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## Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise.

Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both

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## **EXECUTIVE SUMMARY**

BEACONING is an ecosystem. It means BEACONING implements a set of components and processes that depend on each other and interact with the same unifying purpose: to drive pervasive game-based learning experiences.

The core BEACONING Platform supports services and a communication framework with a focus on interoperability standards and governing industrial practices<sup>1</sup>. Around the core platform, a set of components such as the authoring tool, the game and graphics engine, the geolocation game engine and mini-games are applications that utilize a reuse-driven assets library. A set of industry standards enable the interoperability and coupling of these units. The platform integrates with learning management systems, collaborative learning platforms and context-awareness providers via a set of industry standards. Communication between the units, at data level communication rely two types of data models: standards (as ADL xAPI standard); and custom, developed within the project using JSON format for describing embedded mini-games and for describing Gamified Lesson Paths and can simply inform future standards.

This document is the “Intermediate” version of the standardization in BEACONING Ecosystem, briefing the elements of interoperability and coherence among the components.

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<sup>1</sup> Refer to D4.1 Integrated BEACONING Ecosystem (M18)

## **1 INTRODUCTION**

### **1.1 ROLE OF THIS DELIVERABLE IN THE PROJECT**

The 7th work package of the project aims at founding an ecosystem that enables a sustainable adoption of the project developments in real contexts and in the broadest possible community. For such a penetration to occur, the BEACONING Ecosystem should connect with the prevalent educational technologies. Moreover, the ecosystem should also rely on tested communication and interoperability procedures to provide a seamless and reliable experience. For these reasons, industrial or de facto standards are used throughout the development of the project outcome. This deliverable documents these standards as well as their context with the purpose of not only reporting them, but also cross checking, as the beta release of the system has just been completed.

### **1.2 APPROACH**

The knowledge of standardization needs and efforts is organized in a top-down approach, starting with the relations between the BEACONING ecosystem and the other learning technologies already identified as part of the project which constitute its environment (such as LMSs), followed by the standards utilized within the ecosystem and finally at the data communications level.

### **1.3 STRUCTURE OF THIS DOCUMENT**

The document consists of four main sections. The connections between the BEACONING Ecosystem and the typical technologies in educational environments such as learning management systems (LMSs) or systems for educational collaboration, communications and context-awareness providers, will be described in the first section. Following that standards used internally will be documented in two sections covering those among the elements of the system and those about the content. The final section about standards will focus on the data layer.

## 2 BEACONING AND ENVIRONMENT STANDARDS

The landscape of worldwide game-based learning initiatives is widespread. This domain is very broad and its concepts vary between subject areas (such as STEM or language training), stages (such as K12 or VET), or purposes (such as engagement or test prep), impacting the standardization process. Standalone games or walled-garden educational games platforms (such as Kahoot!) endorse de facto standards if they manage to gain popularity. BEACONING is an “innovation action” project, which brings together existing achievements of the project partners, hence it diverges from these examples and adopts an ecosystem approach. Observe in the figure below that this ecosystem covers a meta-game with its own engine, mini-games, authoring tools, context awareness providers and analytics tools. Also observe that, these components have to connect to user devices and various learning and collaboration management systems, because they will be taken to large scale piloting.

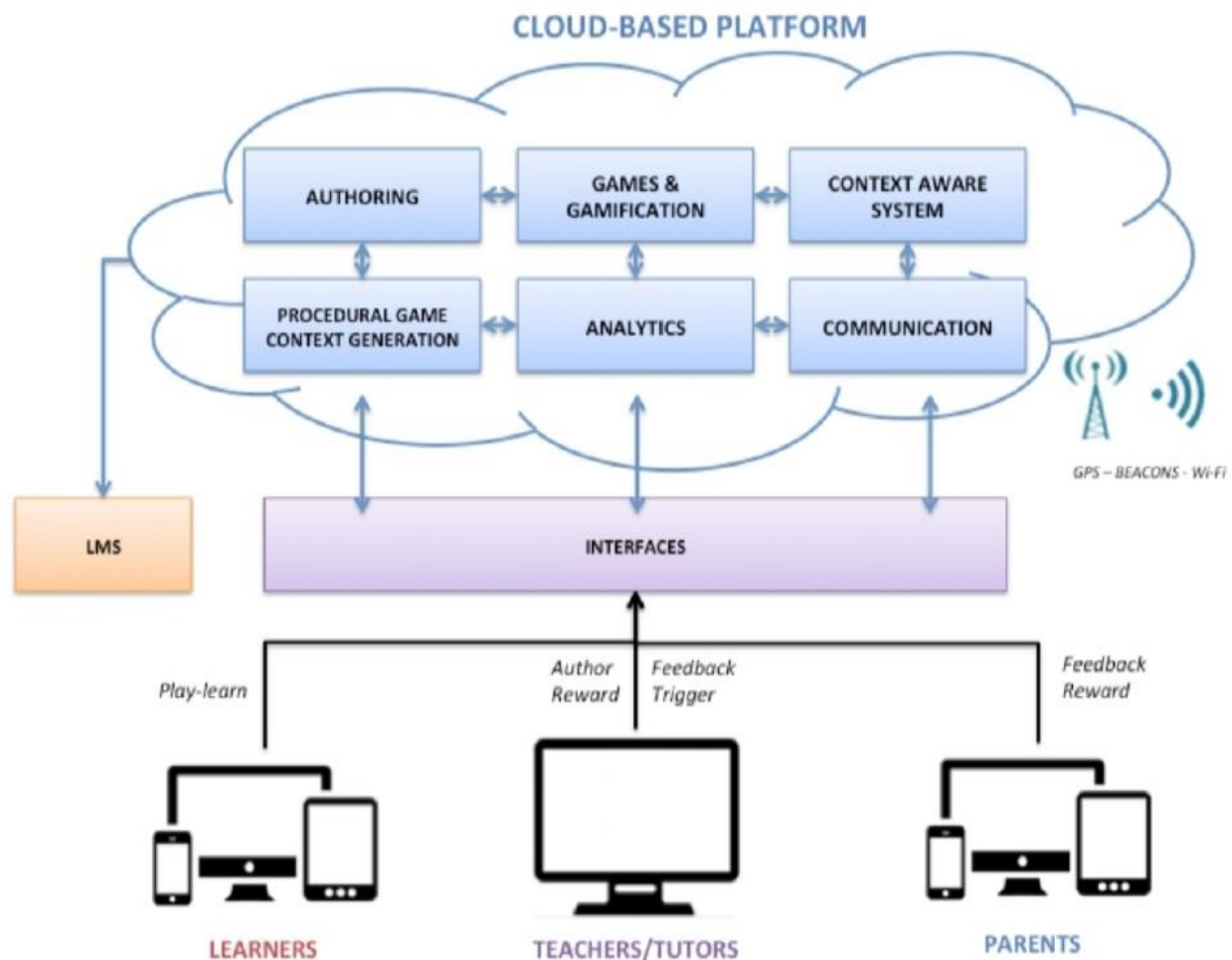


Figure 1. The BEACONING Ecosystem

## 2.1 LMS INTEGRATION AND THE IMS LTI STANDARD<sup>2</sup>

The 3 major piloting partners of the BEACONING project outcome indicated their piloting environment as:

- SIVECO: will run the pilots on the BEACONING platform
- ORT: will run on either the BEACONING platform using Moodle as an LMS or directly on the BEACONING platform depending on the piloting countries and schools.
- SEBIT: will run on the BEACONING platform using VCloud as an LMS

Moodle and VCloud are digital environments that provide Learning Management System (LMS) functionalities to manage courses and assignments processes in educational establishments. Once deployed, the daily educational activities of the establishment is governed using these systems. As BEACONING gets integrated to these, the main role of the LMS functionality would be authentication, after which the user will be directed to the BEACONING platform.

Once authenticated the user “lands” on the LMS page that s/he is used to. The LMS “gets” the list of available BEACONING Game-Lesson Plans (GLPs), resolves grade/subject/title info and adds the GLPs as extra lesson plans available alongside the other plans in the LMS.

When the user selects one of the GLPs, the redirection occurs. This enables a teacher to assign a GLP to her students within the LMS, hence the LMS notifies students of the assignment and keeps track of the GLP use, together with all the activity that is done via the LMS.

There are two standards to achieve compatibility between content or lesson plans (such as GLPs) and current LMSs: ADL SCORM and IMS Content Package<sup>3</sup>. They are both supported by almost all LMS and IMS LTI is commonplace to integrate external content and services to the LMS (e.g. to integrate BEACONING GLPs to Moodle or SEBIT VCloud)<sup>4</sup>. The main difference is that IMS is mainly for “static” content - SCORM allows tracking of question/answers and reports a “grade” at the end. Lately though, Advanced Distributed Learning Initiative (ADL) has initiated an update on its set of standards, which is called ADL Training and Learning Architecture (TLA) around which open source software is being built.

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<sup>2</sup> Learning Tools Interoperability (LTI) is a standard developed by [IMS Global Learning Consortium](http://www.imsglobal.org/activity/learning-tools-interoperability).  
<http://www.imsglobal.org/activity/learning-tools-interoperability>

<sup>3</sup> Creating SCORM and IMS Content Package for LMS import. Retrieve at  
[http://www.elml.org/website/en/html/output\\_cp.html](http://www.elml.org/website/en/html/output_cp.html)

<sup>4</sup> <http://www.imsglobal.org/activity/learning-tools-interoperability>



### Training and Learning Architecture (TLA): Web APIs and Open Source Software

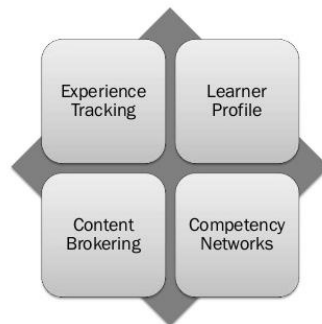


Figure 2. The four branches of ADL TLA<sup>5</sup>

The TLA has four branches (**Error! Reference source not found.**): experience tracking, learner profile; content brokering; and competency networks. All of these 4 branches of standards are relevant to BEACONING, with a special note to “experience tracking,” commonly known as xAPI, which is already implemented in the project. Using the tracked data, competency state calculation and grading can be made. IMS CALIPER is the corresponding standard to xAPI, but it was started a few years after xAPI was initiated, and it is not as advanced as xAPI<sup>6</sup>.

“ADL describes four phases for transitioning from standard packaged content and an LMS-centric approach to a more distributed one based on collected information (i.e. learning record store), or to full service-based learning platform where a LMS is not even required”<sup>7</sup>.

Most serious games are used independently of LMSs, but when an organization uses an LMS, all processes revolve around the LMS. The “ecosystem approach” envisions a loose-coupling between distributed services; indicating easy provisioning and scalability, as well as a division of labour among eLearning systems. “21st century ecosystem of learning that combines in-school, out-of-school, work-based, and online learning opportunities that are visible and accessible to all”<sup>8</sup>.

As far as the BEACONING project is concerned, how the redirection or GLP list retrieval occurs is not set yet. It can be done by using IMS LTI standard, or by revising a core service such as the one below::

<sup>5</sup> <https://www.adlnet.gov/tla/>

<sup>6</sup> <http://www.adlnet.org/adl-experience-api-and-ims-caliper-discovery-review>

<sup>7</sup> Freire, M., Serrano-Laguna, Á., Iglesias, B. M., Martínez-Ortiz, I., Moreno-Ger, P., & Fernández-Manjón, B. (2016). Game Learning Analytics: Learning Analytics for Serious Games. In Learning, Design, and Technology (pp. 1–29). Cham: Springer International Publishing. [http://doi.org/10.1007/978-3-319-17727-4\\_21-1](http://doi.org/10.1007/978-3-319-17727-4_21-1)

<sup>8</sup> <https://www.lrng.org/>

**Core Service: ListGLPs**

- **Description: Service for fetching GLPs matching a certain criteria**
- Inputs:
  - Category(String) (Optional for filtering)
  - Title(String) (Optional for filtering)
  - Description (String) (Optional for filtering)
  - AuthorID (String) (Optional for filtering)
- Output:
  - GLPs(List of GLP JSON)

During redirection OAuth 2.0 Tokens-based Authorization Protocol will be used to achieve single sign-on, that is the user credentials approved during LMS login will be passed to the BEACONING core services, much the same as a user can login to Spotify using Facebook, and be redirected to Facebook's website to do the authentication.

After redirection, at BEACONING page, it may be possible to use IMS LTI or just JavaScript to retrieve (encrypted) a user name from LMS in order for that user to see his/her name on the BEACONING page. Such call would be made from the user's browser, straight to the LMS, without any BEACONING intermediary, so it should not be a privacy concern, but this still needs to be cross-checked with the latest privacy policies of General Data Protection Regulation which becomes enforceable from 25 May 2018.

A learning analytics dashboard is used within the BEACONING platform. Yet the LMS can access basic usage data or even the evaluation results of the GLP performance to include them in its own reports. That may require a call by the LMS to the Elasticsearch of the BEACONING analytics subsystem or the LMS can as well be positioned as an analytics service provider, which just accesses the Learning Records Store and uses the data for its own reporting purposes.

Final aspect of LMS integration is the use of the same "competency framework" so that activities both on the LMS and on BEACONING that contribute to the same competency can be combined for assessment. Competency-Based Education programs are increasingly offered at US and EU higher education institutions. These programs recognize prior competencies of enrolled students in order to personalize the program for each student. They rely on backward design of lesson plans, authentic assessments, various learning workflows, personalization and adaptability, and learning and performance analytics<sup>9</sup>. Since competency tracking is essential in these programs, competency dashboards are provided to students at the school's digital platform. These dashboards usually utilize standards such as IMS LIS, OneRoster, and LTI to gather data about and evidences of mastery. However, they are most effective when evidence-centred, backwards design of lesson plans are and entered carefully to the digital

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<sup>9</sup> J. Mott et al, "The Next-Generation CBE Architecture: A Learning-Centric Standards-Based Approach," at Handbook of Research on Competency-Based Education in University Settings, 2017. Refer: <https://www.igi-global.com/chapter/the-next-generation-cbe-architecture/167900>

platform. As the standards-based learning management systems increasingly prevail at the school and pool the data about evidences of mastery, even third party dashboards are now available, such the Intelliboard dashboard which is designed as an add-on to Moodle<sup>10</sup>.

Not only IMS TLA (which is more recent), but also IEEE Simple Reusable Competency Map (IEEE SRCM)<sup>11</sup>, developed by the Learning Technology Standards Committee of the IEEE Computer Society, define an information model for simple, reusable competency maps. These maps can be utilized commonly for describing, referencing, and exchanging data about the relationships between competencies (the word competency is used in a very general sense that includes skills, knowledge, attitude, and learning outcomes.)<sup>12</sup>

Since BEACONING has a main goal to focus on improving STEM competencies for its users, a competencies schema/map that involve some generic STEM skills can be adopted and shared with the LMS or any other competency tracking unit in the environment. If IEEE standard is used such map can even include:

- i. CompetencyEvidence information which can be used to capture information to substantiate the existence, sufficiency, or level of a Competency. CompetencyEvidence might include quiz results, reports, performance appraisals, evaluations, certificates, licenses, or a record of direct observation, such as a report given by a teacher.
- ii. CompetencyWeight information, which allows the capture of information on the relative importance of the Competency or the sufficiency required or other type of dimension. An extensible “type” attribute is available so that custom weights or dimensions may be specified. Multiple CompetencyWeights are permitted since more than one type might apply to the competency.

This is an ongoing development in the project, which will be reported in the next version of this deliverable (M36).

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<sup>10</sup> <https://www.moodlenews.com/2017/how-to-keep-track-of-competencies-with-the-intelliboard-dashboard-for-moodle/>

<sup>11</sup> IEEE Learning Technology Standards Committee, “Simple Reusable Competency Map” available online at <http://ieeeltsc.files.wordpress.com/2009/03/reusablecompetencymapproposal.pdf>

<sup>12</sup> Luis E. Anido-Rifón, “Standardising Competency Definitions for Engineering Education,” in Proc. IEEE Global Engineering Education Conference (EDUCON), April 2011, available at [https://www.researchgate.net/publication/260741912\\_Standardising\\_Competency\\_Definitions\\_for\\_Engineering\\_Education](https://www.researchgate.net/publication/260741912_Standardising_Competency_Definitions_for_Engineering_Education)

## 2.2 CONTEXT-AWARENESS PROVIDERS

Context-awareness in BEACONING regards location.

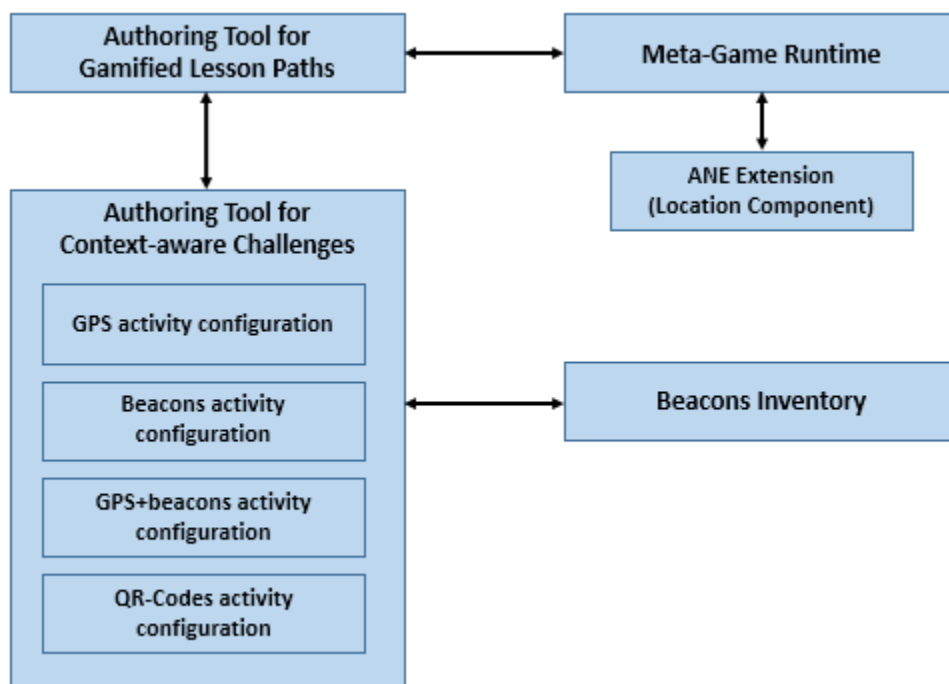


Figure 3. The BEACONING Ecosystem Context-Aware Components

D4.2 Location-based Component explains there are three position tracking technologies available in the BEACONING ecosystem:

1. **Beacons:** Modules with version 4.0 or higher of Bluetooth Low Energy Standard can be physically placed in the territory where location aware activities would be carried out. Next, each one of these devices must be entered at the “Authoring Tool for Context-Aware Challenges” so that when a user enters in their near vicinity, a game-based learning challenge would be launched automatically. Alternatively, the network of a beacon service provider can be exploited, such as Blesh in Turkey, Pole Star in France or IFINITY in Poland, which is one of the BEACONING consortium members. These providers implement the “Proximity Beacon API” Standard which is a part of the Bluetooth low energy (BLE) beacon platform that includes Eddystone Standard, an open beacon format from Google. The Proximity Beacon API is a cloud service that allows users such as the BEACONING Ecosystem to manage data associated with BLE beacons using a REST Standard interface<sup>13</sup>.

<sup>13</sup> For the details about Eddystone Standard and compliant service providers, refer to <https://developers.google.com/beacons/eddystone>

2. **GPS:** Global Positioning System, is a system that allows a receiver to locate its position with a few meters' accuracy. This is achieved by triangulating signals sent by geostationary satellites. The first set of GPS satellites were just three, donated by the US Army for public use and were accurate to 50 meters. In the years that follow accuracy is improved by added satellites. Lately, the Galileo satellites launched into orbit by European Space Agency consist of 18 satellites, with 6 more to be added by 2020. This European system is activated at the end of 2016 and it provides accuracy down to a few centimeters.<sup>14</sup>
3. **QR Codes:** QR Codes are two-dimensional barcodes first designed for the automotive industry in Japan. They can be scanned or read by smartphone cameras, and processed even if the image was distorted because they use Reed–Solomon error correction standard. They can be printed and placed in areas where a BEACONING geolocation GLP is performed. The BEACONING application would interpret them and launch the corresponding activity.

## 2.3 Systems for Educational Collaboration

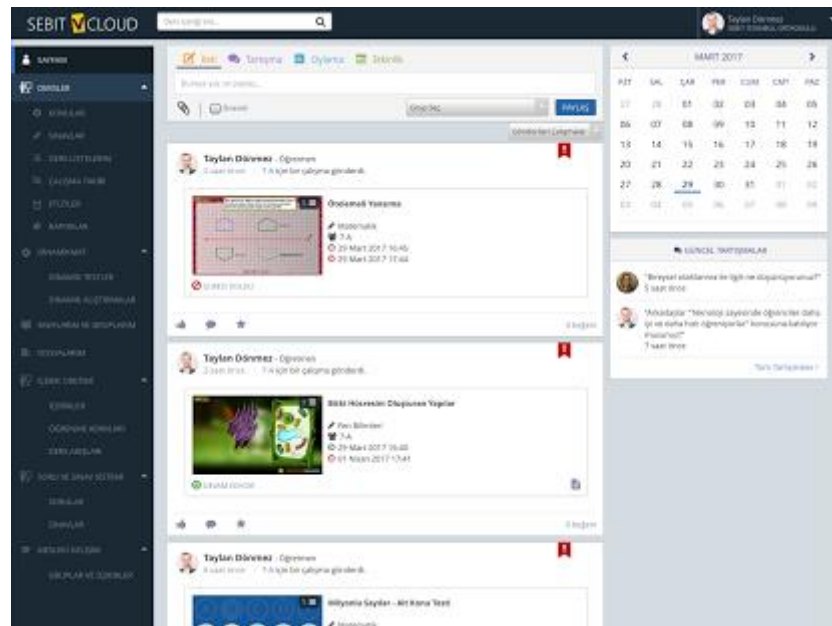
Digital platforms such as SEBIT VCloud, Edmodo, Canvas or other social LMSs are becoming increasingly common in schools for educational collaboration. Gaming is best enjoyed when done as a group. Considering this, most BEACONING activities are also group activities. Therefore, BEACONING in an environment of educational collaboration software would benefit a lot from integration, where BEACONING game-based learning activities would be a topic of discussions and sharing of experiences.

SEBIT VCloud is a novel educational collaboration platform, already used by more than 50,000 students and it is a venue indicated to take a role in BEACONING large scale pilots in Turkey.

Integration of BEACONING with SEBIT VCloud will essentially be similar to the integration to an LMS, where IMS LTI would be used. However, to make it easier to launch discussion topics over BEACONING activities, further integration is planned to be achieved using learning content on VCloud, as a part of BEACONING GLPs. Dialogues on content is a design property in VCloud. Therefore, each content object that is added to a GLP will immediately be a potential discussion topic.

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<sup>14</sup> For an up-to date list of devices that could process Galileo signals, refer to <http://www.usegalileo.eu/EN/>



### 3 BEACONING ECOSYSTEM STANDARDS

The BEACONING Ecosystem implements a REST architecture, which use the HTTP Standard requests to let a set of core services which enable discrete user-facing apps and tools to share content and data among each other to present a coherent experience.

Deliverable 4.1 Integrated BEACONING Ecosystem (M18) expands Deliverable 3.6 System Architecture (M15) and presents the core services of the cloud-based learning platform, describing the key functions that carry out the asset management, the mini-games management, and the game plots management. The services provide a full-featured built-in user management that can easily authenticate users across platform components. Since the architecture relies on an open standard, it can further be expanded with new services and front-end apps. An updated version of this deliverable will be provided in M28.

#### 3.1 PROCESSES COUPLING

The core services of the BEACONING Platform are implemented using the Node.js application platform, which is a de facto standard based on JavaScript and allows integration and data transfer between the core services and the front-end web apps. Node.js is tailored for creating distributed REST services with low overheads and quick response times (see D4.1).

As reported in D4.1, “the system is based on an open architecture that allows new components to be integrated using a set of documented APIs<sup>15</sup>, and maintains an equal level of privileges between build-in components and third-party components that from the ecosystem. To facilitate increased user adoption, the services are provided through a cloud-based approach but can also be deployed locally if needed.”

#### 3.2 STANDARDIZATION IN CONTENT FORMAT AND STORES

In BEACONING Ecosystem, there are three authoring tools:

1. Game plot and narratives authoring tool: This tool is used to create the game plots and the associated assets, narratives. It stores them in a repository called “the Vault.” Deliverables D3.5 and D4.3 describe these components.
2. Authoring Tool for Gamified Lesson Paths: This tool starts from a game plot and lets the instructional designers organize and link the game challenges with learning activities and material. The result is called a GLP (Gamified Lesson Plan) and they are stored in the GLP repository.
3. Authoring Tool for Context-aware Challenges: The mini-games of geolocation type has an authoring tool of their own. All mini-games are accessible and can be instantiated at the mini-games repository.

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<sup>15</sup> <https://core.beaconing.eu/api-docs>

The relation between these content parts are given by the schematic below, PCG stands for Procedural Content Generation:

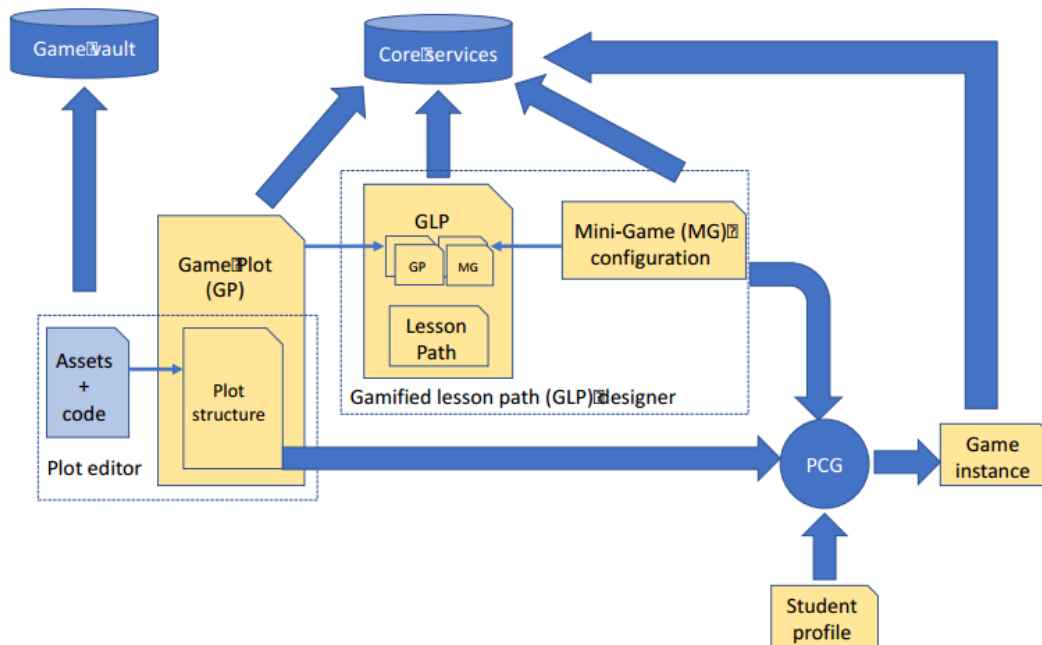


Figure 5. BEACONING Content Parts



The Vault, GLP and Mini-game stores are three entities in the BEACONING Ecosystem, designated to expand indefinitely, and hence may become de facto standards.

The game plots in the Vault are in the form of a JSON file that has a set of metadata, defined for each narrative so that the instructional designers can base the GLPs on the challenges of the game plot. The metadata include:

- The challenge id;
- The output of the challenge (to which other challenge this challenge is leading);
- The title of the challenge: the title of the challenge will be displayed in the editor;
- The description of the challenge (to be displayed in the editor);
- The default mini-game id matching the challenge;
- The id of the dialogs happening during the challenge.

When a game plot is requested by the GLP authoring tool, it is provided as an external JSON file so that it can be configured and repurposed into a GLP.

At the moment the game plot taxonomy and data format is not designated to be endorsed outside the project and indicated to become a de facto standard. However the GLP taxonomy is indicated to be one.

The GLP taxonomy relies on learning activities (which may as well be configured as mini-games) that stem from a backbone of challenges in a meta-game plot. The idea is to engage the users with the meta-game plot and let them feel the need to carry out the learning activities to advance in the meta-game.

The full description of GLP format and properties is given in D4.8 Gamified Lesson Plans (M18). The GLP authoring tool is used to create the GLPs and mini-games are also accessible from within this tool following a JSON schema based approach.

Once done the GLP is stored and passed back to the runtime player again in the external JSON file format. Alternatively, this file can be wrapped with a manifest into a standard content package so that an LMS in the environment can parse and resolve the specifics as well as the URL of the runtime player to redirect the GLP to be rendered.

### **3.3 USER INTERFACES AND ACCESSIBILITY STANDARDS**

The platform GUI is planned to be a demonstrator (D4.5) by M24. The goal is not to let the BEACONING experience be hindered for those users with:

- Dyslexia and associated conditions
- Dexterity issues
- Physical Disabilities
- Visual Impairment
- Hearing Impairment

Accessibility standards about all these special needs have been established by the Web Content Accessibility Guidelines (WCAG) which are part of a series of web accessibility guidelines published by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C).

BEACONING GUI takes these standards on board via an innovative tool called “Accessabar.” The Accessabar is an all in one Accessibility Toolbar incorporating Text-to-Speech, Magnification, Font Size & Settings, Simplify Mode and Screen Tinting. As the features described in D3.6 System Architecture indicate, “they will primarily be built using HTML for structuring and CSS for styling. A Webpack will be used to create an ES6 JavaScript bundle file to import into the Beaconing site/s itself.”

### **3.4 BEACONING EVALUATION STANDARD**

The purpose of the BEACONING pilot studies is to build a model that predicts the level of acceptance of BEACONING technology by authors (learning designers), teachers and students. The relationships among variables associated with factors that influence technology acceptance as indicated in Technology Acceptance Model 3 (TAM3) will be calculated. TAM 3 is a de facto industry standard<sup>16</sup>. Data will be collected through survey questionnaires and structured dialogues with both teachers and students. Employing structural equation modelling, a set of predictions will be made about the actual end-user behaviour to test the model fitness.

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<sup>16</sup> [https://en.wikipedia.org/wiki/Technology\\_acceptance\\_model](https://en.wikipedia.org/wiki/Technology_acceptance_model)

## 4 BEACONING AND DATA STANDARDS

Deliverable D4.6 Game Analytics and Adaptation Component Design (M12) covers both IMS Caliper and ADL xAPI standards. It argues for the reasons for choosing the ADL xAPI standard as “versatility and lack of constraints of xAPI to define new vocabulary for the statements.” Furthermore, the Experience API (xAPI) Statement Data Model and xAPI Profile<sup>17</sup> is given, to explain the profile can contain new vocabularies along with extensions. One of these extension regards “Serious Games” and it is contributed by the BEACONING partner UCM. The xAPI Serious Games (xAPI-SG) Profile has been tested out with a case study by UCM, but the large scale piloting is intended to be in BEACONING project.

### 4.1 ADL EXPERIENCE API (XAPI) AND THE SERIOUS GAMES PROFILE

Deliverable D4.7 Game Analytics and Adaptation Components Reference Implementation (M24) describes in specific detail how the data will be collected during the execution on GLPs in the form of completion, selection and variable traces. These traces are stored in a Learning Records Store in implementation of the ADL xAPI standard. The xAPI statements for the traces would comply xAPI-SG Profile.

Developed after analysing the most frequent interactions in SGs, the xAPI-SG Profile specifies the verbs, activities and extensions to be used for the information sent by the game. It has been implemented and it is accessible online<sup>18</sup>.

By performing analytics on the traces, the system can issue alerts, warnings and even trigger interventions by means of the adaptive components of BEACONING such as the Procedural Content Generation. Specifics of procedural content generation will be described in D4.4 which is due M26 (end of February 2018).

The analytics operation that will be performed on SGs in order to inform the adaptive components is captured in Learning Analytics Models (LAMs) and the analytics operation that will be performed on GLPs in order to inform the adaptive components is captured in Meta LAMs. The nature of LAMs and Meta LAMs are described in D4.7.

The proposed Meta LAM structure is based on a simplification of the IMS Simple Sequencing Standard<sup>19</sup>. This structure supports the basic GLP model where mini-games (incl. geolocalized games) and learning activities are launched as stemming from a meta-game flow. Similarly, the model where several mini-games can be launched when positions in the map are reached in a geolocalized game is also supported.

<sup>17</sup> <http://datainteroperability.org/research-activity-xapi-data-interoperability/xapi-profiles/>

<sup>18</sup> <http://xapi.e-ucm.es/vocab/seriousgames>

<sup>19</sup> Perez-Colado, I. J., Alonso-Fernández, C., Freire-Moran, M., Martinez-Ortiz, I., & Fernández-Manjón, B. (2018). Game Learning Analytics is not informagic! In *IEEE Global Engineering Education Conference (EDUCON)*.

## **4.2 USER PROFILE DATA**

BEACONING adaptation components are indicated to be sensitive to users' specific needs, such as with learning difficulties or attention deficits. Similarly, the GLP production pipeline regards various roles across each step. Therefore, maintaining roles and attributes of the users and sharing them safely and securely across the BEACONING ecosystem is necessary.

The core services component provides centralized storage, management and auditing for user profile data. The main user categories managed at Platform level are teachers, students, and parents.

The Authentication & Authorization (A2) API of the analytics system informs the analytics operations with user roles and status<sup>20</sup>. Each role can obtain information using the corresponding API calls that they are allowed to make:

- Teachers can create classes and sessions, and obtain the list of classes they belong to and the list of all public games
- Students can obtain the classes they belong to
- Game developers can create games

The visualizations are reporting ends of the analytics system and they can be configured flexibly, also based on the user profile information. For instance users with visual impairment can have feedback about their progress in different visual forms than other users.

## **4.3 DATA PRIVACY STANDARDS**

BEACONING core services component implements data privacy settings. While the privacy policy applied to all categories of users and user data is encrypted at rest and in flight, for students additional protections are implemented to depersonalize the student data. However, when students would view their own analytics reports they will be able to observe their names and status on the page by means of BEACONING Data Privacy Flow. Figure 6 shows the workflow for obtaining and managing the real identities of the students involved in BEACONING piloting securely. Personal Data Store component that implements the Data Management Plans defined in D1.7 and D1.8, is responsible for the privacy protections of student data and sensitive data management during small- and large-scale piloting.

---

<sup>20</sup> A2 API is accessible at <http://e-ucm.github.io/a2/>

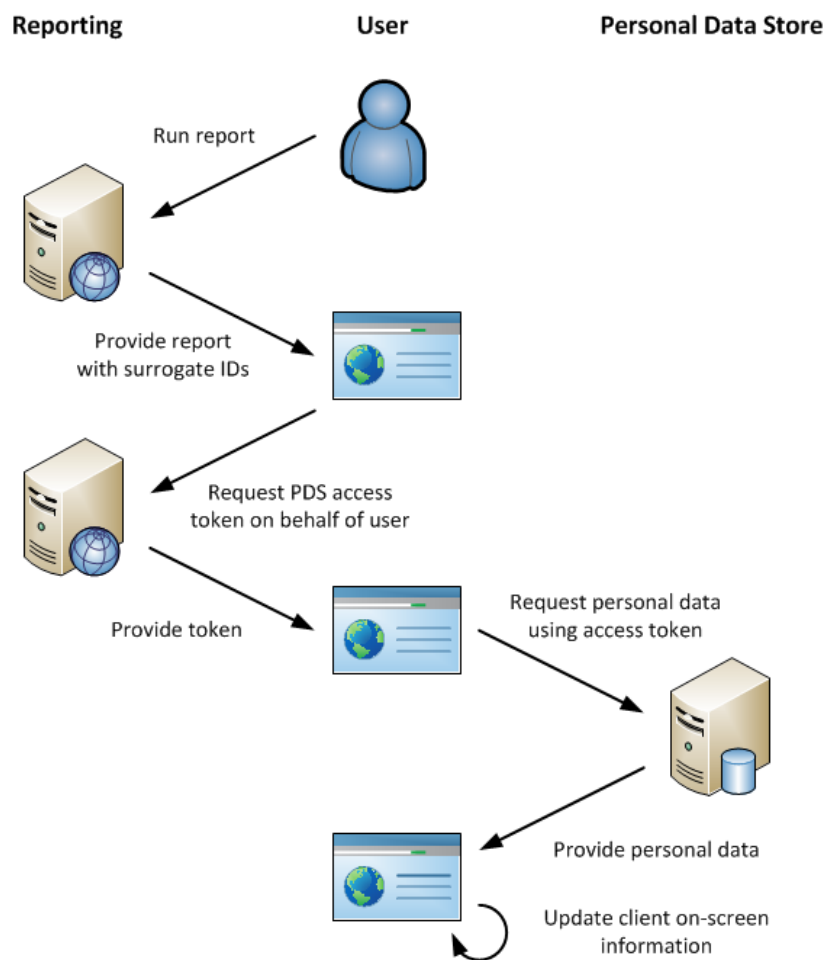


Figure 6. BEACONING Data Privacy Flow

## 5 FUTURE STANDARDS THAT BEACONING INFORMS

As part of the tasks in WP7 - Exploitation, Impact and Standards, BEACONING partners have identified 5 potential ways that the project could inform future standards. These are intended to be endorsed or de facto standards.

### 5.1 THE GAMIFIED LESSON PLAN STRUCTURE

The fishbone structure of the BEACONING GLP is a specifically designed to balance the game play and learning activities. It lets both a game designer and an instructional designer to work on the same plan and additionally, allows the teachers to further customize specific parameters, such as the location or duration of the activities.



Figure 7. Learning activities that branch from slots/gates at the meta-game plot challenges.

The concept of “slots” in the game plot allows pedagogical content and learning activities to be slotted. Note that some learning activities may require the player to go outside of the game plot to collect evidences, acquire knowledge or complete actions, in order to progress. These slots are conceptualised as “gates” within the meta-game (or the main game) and they enable a more flexible narrative design around pedagogical content. Even “teleport gates” are envisioned which lead the player to move out of the game plot into a real world location. The slots can be used to launch mini-games, location based activities, learning content or can be skipped during GLP authoring.

This novel architecture is described in Deliverable 4.8 in detail. The purpose is to enable switching between learning playing or play-learning activities seamlessly, without breaking immersion. Utilising this fishbone style structure allows traversing back and forth naturally in a game plot. It is built into and endorsed by the GLP Authoring Tool which can store these GLPs in an extern JSON file format. As both pedagogical and game design will be iterated through the pilots using the authoring tool, more creative utilizations for the slots will be exemplified.

The GLP Structure and taxonomy is indicated to be a de facto standard for future serious games to blend learning activities in seamlessly. A sample GLP structure can be found in the Annex of this document. The authoring tool is in a position to endorse it as a de facto standard.

## **5.2 THE MINI-GAMES SCHEMA**

Alongside the GLP taxonomy, the mini-games schema enable their configuration from the authoring tool. In order to let the mini-games repository to grow this schema can be endorsed as another de facto standard, so that any mini-game (after some process of moderation) can be included in the BEACONING ecosystem.

## **5.3 DATA PRIVACY BEST PRACTICE**

Large-scale pilots take place in very few EC-funded projects. Those which involve collection and processing of data as a result of end-user activities is even sparser. Considering that the General Data Protection Regulation becomes enforceable from 25 May 2018<sup>21</sup>, the second round of BEACONING pilots will be one of the first cases where projects deploy a large-scale pilot that would comply with it across many countries at once. Hence, if all clearances can be achieved, it is entitled to set the best practice for data privacy preserving large pilots of other projects to follow.

## **5.4 ADL XAPI GEOLOCATION PROFILE**

As a project “background” (via our partner UCM) ADL xAPI Serious Game Profile and its implementation is available and will be used in the BEACONING Ecosystem. As a project “foreground” UCM intends to develop an ADL xAPI Geolocation Profile. A profile is a specific set of rules and documentation for implementing xAPI in a particular context, which, in this case, is geolocation based games and activities. Profiles generally provide a particular vocabulary of terms, some created specifically for the profile, and some are referenced from other vocabularies. Expanding a standard such as ADL Experience Tracking is a long and tedious process. However, geolocation games in BEACONING Ecosystem are rather mature components and the project piloting activities presents robust use cases to demonstrate the uses of such extensions. Therefore, as required for the H2020 BEACONING Project, an extension of such profile is being considered for geolocated games<sup>22</sup>.

## **5.5 STEM BADGES**

Digital Badges are fast becoming a giant business sector of Educational technology (EdTech). With the increasing popularity of online learning via MOOCs and other providers, learners at all stages and ages are turning to online programs to build themselves a portfolio of certificates and credentials. Right on this trend, Open Badges movement, originated among those working at the Mozilla and MacArthur foundations since 2010 is fast becoming an industry standard, because they not only mean the achievements but let employers to drill down specific gains and outcomes of a learner had on the way to those achievements:

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<sup>21</sup> [http://ec.europa.eu/justice/data-protection/reform/files/regulation\\_oj\\_en.pdf](http://ec.europa.eu/justice/data-protection/reform/files/regulation_oj_en.pdf)

<sup>22</sup> <http://xapi.e-ucm.es/vocab/geolocated>

“Badges are verifiable, portable digital badges with embedded metadata about skills and achievements. They comply with the Open Badges Specification and are shareable across the web.”<sup>23</sup>

An Open Badge is associated with metadata that not only bears information about the recipient and the issuer but also supporting evidence. Based on that, often badges are combined by the recipients to tell a more complete story of their studies and performances towards achieving a certain degree of expertise on their fields of acclaim.

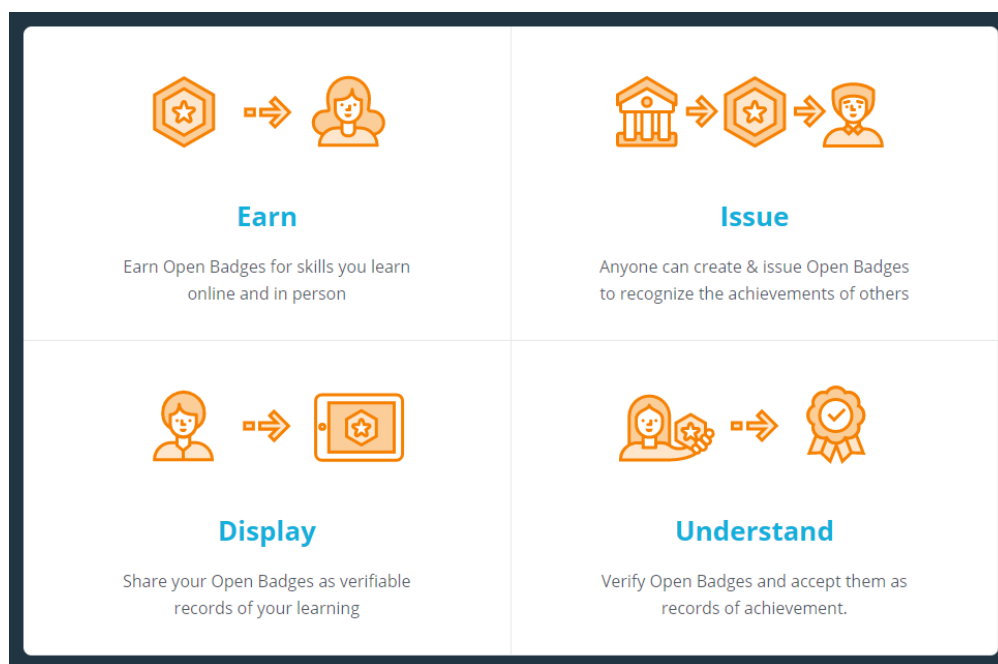


Figure 8. Discover Open Badges

Since BEACONING has a specific focus on STEM fields, and game based activities that involve performances towards overcoming designed challenges, these can be associated with Open Badges defined by BEACONING as evidences of achievement. As part of this vision a fixed, yet small set of STEM competencies can be addressed consistently during GLP authoring and a competency based assessment structure can be established. If the large scale pilots can demonstrate the pedagogical benefits BEACONING can be an issuer of Open Badges. On platforms which are available as open source software for issuers, a future BEACONING alliance or other spin off establishment can customize badging applications further and create an Open Badges compliant issuer service.

Badges as part of BEACONING ecosystem is considered in the project plan. However, turning these badges into Open Badges and promoting them to become wide spread is a part of the exploitation vision, and considered to happen beyond the project timeline. Nevertheless, the last round of large-scale pilots in fall 2018 could be an opportunity to start off this work.

<sup>23</sup> <https://openbadges.org/get-started/>



## **6 CONCLUSION**

This is an “intermediate” deliverable of Task 7.5 of the project, which defines the uses of, and potential influences to various industry standards in eLearning and web/internet technologies.

The project outcome is regarded as an ecosystem and the standards that keep this ecosystem integrated internally, as well as externally to its environment are described.

Furthermore, specific areas where the project can inform future standards are identified and related to not only the immediate goals of the project, but also future exploitation strategies.

The “final” version of this deliverable will be created and submitted at the end of the project, in Month 36.

## ANNEX A

As example, here is a GLP format used in the ecosystem:

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  "year": "2017",
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  "competencies": "Algèbre, Maths de base, Physique, Electronique",
  "missions": [
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      "skills": "",
      "quests": [
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      "externalAT": "undefined",
      "minigame": "true"
    }
  ]
},
{
  "id": "5",
  "title": "Challenge5",
  "name": "Challenge5",
  "x": "118.266",
  "y": "501.984",
  "activities": [
    {
      "name": " Generic Quiz Game ",
      "session_id": "1892859168",
      "configuration":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gameconfig&key=1892859168",
      "configurationAT": "\"\"",
      "schema":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gamejsondescriptor&game=GQ_GAME",
      "resources":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gamejsonresources&game=GQ_GAME",
      "runtime": "https://beaconing.seriousgames.it/games/genericquiz/?session_id=",

```

```

      "update":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=updategameconfig",
      "load":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gameconfig&key=",
      "externalAT": "undefined",
      "minigame": "true"
    }
  ]
},
{
  "id": "6",
  "title": "Challenge6",
  "name": "Challenge6",
  "x": "405.367",
  "y": "490.5",
  "activities": [
    {
      "name": " Generic Quiz Game ",
      "session_id": "1399744196",
      "configuration":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gameconfig&key=1399744196",
      "configurationAT": "\"\"",
      "schema":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gamejsondescriptor&game=GQ_GAME",
      "resources":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gamejsonresources&game=GQ_GAME",
      "runtime": "https://beaconing.seriousgames.it/games/genericquiz/?session_id=",

```

```
        "update":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=updategameconfig",
        "load":
"https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gameconfig&key=",
        "externalAT": "undefined",
        "minigame": "true"
    }
]
}
],
"connections": [
{
    "source": "0",
    "target": "2"
},
{
    "source": "1",
    "target": "2"
},
{
    "source": "2",
    "target": "3"
},
{
    "source": "3",
    "target": "4"
},
{
```

```
        "source": "4",  
        "target": "5"  
    },  
    {  
        "source": "5",  
        "target": "6"  
    }  
]  
}  
}  
}  
]  
}  
]  
}
```