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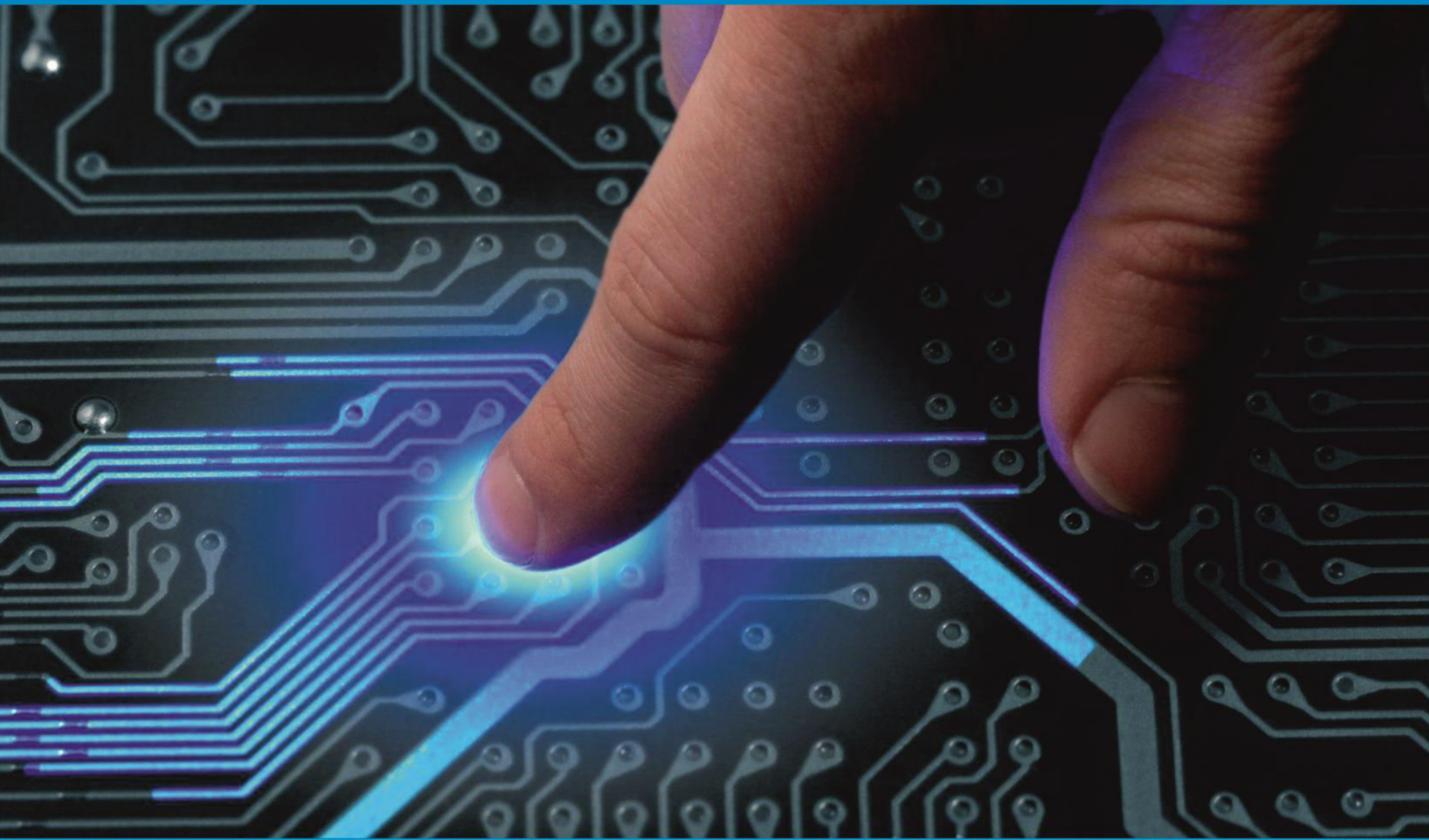

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Data Analytics Enabled Smart Learning Environment Frameworks Using Block Chain Networks

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Abstract: An intelligent learning method as Smart learning is efficient, proficient, interesting, and easy to use. Context-aided learning includes the use of sophisticated tools to provide students with access to content relevant resources in the school campus so that they can benefit about the relevant climate. Technology must be upgraded and combined with the new LMSs (Learning architecture) to have state-of-the-art instructional-art facilities enhanced systems must rise to the higher levels of degree of knowledge. This test will tell you what degree of "smartness" you have in the learning area that you've found a match in. Maintaining a high degree of intelligent complexity is essential when implementing smart architecture; it is necessary to do an analysis of how well you've done so that you can see how well you've done. This educational concepts are used as references for Learning Systems implementation serves as an important demonstration project for new methods and techniques. It is defined in this paper with the use of a Scenario-based verification technique in mind. to do Petrinet; use Matrix Modulo the reachability study, Simulation and Generalized Petri Nets (SPN); and then perform the first-order Petrinet conversion, to produce a proof operation diagram, Reachability graph, and Simulation, followed by the expansion to produce a Simulation; followed by another Reachability analysis to produce an Activity Diagram Petrinet; then perform the systematic Petriet to verify analysis to result in a Simulation, and a Stochaem Reachability Graph. a new approach for an online scenario has been suggested for the most recent SLE application with a use of the Blockchain algorithm The standardization issue that originally involves two degrees of Smartness - as well as protection is becoming a little harder here due to the protection, was changed to simply addressing software "validity". A approach suggested for the numerical confirmation of the device is first reduced to a well-formulated petrinet.

I. INTRODUCTION

In the domain of online learning, the IEEE standard of Learning Technology Systems Architecture is a widely known standard framework proposed in the year 2003[10]. It provides a generic Software architecture for the Learning Management systems. In the same year IMS Global Learning Consortium has proposed IMS abstract framework [22]. MIT has proposed (Open Knowledge Initiative)[24]. But in the later period, the OKI was dropped from the archives of MIT due to its impediments. A universally accepted framework stemmed from the Joint Information Systems Council (JISC)[23] from the UK which has the approval of the online learning research community. However, these are not regarded as smart learning frameworks [4][9].

Smart learning is concerned with the context-aware ubiquitous learning [27]. Contexts include the interactions between learner and the learning environments. The smart learning environments comprises of technology enhanced learning environments to fulfill the need to provide right content at right time. The smartness level is a measure to assess the smartness of the smart learning environments [9]. There are certain Standardization challenges, which are associated with the six Smartness levels [4][9].

The existing learning architecture frameworks have their own limitations. They stand at various levels of smartness some of them are not considered to be smart [3][4]. There exist limitations such as missing of some functional areas and could not achieve the current complex requirements [20]. Thus IEEE LTSA standard [10] was withdrawn in the year 2009[20][10]. In the assessment of smartness of the Learning technology frameworks, IEEE LTSA is concluded to be at the Pre-Smartness level[4]. There exists a requirement for the new age smart Learning Environment Frameworks which can adopt the latest sophisticated technologies [4]. There is a challenge in adopting new technologies to the learning environments to enhance the analytical capability of the learning environments [4]. This has motivated to address the challenges in Smart Learning Environments.

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To address the most important standardization challenge " Security" which is present in both the first and second levels of smartness(Adapt, Sense), the IEEE LTSA framework is extended[1] . The risk parameters are quantitatively evaluated on the IEEE LTSA framework and Blockchain-enabled Smart learning environment framework [1]. It is concluded that the Blockchain-enabled architecture is more robust, secure and immutable[1]. This paper proposes an algorithmic procedure for storing the online examination responses into the Blockchain-enabled Smart learning environment. There is a need to formally validate the proposed architecture for various scenarios.
The online examination scenario is represented ito equivalent activity diagram , as the UML diagrams are powerful mechanism to write software blueprints[2][16]. The UML diagrams are informal notations, thus they are converted into the Petrinets using the procedure proposed by Yasmina[5]. Petrinets are a formal representation of the system that can perform various analysis to prove the correctness of the system. A system design must be safe, bounded and deadlock-free that can be analyzed with the State space analysis of the Petrinets. .

The Research contributions of this paper are listed below A Procedure to verify an SLE framework

- An Algorithmic procedure for a scenario of the Blockchain storage of Online Examination responses from the students
- Formal analysis of the proposed scenario's procedure for verification

II. RELATED WORK

2.1 Learning Technology Systems Architecture

Learning Technology Standard Committee (LTSC)[10] has proposed a standard, called as IEEE Learning Technology Systems Architecture 1484.1 in 2003. It is a high-level architecture for Online learning that provides an abstract framework. There are 2 data stores, 4 Processes, and 13 data flows as described in the standard [10]. The Learning Resources stores the learning content and the Learner Records is the dedicated data store to save the learner's information. It's built on the centralized data-store system. The processes in the architecture communicate with the data flows mentioned in the Figure 1. There are security threats due to the centralized storage system. The non functional parameters like availability get compromised which is one of the major limitations.

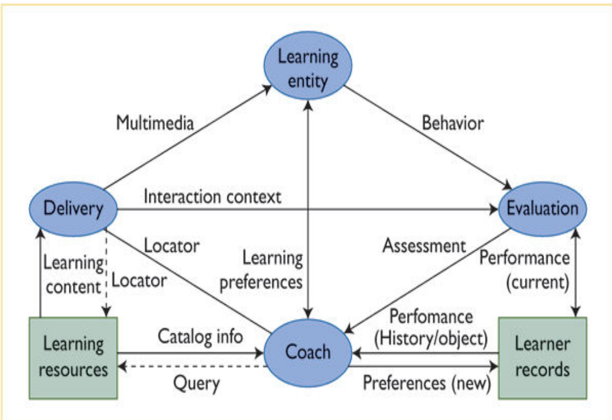

Figure 1 IEEE LTSA framework [10]

Praveen et Al [20] have attempted to convert the centralized data storage schema in LTSA to distributed schema. They have emphasized the need of security in online learning due to continuous evolution of hacking techniques that

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makes the possibility of attacker's intrusion into information system. Formal evaluation has not been performed to this architecture.

2.2 Threats in Online Learning

The smart learning environments designed are supposed to possess high security and reliability [4][9]. The e-learning process is facing challenges in assessing the learning objectives and in conducting examinations through an online mechanism, as the evaluated results reflect the impact directly on the learning outcomes[11][12]. The data generated and stored during the assessment must be tamper-proof and immutable.

Abrar et al [12] have classified the threats in remote online examinations into Intrusion based and Non-intrusion based. The threats include impersonation, collusion and abetting. To address these threats, a framework must ensure transparency and non modifiability of the examination data.

Shaibu [19] listed out the security issues in e-Learning and M-learning environments as SQL Code Injection, Cross site scripting, Cross site request forgery, Stack-smashing attacks, Session Hijacking, Denial-of-Service attack (DoS). A Framework design should avoid four types of threats which are Fabrication, Modification, Interruption and interception. This mandates the designer to explore and adopt a robust secure mechanism to the SLE framework.

2.3 Block chain-based Storage Systems

A Block chain is a distributed database that has data definition and update mechanism [6]. It allows to add new data as well as ensures that uniform data is present in whole network. The Blockchain is a decentralized linked data structure for retrieval and data storage. The data stored once is resistant to any modification, which is a robust storage mechanism. Blockchain mechanism provides Integrity, Transparency, Immutability, audit-ability and fault tolerance. Muhammad Muhammad et Al [6] proposed an application platform that has Blockchain mechanism. ChainSQL is used in this research work, that explained the components in the Blockchain system. The architecture of this Blockchain based system contain the flow of interaction of Application, Network nodes and Database. This Blockchain system architecture [6] is adopted in our work for designing the Smart Learning Environment Framework.

III. METHODOLOGY

Algorithm for the Online examination Scenario for Block chain
The Scenario based formal verification of a framework can be performed with the following procedure. The workflow of each scenario needs to be constructed for this purpose. There can be many scenarios addressing various services of the framework. General verification follows by prioritizing the scenarios and proceeding with the most significant one.

The verification begins with the Requirements of the framework. The requirements are Functional and non-functional. To verify the correctness of the methodology for a scenario, the following steps are to be followed.

1. Specify the workflow of tasks necessary to provide a service
2. Express the workflow in an Activity diagram
3. Convert the Activity diagram (informal notation) into a Petri net (Formal notation)
4. Evaluate and Analyze the Results obtained from the Petri net and Architecture
5. Revise: Repeat the procedure until complete Requirements are addressed.

A workflow for a scenario can be developed if a set of tasks are well defined, predictable and repetitive. The successful completion of any workflow mainly relies on two factors:

- Modeling power
- Decision power

Modeling power is delineated as the capability to represent the system to be modeled, and the decision power is set out to evaluate the model and define the feature of the modeled system. The framework of the workflow needs to be formally represented which works as a powerful tool that yields a proper analysis. This can be better represented with UML diagrams.

Unified Modeling Language (UML) is a powerful mechanism to write software blueprints. The activity diagram, one of the UML diagram that can demonstrate the flow of activities to provide a service. They are helpful in modeling use cases for representing business workflows. They help model the coordination of a collection of use cases for representing business workflows.

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In the activity diagram, every event is taken as an activity.

To build an activity diagram,

- The tasks in the workflow need to be identified
- The order of the tasks must be listed
- The initial and final tasks are to be marked.
- The precondition and post condition for each task must be derived
- The Workflow between tasks must be modelled.

The conversion of UML activity diagrams into a Petri net is performed by the framework proposed by Yasmina[5]. This procedure involves identifying the Places and transitions from the activity diagram. The rules for this conversion are The initial node is taken as a Place, An Action to a transition and Every decision to a place. From this procedure, a Petri net can be generated. A Petrinet analysis can conclude the correctness through the Safeness, Liveness(Deadlock free), Boundedness[18].

A holistic picture of the projected procedure is depicted in the Figure 3.

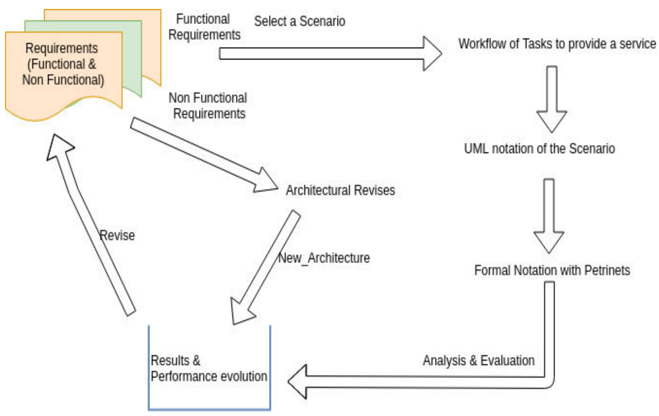

Figure 3 Procedure of Verification of a Software Architecture

1. Algorithm for the Online examination Scenario for Block chain enabled SLE

To address the "Security" threat for the online examination scenario, an Algorithmic procedure in accordance with the Blockchain based Smart Learning Environment framework[1] is presented as below

Data: Exam Activity log = $\{a_{t_0}, a_{t_1}, a_{t_2}, ...a_{t_n}\}$, where a_{t_i} is an activity at instant t_i. Initial time t_0, Current Time t_c, Duration of exam d, $n(t_i)$ the number of transaction from t_0 to t_i, termination time t_t, initially $t_c = t_0$, Final time $t_f = t_0 + d$

Result: The Responses and activities during online examination are stored securely into the Blockchain

while $t_c < t_f$ & $t_t \neq NULL$ **do**
    if $(n(t_c)\%s \leftarrow 0)$ **then**
        $flag = t_c$;
        generate($H(a_{t_c})$) ;
        P = { collection of the hash values of a_{t_0}, a_{t_1}, a_{t_2},..... $a_{(t_c - flag)+1}$ } ;
        if *validation_ failed* **then**
            initiate Rescue Mechanism
        else
            $t_c = t_c + 1$;
            generate($H(a_i)$) ;
        end
        current section becomes this one;
    end
end
Upload the final block
Conclude the exam

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Algorithm 1 : Algorithm for the online examination Scenario

Each exam has a fixed duration '*d*' defined while creating the examination. The Exam Activity log is a set of student responses recorded during the time duration *d*. Each record in the log including other parameters [1] is a transaction. A block consists of a fixed number of transactions. Once a student authenticates and begins an exam at t_0, their responses are stored into the Exam activity log for the duration d. If the current instant of time t_c is less than the final instant of time ($t_f = t_0 + d$) then the transactions are stored. A hash value for each transaction is computed instantly and stored in the exam activity log. The block generation process is initiated once the required numbers of transactions are recorded. The slot number '*s*' defines the number of transactions per block. Once a block is generated by any local node, it is attempted to validate. On successful validation, the corresponding block is to be added to the blockchain. In the failure of block validation, a rescue mechanism is initiated. The rescue mechanism is subjective to business policies. If the exam duration is completed, or if the student submits the exam before the final time, a final block needs to be generated. The final block consists of the exam log transaction along with the final response record of that student. The behavioral data obtained during the exam helps in deriving various properties. The final block helps in evaluation. As per the architecture, once the exam is done, the Evaluation process commences. The evaluation process can be carried just by confirming the last block hash value with the Quiz (exam) responses hash value. An algorithm for the above-mentioned procedure is mentioned at Algorithm 1.

IV. CONCLUSION AND FUTURE SCOPE

A procedure for the validation of SLE is proposed. An algorithmic procedure for the online examination scenario is presented. The correctness of the proposed procedure for achieving enhanced security is verified. Its workflow is converted into a UML-Activity diagram. Later, a Petri net is generated for formal analysis. The generated Petri net confirms the proposed procedure of Blockchain-enabled data storage mechanism for the online examination is valid. This formal validation procedure can be used for any Scenario-based evaluation of a Software architectures. This procedure can be further continued to achieve the other standardization challenges to reach higher levels of smartness.

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