TERMS OF REFERENCE FOR THE R&D PROJECT

Title of the Project: Study of Learning Record Store Interoperability Augmented by Blockchain

1. Background:

A Learning Management System (LMS) is a software application that can be used for offering online courses to students and organizing assessments to evaluate student's performance. Apart from that, LMS captures a student's actions w.r.t his/her course access, assessments, and active participation in different tasks and records the same in its own repository. It even stores information about an instructor's planned schedule of courses, questionnaires, etc., in the same repository.

It is a usual practice that every educational institute (e.g., University, College) will have its own LMS that is administered by respective institutes only. e-Learning standards/technical specifications have been developed to support a collaborative learning environment by way of two different approaches. For example, xAPI (Experiential Learning API) and LTI specifications support collaboration and interoperability between various devices including other LMS applications to provide online learning services seamlessly. Figure 1., below depicts one such configuration or network setup that is possible to implement provided LMS applications have the capability to support these specifications.

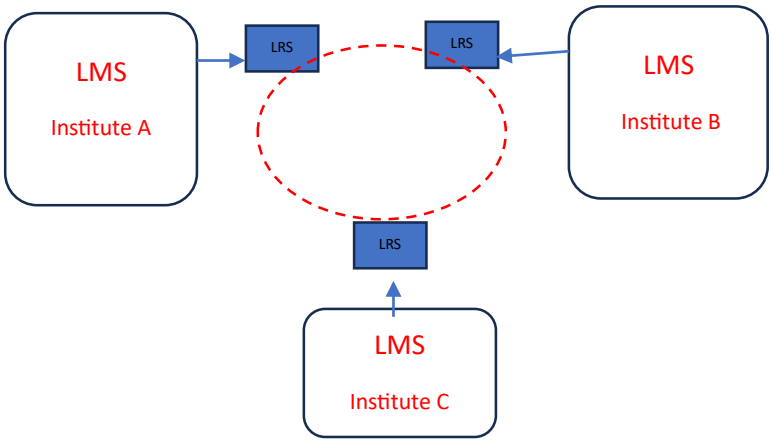


Figure 1: A consortium of educational institutes collaborating with each other

In Figure 1., three LMS applications that are being administered by three different educational institutes are configured with the LRS capabilities.

Because of the LRS capability a particular LMS application can fetch the student's learning experience from the other devices or platforms (including mobile, social media, virtual labs, etc.) where the student has performed any educational-related activities.

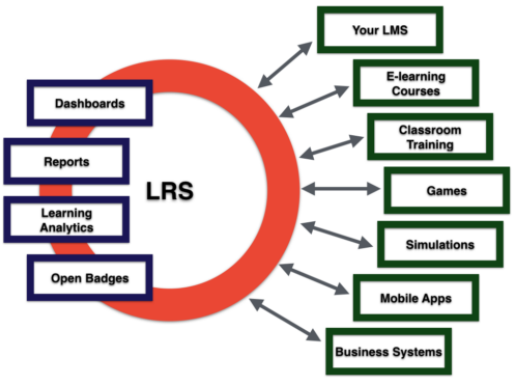


Figure 2: LRS Operational Diagram

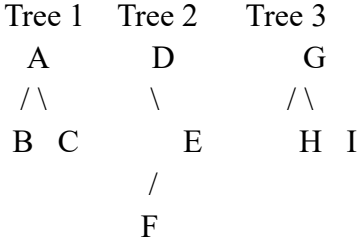
In a traditional situation, a student passes a grade in an undergraduate study moves to graduation, and then to post-graduation study, thus he/she gets admission in three different educational environments. If the LRS instances with which the student was associated in his entire educational cycle are brought onto the blockchain network this would provide a unique opportunity to both the student as well as the institutions in the following manner.

The student's learning experience records will be maintained and shared among all the educational institutes the student might have traversed in his academic lifecycle in a secure and tamper-proof manner. This gives interested parties (e.g., recruiters) to analyze the student's real potential in his academic lifecycle instead of relying upon the scoring mechanism alone. This is because Blockchain ensures that the unique representation of data is stored across all the machines in the Blockchain network, that are administered by respective educational institutes.

The identified gap areas are as follows:

1. It is left to the organizations using LMS with xAPI to define the vocabulary for statements or learner experiences. This aspect may be looked into in detail for possible standardization efforts so that all educational institutes can follow the same metadata structure to define the learning experience.

2. It is challenging to onboard all the LRS educational institutes onto the blockchain network in a student-centric approach as the core idea of this proposal is based upon the maintenance of students' academic lifecycle achievements on the decentralized blockchain network. In the below diagram, each root node (e.g., A, D, G) of the tree may be considered as an institute's blockchain node where LRS is maintained.



Here, the root node of a tree may be the child node of another disjoint tree. The edges between the successive nodes represent the *blockchain channel in which the respective institute's LRS node is a member. For example, in Tree 2, node E is a member of two different blockchain channels 'DE' and 'EF'.

A more complex scenario could be like

Assuming two students who have passed out from E have taken admission in two different institutes called A and F. Now, the node E has to join both the blockchain channels A and F. In this way, every institute may become a member of more than one blockchain channel in order to maintain a unique state representation of the learning experiences of students who have been passed through respective paths.

As far as impact of additional infrastructure is concerned, there won't be any major infrastructural requirement for setting up Blockchain network. This is because, in the proposed concept it is mentioned that each LRS server instance itself will be treated as Blockchain node.

Note:

* A blockchain channel is nothing but a logical sub-networking concept where multiple blockchain nodes become members of that particular channel so that information exchange takes place between member nodes. Such shared information can then be stored in ledgers in respective blockchain nodes. The consensus algorithms of the Blockchain network ensure that every blockchain node has the same information at any given point in time without any loss of data integrity that is nearly impossible to tamper.

2. **Scope**:

Development of a detailed technical study report on augmenting Learning Record Store (LRS) instances with blockchain capability and intricacies of onboarding LRS instances onto to Blockchain network with student-centric academic lifecycle management practices. This project shall highlight this concept from different views and shall result in a future standard document or a new international work item.

3. Expected Deliverables:

- Set up multiple LRS instances representing a particular institute in a network and explore either adding or building a proxy mechanism to support blockchain capability in those instances.
- Define a standard meta-data structure for recording LRS statements so that the same may be stored on LRS cum Blockchain instances.

- Study the intricacies of blockchain network planning mechanisms in the above context and find out processes and communication mechanisms with an intent to look into the possible standard operating procedures.

This project shall highlight this concept from different views and shall result in a future standard document or a new international work item.

4. Research Methodology:

a) Literature Review: A comprehensive literature review to be done to understand the existing standards and relevant studies.
b) Data Collection: Gathering data on LRS Interoperability Standards available in the market.
c) Focus Group Discussions: Conducting focus group discussions with potential users and experts in the field to identify key performance parameters and safety concerns.
d) Stakeholder consultations and at least 2 exposure Visits: Visits to relevant research labs within India to understand the Standards being used for supplementing LMS with LRS and identify the gaps resulting in the interoperability issues of LRS
f) Feedback and Expert Consultation: Seek feedback and consultation from experts involved in e-Learning technologies and working with LRS Interoperability.
g) Any other research methodology to address the expected deliverables for this project.

5. Timeline and Method of Progress Review:

Timelines:

- Setup LRS instances in the LAN environment T0+1 month
- Build a proxy module to interface with the LRS instance w.r.t LRS statements T0+2 month
- Study and experiment with the disjoint tree structures and the effect of message passing in the context of this proposal T1+1 month
- Setup blockchain network treating LRS instance or its proxy as Blockchain nodes T1+1 month
- Define meta-data structure for information exchange between LRS & LMS and and LRS & LRS T2+1 month
- Define smart contract rules for dealing with identified meta-data structures T2+1 month

- Experiment with multiple blockchain channels, smart contract implementation, and their functioning T3+1 month
- Build a prototype of the experimental setup with features implemented in the previous steps to identify standard operating procedures T4+2 month
- Prepare a detailed technical study report on the experiments carried out and observations made T5+1 month

Method of Progress Review: mid term review, discussion, modification & final submission.

6. Support BIS will Provide:

BIS will provide access to latest available editions of Indian standards and/ or international standards relevant to the project, on request.

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