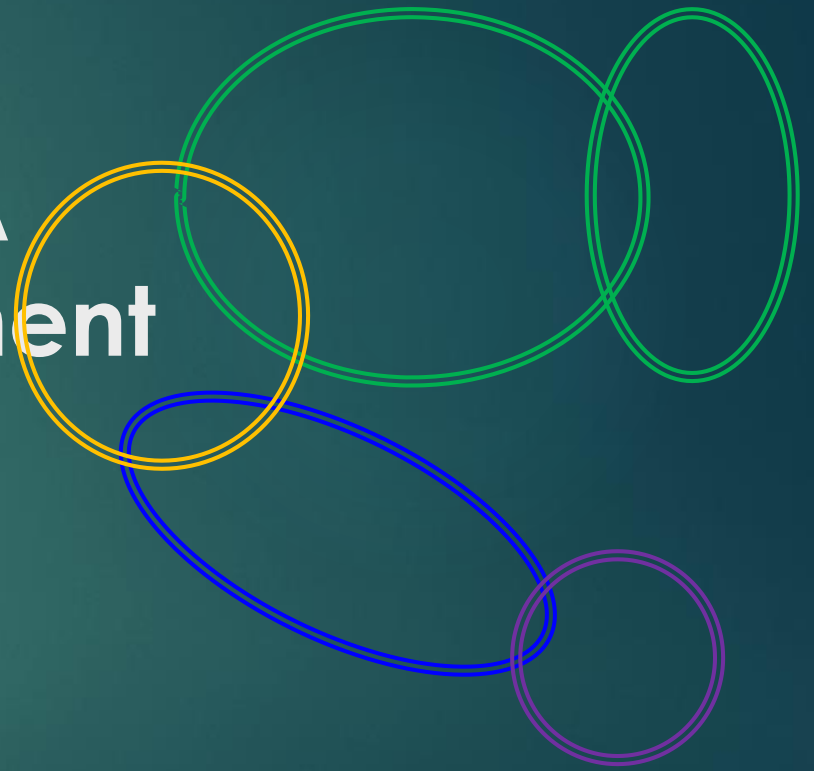
The Korean Nuclear Society Spring Meeting, Changwon, Korea, Dec. 17-18, 2020

Untact-Era based Modeling for Cybersecurity Using Blockchain Algorithms in Nuclear Industry: A Cyber World Integrity Enhancement in COVID-19 Pandemic



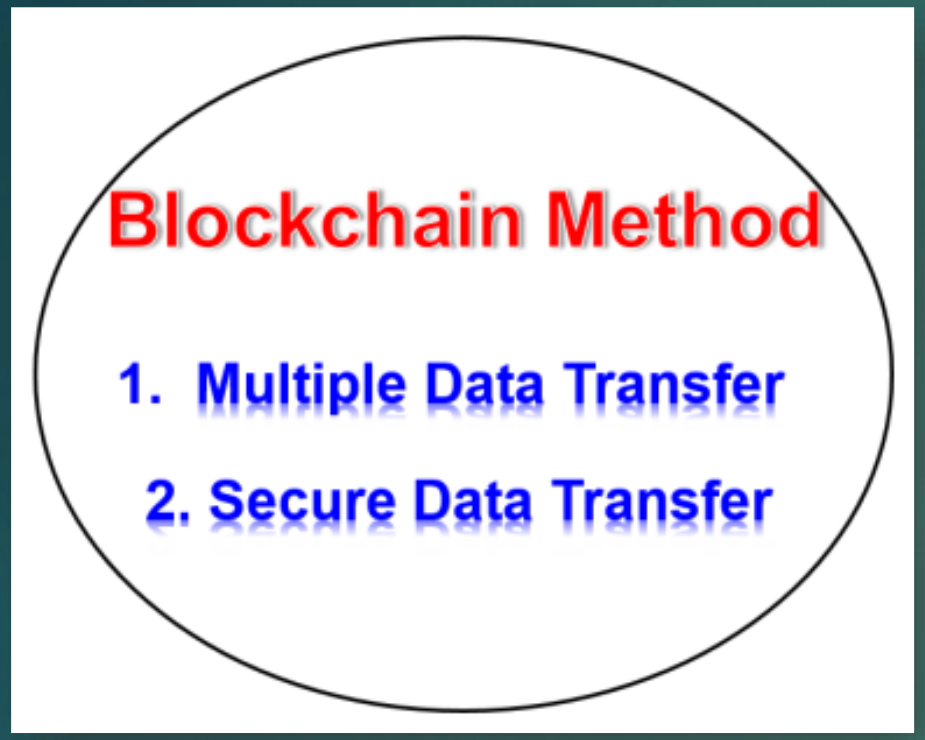
TAE HO WOO

DEPARTMENT OF MECHANICAL & CONTROL ENGINEERING,
THE CYBER UNIVERSITY OF KOREA,
SEOUL, KOREA

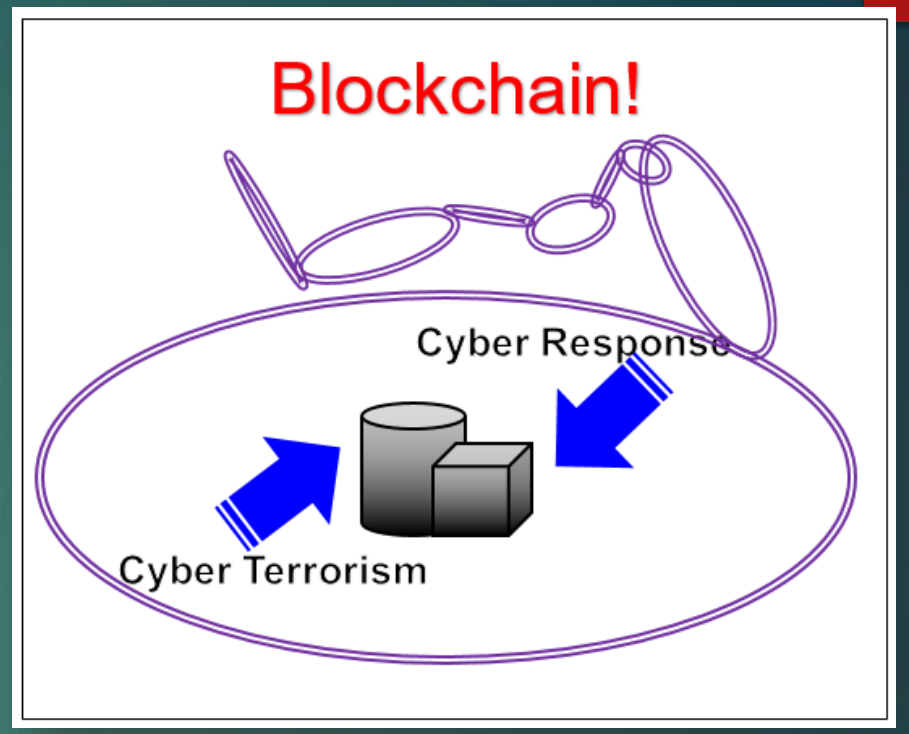
고려사이버대학교
THE CYBER UNIVERSITY OF KOREA

I. Introduction

- The block chain algorithm is applied to the 'Information Transfer' to the plant related personnel, which is a kind of cybersecurity matter.
- Following COVID-19 pandemic, the untact technology is investigated where the blockchain technology has been applied to nuclear industry.
- The Bitcoin has been considered as the cyber-based currency, crypto-currency, which makes a panic to the public in the marketing due to the very high price [2].



(a)

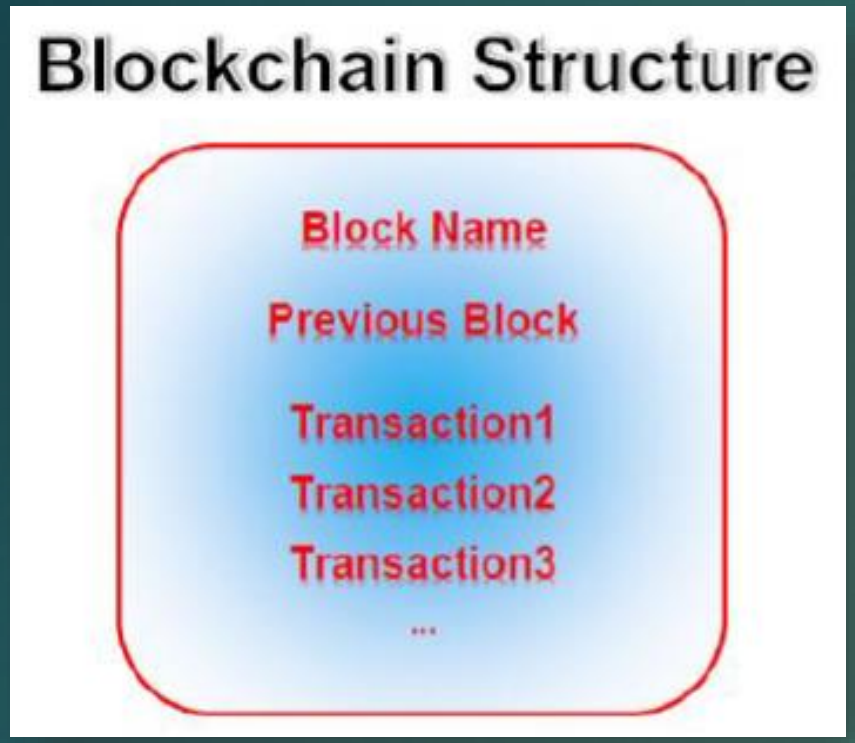


(b)

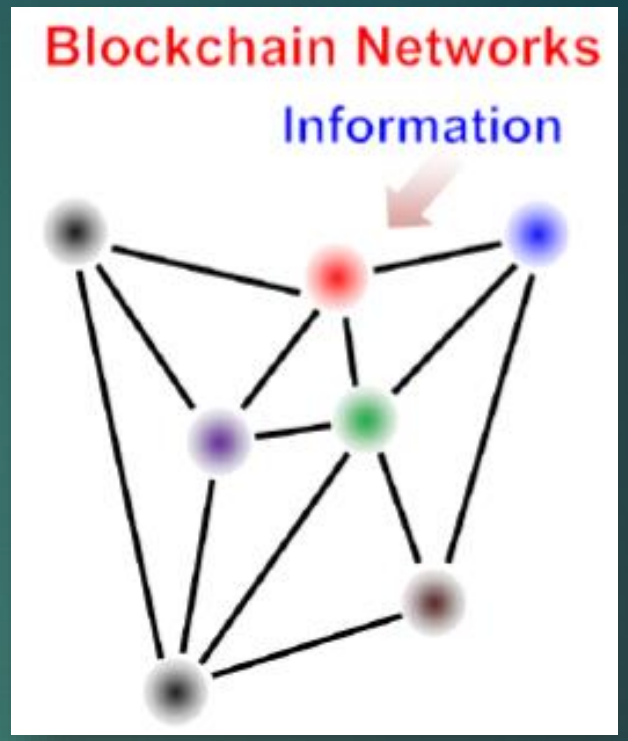
Fig. 1. Concept of bolckchain method and Cyber roles in nuclear power plants (NPPs).

2. Methods

- The cyber roles are seen in NPPs where the untouchable information is not visible and this cyber space can give the enhanced safety capability in the blockchain method.
- A blockchain has been applied to many areas in our lives [8-10].
- It is described for the structure of blockchain which is in Fig. 2 [11] where the blockchain structure and blockchain networks are described.



(a)



(b)

Fig. 2. Blockchain for operations (a) Blockchain structure and (b) Blockchain networks.

2. Methods

- One of the hash functions, as an example, could be imagined. That is to say, A mod B produces the remainder value [12].
- The previous block means the previous hash. The networking could be connected each other. In addition, it is accumulated by dynamic manner as follows,

$$\text{Block } 1 + \text{Block } 2 + \text{Block } 3 + \cdots\cdots + \text{Block } (n\text{-}1) + \text{Block } (n)$$

- Fig.2 (b) is the arbitrary networking where the block chained information are transferred.

$$A = B = C = D = E = F = G = \cdots\cdots$$

2. Methods

- In Table 1, it is shown the values of each variable are listed. In the case of SCS (safety cooling system) Start Failure, if the randomly generated number is lower than 0.3, the value is 0.0.
- Otherwise, it is 1.0. It is the typical quantification way in the system dynamics (SD) which is based on the random numbers. For Table 2, the modulus is presented as MODULO in Vensim code.

MODULO (X, Y) = remainder of X/Y

Name	Value
SCS Start Failure	if then else(random 0 1 () < 0.3, 0, 1)
Pre-Turbine System Trip	if then else(random 0 1 () < 0.3, 0, 1) * SCS Start Failure
Coastdown of Coolant Flow & Power Eq.	if then else(random 0 1 () < 0.5, 0, 1) * Pre-Turbine System Trip * (To Be Inadequate + Overpower)
Recriticality Achieved	if then else(random 0 1 () < 0.4, 0, 1) * Coastdown of Coolant Flow & Power Eq.
Long-term Conduction	if then else(random 0 1 () < 0.3, 0, 1) * Recriticality Achieved

(a)

Name	Value
SCS Start Failure	if then else(random 0 1 () < 0.3, 0, 1)
Pre-Turbine System Trip	if then else(random 0 1 () < 0.3, 0, 1) * SCS Start Failure
Coastdown of Coolant Flow & Power Eq.	if then else(random 0 1 () < 0.5, 0, 1) * Pre-Turbine System Trip * (To Be Inadequate + Overpower)
Recriticality Achieved	if then else(random 0 1 () < 0.4, 0, 1) * Coastdown of Coolant Flow & Power Eq.
Long-term Conduction	MODULO (if then else(random 0 1 () < 0.3, 0, 1) * Recriticality Achieved, 0.7)

(b)

Table 1 List of variables (a) for conventional tree method and (b) for block chain modified method.

2. Methods

- For the modeling, the accumulations of the event calculation are done in the networking as well as the dynamical state. That is, the level is as follows,

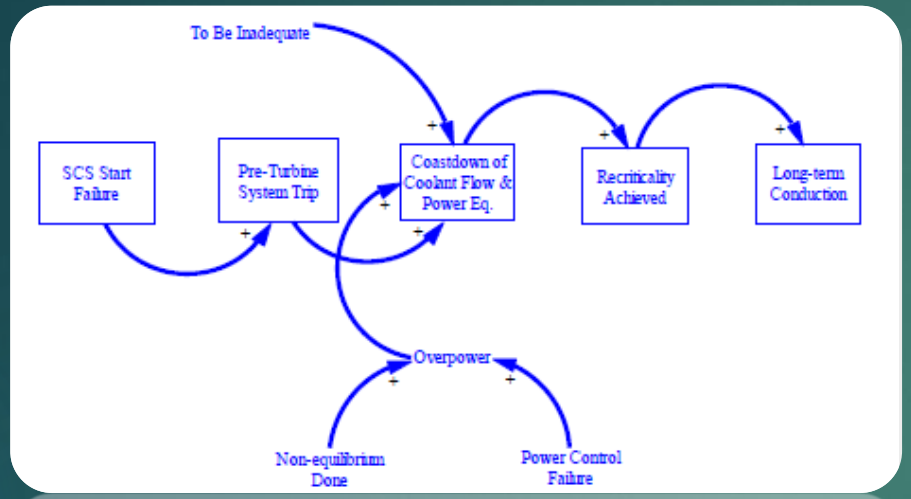
$$Output = \int_o^t Input(t)dt$$

- In the application of networking as the blockchain, the discrete values are summed up as,

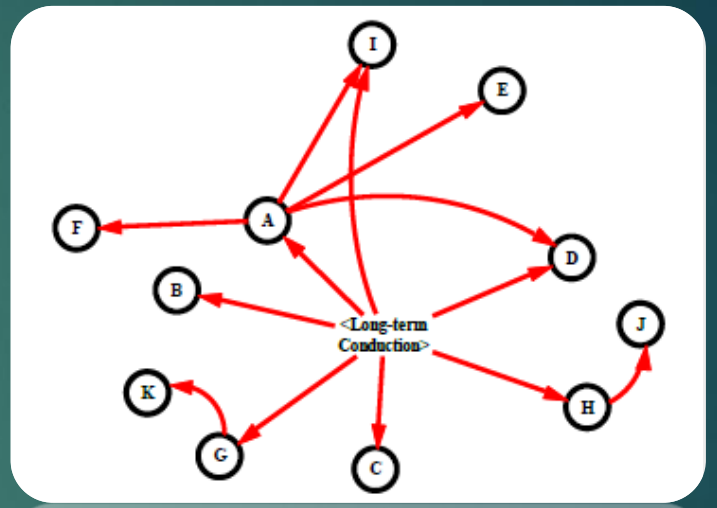
$$Output = \sum_o^t Input(t)$$

2. Methods

- In the case of the Fukushima accident, the golden time to prevent hydrogen explosions had gone away without two treatments as the opening of ventilation value for hydrogen gas and the cooling by the sea water.
- The time had passes about one day after earthquake shock induced tsunami that produced the pumping failure by flooding without these treatments.
- Fig. 3 (a) presents the diagram of event and fault tree. In Fig. 3 (b) there are some connected operators. This Vensim code is used for the modeling which is in Fig. 3 (a).



(a)



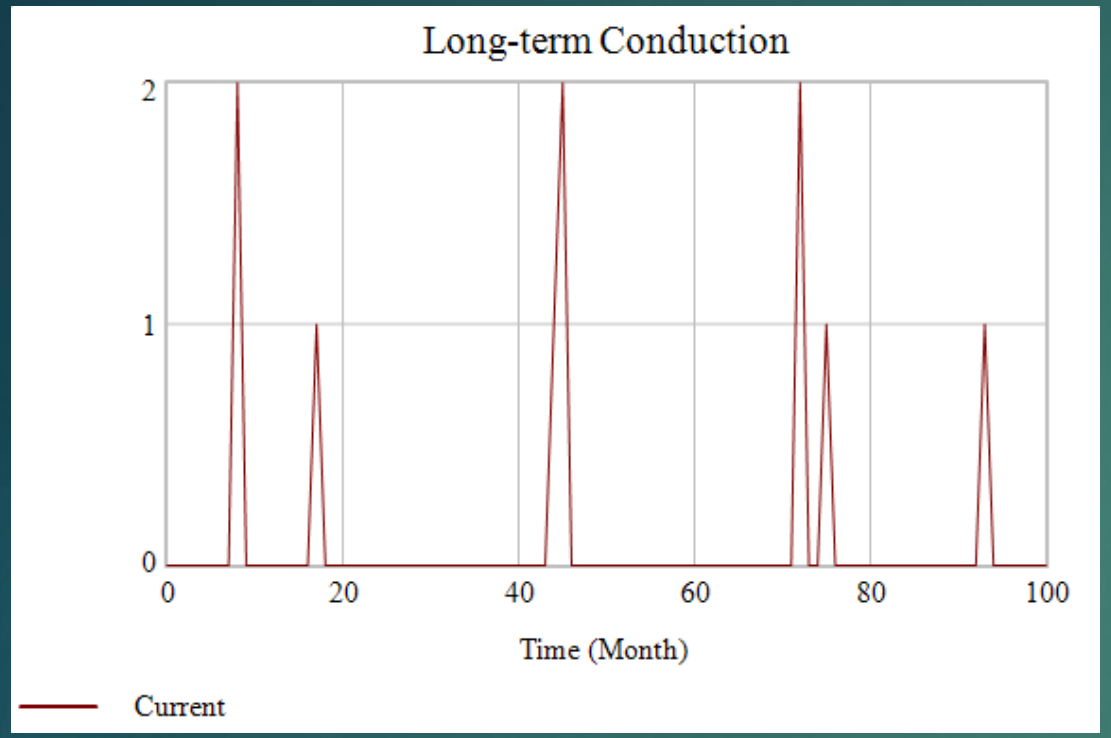
(b)

Fig. 3. Blockchain for operations (a) Blockchain structure and (b) Blockchain networks.

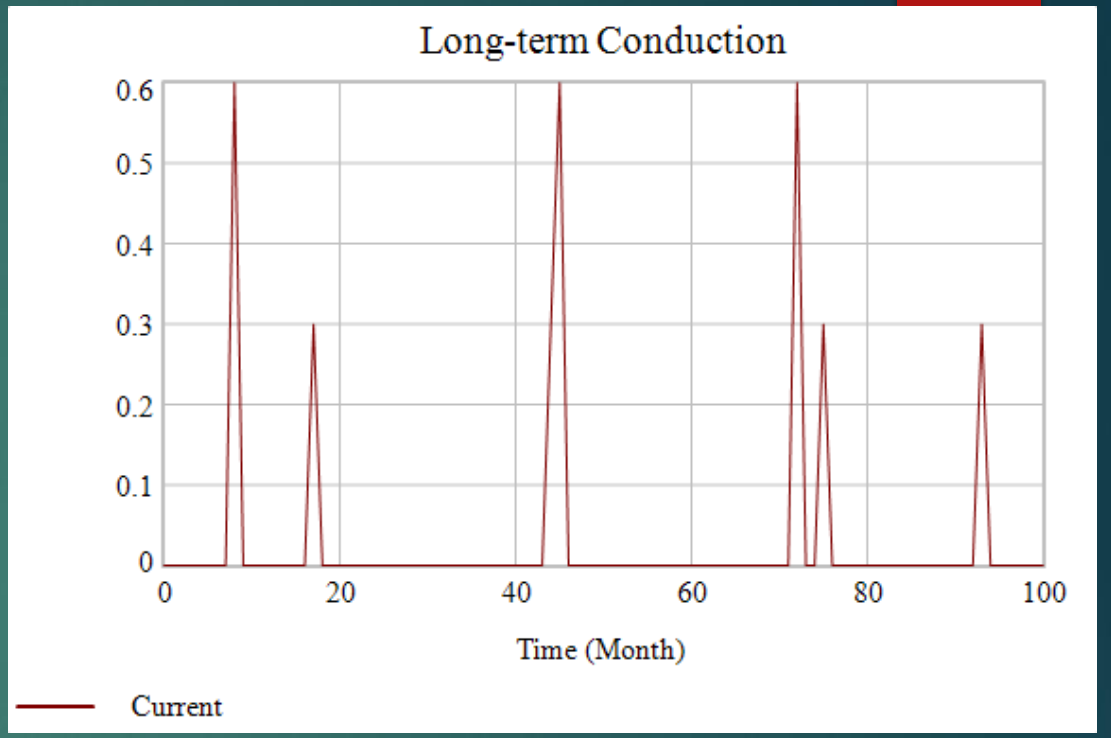
3. Results

- If the randomly generated number with ‘Recriticality Achieved’ is divided by 0.7, the quotient is 2.0 and the remainder is 0.6 at 8th month. This is the configuration of blockchain as follows,

MODULO (if then else (random 0 1 () < 0.3, 0, 1) * Recriticality Achieved, 0.7)



(a)

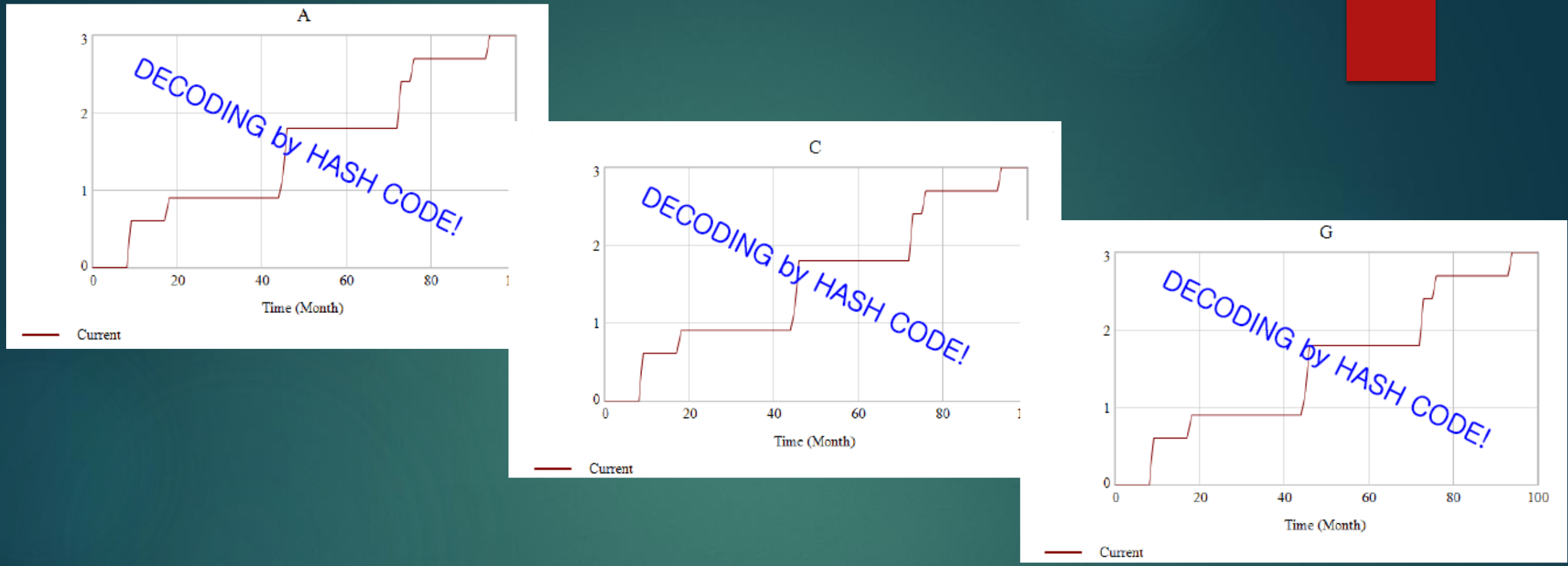


(b)

Fig. 4. Diagram for simulations (a) Conventional and (b) Blockchain modified.

3. Results

- In Fig. 5, there is the diagram for networks simulations for blockchain modified A, C, and G where Fig. 5 (b) is calculated by accumulations as the cumulative unavailability.
- Using the information of hash code, the decoding could be performed. The networking bodies have same information and can take the secured information.
- Fig. 6 shows the procedure of the study.



(a) (b) (c)

Fig. 5. Diagram for networks simulations for Blockchain modified (a) A (b) C and (c) G.

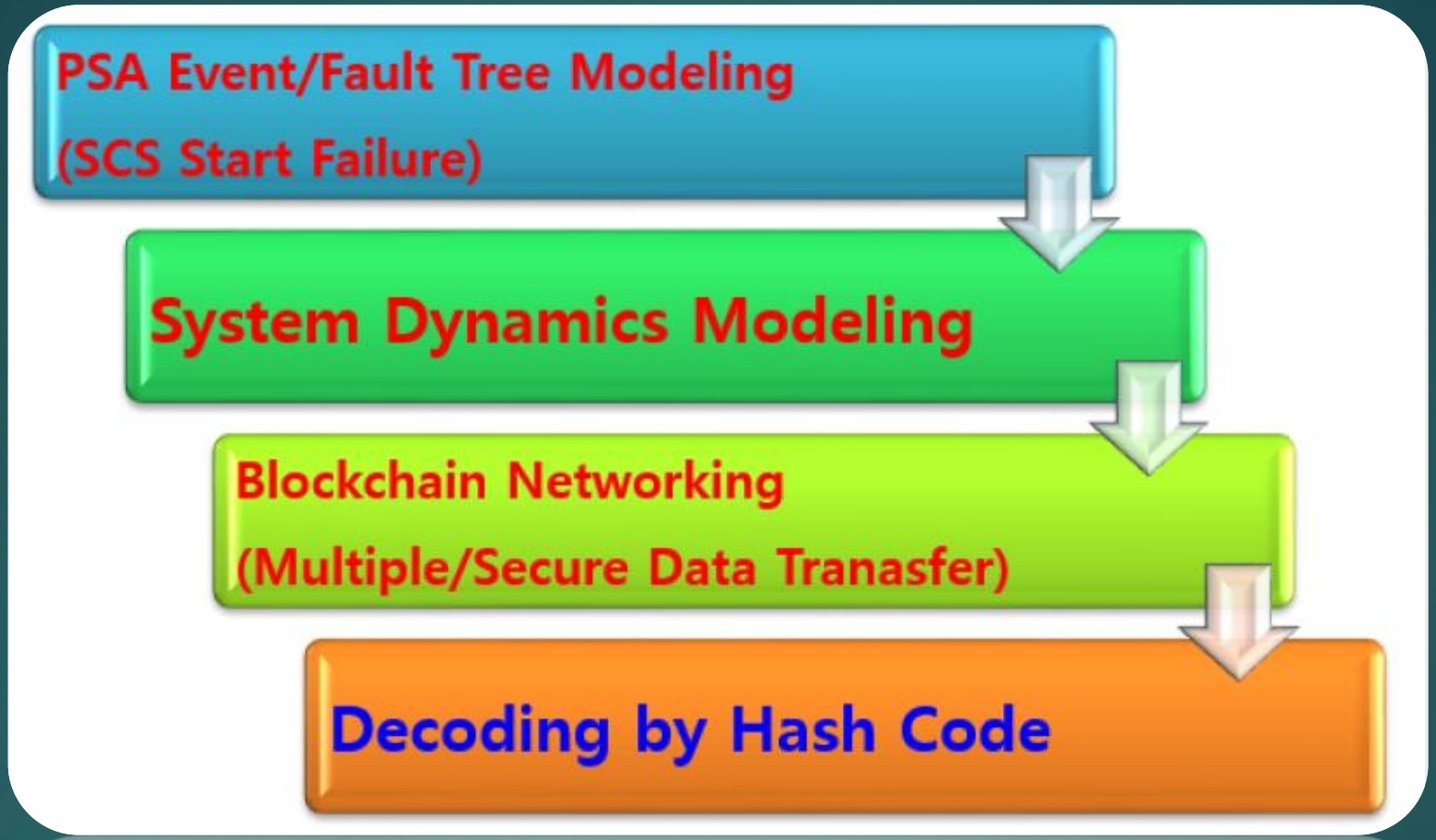


Fig. 6. Procedure of the study.

4. Conclusions

- It is applied to the nuclear safety for the security reasons using the blockchain technology.
- Additionally, the cyber security of the NPPs could be improved significantly [13].
- Any kinds of information in the nuclear stuff can be applied using the blockchain technology.
- For the secured analysis of the nuclear safety, the blockchain method is very effective considering the industrial significance, because the accident could make the unavoidable tremendous damages to the environment such as Chernobyl or Fukushima case.
- Therefore, the networking based data processing could be the ultimate security technology in the nuclear communities.

References

[1] A. Shalal, IAEA chief: Nuclear power plant was disrupted by cyber attack. Reuters, London, UK, 2016, <https://www.reuters.com/article/us-nuclear-cyber/iaea-chief-nuclear-power-plant-was-disrupted-by-cyber-attack-idUSKCN12A1OC>.

[2] J.H. Ziegeldorf, R. Matzutt, M. Henze, F. Grossmann, and K. Wehrle, Secure and anonymous decentralized Bitcoin mixing. Future Generation Computer Systems, Vol. 80, p. 448, 2018.

[3] R.-Y. Chen, A traceability chain algorithm for artificial neural networks using T–S fuzzy cognitive maps in blockchain. Future Generation Computer Systems, Vol. 80, p. 198, 2018.

[4] Piotrekr, Government should "begin to think" of using Blockchain for nuclear safety, Technology News, 2017, <http://technologynews.site/2017/10/20/governments-should-begin-to-think-of-using-blockchain-for-nuclear-safety/>.

[5] H. Zaremba, Blockchain tech is transforming the energy industry, OilPrice.com, 2018, <https://oilprice.com/Energy/Energy-General/Blockchain-Tech-Is-Transforming-The-Energy-Industry.html>.

[6] J.I. Wong, Even the US military is looking at blockchain technology-to secure nuclear weapons, Quartz, 2016, <https://galois.com/news/even-us-military-looking-blockchain-technology-secure-nuclear-weapons/>.

[7] SDS, What is SD, System Dynamics Society (SDS) Home Office, Albany, USA, 2017.

[8] N. Kshetri, Blockchain's roles in strengthening cybersecurity and protecting privacy, Telecommunications Policy, Vol. 41, p. 1027, 2017.

[9] G.J. Larios-Hernández, Blockchain entrepreneurship opportunity in the practices of the unbanked, Business Horizons, Vol. 60, p. 865, 2017.

[10] C. Yang, X. Chen, and Y. Xiang, Blockchain-based publicly verifiable data deletion scheme for cloud storage, Journal of Network and Computer Applications, Vol. 103, p. 185, 2018

[11] M. D'Aliessi, How Does the Blockchain Work? Medium, 2016, <https://medium.com/@micheledaliessi/how-does-the-blockchain-work-98c8cd01d2ae>.

[12] D. Ying, S. Jia, and W. Du, Digital enablement of blockchain: Evidence from HNA group, International Journal of Information Management, Vol. 39, p. 1, 2018.

[13] Woo, Cybersecurity analysis using the blockchain algorithm in nuclear power plants to enhance safe operations. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, xxx, xxx-xxx, 202x.

Thank you !

고려사이버대학교
THE CYBER UNIVERSITY OF KOREA