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Deliverable D12.1
GÉANT Open Educational Resource (eduOER) Business Case Development

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Abstract
The GÉANT eduOER service is an open educational resource (OER) metadata aggregation hub and portal service that facilitates access to digital multimedia content at the European level in the form of repositories, infrastructures and services. This document outlines the business case for the service, presenting the value proposition and cost-benefit analysis. It also describes the service design, architecture and services; outlines the development roadmap; and explains the user engagement and marketing strategy. Further information is available on the service website at: https://oer.geant.org/.

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Executive Summary

This document is the official deliverable of GN4-1 Project Service Activity 8, Real-Time Applications and Multimedia Management, Task 3, Open Educational Resource (OER). Its purpose is to outline the business case for, and to introduce, the GÉANT eduOER service, primarily targeting national, institutional and/or thematic repositories, their owners or administrators, as well as their corresponding user communities.

eduOER is an open educational resource (OER) metadata aggregation hub and portal service for the European research and education community. Its differentiating, value-adding features are:

- eduOER collects multimedia content (lecture recordings, webinars, video clips, audio-visual objects, animations, etc.) at the European level and is able to contribute to other, higher-level OER aggregators or services (such as OpenEducationEuropa or OpenAIRE).
- eduOER is not a repository (it does not store content) but a referatory (it only stores and handles metadata); it is able to harvest metadata via standard protocols and is also harvestable in the same way.
- eduOER is operated and managed by GÉANT and the National Research and Education Network (NREN) community, which has privileged access to higher education and research, supporting institutional repositories of any size or maturity.

eduOER addresses the main challenges of searching and finding good-quality, properly licensed, openly accessible educational content and learning objects – especially multimedia types – across repositories, countries, disciplines and languages. The key issues addressed by eduOER are:

- Many institutional video repositories are small, not mature enough for open sharing, and the content stored in them is widely scattered around institutions.
- Web search engines (Google Search and the like) do not penetrate into the deep metadata structure of repositories, so much educational content remains hidden under the web.
- Commercial video search portals (YouTube, iTunes and the like) do not make their metadata available, do not focus specifically on research and education, and create closed-service silos with no interlinking or cross-pollination between their objects.

The eduOER service is operated and managed by GÉANT and the NREN organisations. (This excludes responsibility for the content, which lies with the content owner or the source repository itself.) NRENs are in a good position to develop and aggregate institutional multimedia repositories because:

- NRENs provide the primary network connectivity to most of the higher education institutions, campuses, colleges and research labs (in some countries even primary and secondary schools) across Europe and beyond.
- NRENs support the multimedia services, lecture recording and video production of university IT teams in many European countries.
- NRENs – within their GÉANT collaboration – are able to break technology silos, bring together and mobilise user communities, and reach the critical mass on the global scale that increases the competitiveness of Europe.
- The NREN community is able to operate and manage the eduOER service at a marginal operational cost using their advanced cloud-based infrastructure services and delivery model.

The main benefits of eduOER are twofold. The primary benefits are realised by the repository owners and content providers that connect to the eduOER hub and exploit its back-end services. The secondary benefits are realised by the end-user communities of the connected repositories and also by those users who have no access to such repositories and usually search globally on the web.

- eduOER provides an open infrastructure hub for multimedia repository owners and administrators to make their content searchable, findable and exchangeable across silos. It saves them development and service integration time and effort, and enables repositories to enrich their content offerings as well as offer value-added services at a low cost via a simple interface (application programming interface (API)) to eduOER. Information for content providers can be found on the eduOER service website at the URL provided at [eduOERCPSvcs].

- eduOER provides a metadata-rich, multimedia-optimised web portal for all users searching open research and educational content globally on the web. It provides better access to content that is hidden from web search engines – sitting in institutional repositories – and also provides interlinking and cross-pollination between objects that are in closed commercial service silos (e.g. links between educational videos stored in YouTube and iTunes channels). The user portal can be found at the URL provided at [eduOEREUSvcsMWP].

This document describes the eduOER service design, architecture and services, outlines the proposed development roadmap, and presents the value proposition and cost-benefit analysis for the service. After explaining the user engagement and marketing strategy, it concludes with the recommendation that, to realise the full benefits of eduOER, the service be continuously maintained, operated and, if possible, developed further by the NREN community under the umbrella of the GÉANT collaboration. The GÉANT eduOER service will be officially launched in March 2016, building on the 2014 TERENA (now GÉANT Association) pilot.

1   Introduction

1.1   Background

With the expansion of technological possibilities in education, many higher education institutions (HEIs) have begun to integrate web applications in order to enrich their learning materials. An increasing number of teachers integrate applications and open educational resources (OERs) in order to enrich their instructional materials, and many of the HEIs take part in establishing local and institutional open repositories and use them in their teaching.

Many of the European National Research and Education Networks (NRENs) are active in open education (OE) activities and have made a significant contribution to the deployment and availability of OE digital technology and content. The NRENs would like to offer their knowledge and expertise to progress the objectives of the EC's open education policy.

The focus in open educational resources continues to be largely on increasing access to digital content in the form of repositories and infrastructures. To encourage the wider take-up and use of open educational resources, more consideration needs to be given to how technology can support educational institutions in offering open education facilities in a financially sustainable manner, and to developing methods and practices that enable learners, teachers and institutions to best engage with OER.

The NRENs are well qualified to contribute to these next steps, in collaboration with the EC, educational institutions and others. Beyond providing and supporting the technology that delivers OER / Massive Open Online Courses (MOOCs) to users, NRENs should support the application layer to engage with educators and participate in the production of openly licensed content (course development), especially in the area of ICT and networking, for the benefit of teachers and the next generation of the knowledge economy. In return, educators should support the openness by using and reusing learning materials and encourage students by creating appropriate policies to better use the NREN services directly or indirectly offered to them.

Europe's NRENs, within their GÉANT collaboration, proposed developing a pilot European open educational resource portal service (called eduOER), which prototypes a one-stop shop (broker) for national learning resource organisations. The portal enables structured searching and reuse of content on a European level. The initiative is complementary to the European Commission's Open Education Europa portal and can be listed there.

The European NREN community is in a good position to facilitate how open educational resources can be findable and accessible, and more effective in helping students, serving minority populations, supporting multilingual learners, improving the teaching and learning process, and potentially lowering the cost of higher and adult education. eduOER aims to facilitate the collaborations between higher education institutions that are NREN members by providing them with an infrastructure and associated services to exchange quality learning materials at no cost.

The European NRENs support the EC's policy of EU-level cooperation to push reforms towards the adoption of open learning, and are ready to engage in discussion and activity aimed at realising reform.

1.2   In this Document

Having provided a brief introduction to the eduOER service concept in this section, the structure of the rest of this document is the following:

- Section 2 digs deep in the service design and architecture, including the detailed description of the set of eduOER sub-services.
- Section 3 explains the service development roadmap foreseen for future projects.
- Section 4 presents the value proposition for the eduOER service. It explains how eduOER is unique and via which business mechanisms it provides value to both repositories and end-users.
- Section 5 is a high-level cost-benefit analysis, which is needed for GÉANT management to make a decision on the future of the eduOER service.
- Section 6 explains the user engagement strategy and highlights proposed key marketing and PR actions to promote the service. It also includes the full list of presentations given by the eduOER service development team under GN4-1 SA8 T3.
- Section 7 closes the document with the team's conclusions and recommendations.
- Appendices A, B and C offer background information on subcontracting, initial repositories and service FAQs respectively.

2 Service Description

2.1 Strategy

The authors' belief is that the well-established NREN collaboration in Europe is the gateway to bridge the open education digital divide concerning the penetration of European OER and Massive Open Online Courses (MOOCs), as well as to overcome the technical, cultural and language barriers – especially the dominance of the English language – by demonstrating efficient knowledge sharing and multilingual diversity through eduOER.

- Instead of competing with the commercial or large-community-based software-development market, NRENs can better focus on application development and service integration for the benefit of the research and education sector that they know very well. Connecting the still scattered landscape of the European institutional and national multimedia content repositories using standard metadata schemas and harvesting protocols is one of the GÉANT NRENs' areas of interest.

  The position paper issued by GÉANT in November 2014, titled *GÉANT Association NRENs and Open Education: NREN Community Statement on Open Education* [Statement], includes the list of 12 NRENs that supported the piloting and development of the eduOER service (namely, ARNES, FCT/FCCN, GRNET, IUCC, LITNET, NIIFI, PSNC, RedIRIS, RENATER, SURFnet, SWITCH and UNINETT).

- NRENs are in the forefront of the development and deployment of federated Authentication and Authorisation Infrastructures (AAIs) around the globe. State-of-the-art AAI is the key to ensuring the full benefits of Open Education.

- The digital divide concerning the European education sector cannot be efficiently bridged without the engagement of the best technical experts – those working for the NRENs – in teaching and learning processes. NRENs are well positioned to contribute to traditional and online (such as MOOCs) course development, especially in the area of ICT and networking.

- eduOER offers easy access for multimedia OER from across Europe, improving their retrievability by using an efficient, unified metadata scheme. By making learning materials easy to access, eduOER increases the likelihood that they will be reused and therefore will become more cost-effective

2.2   Design Principles

While it is a fact that millions of learning objects and OERs can be found on the Internet using search engines like Google, there is no guarantee that a query will lead to trustable, openly licensed material on which high-quality open education can be built. Well-managed OER repositories that aggregate high-quality content offer a solution to this problem.

The primary aim of GN4-1 Service Activity 8, Real-Time Applications and Multimedia Management (SA8), Task 3, Open Educational Resource (OER) (T3), is to develop and launch a GÉANT Open Educational Resource portal service (eduOER) by adapting and developing a scalable metadata aggregation engine and a web portal front-end demonstrator. The objective is to provide this service for the broader GÉANT community in order to:

- Facilitate connection of the scattered institutional/national OERs and unlock the deep-web (i.e. the part of the Internet not indexed by standard search engines) by enabling structured searching and reuse of content.
- Prototype a one-stop shop (broker) for national learning resource organisations, each of them managing and/or federating one or more learning object repositories within the country.

Eventually, GÉANT will be able to make a suite of online services and tools available to its partners for the exchange of learning resources, and facilitate access to the worldwide open education community (i.e. GLOBE or EC Open Education Europa) guided by the following principles:

- Keep the barrier of entry to GÉANT eduOER low and participation high.
- Provide open specifications and community source code as much as possible, openly shared among and beyond community members.
- Use open standards, where appropriate, and contribute further to the development of these standards based on experience and best practices.
- Respect and build on European values and operate as a community of peers.

The eduOER service is leveraging the outcome of the previous open-source projects ARIADNE [ARIADNE] and PuMuKIT [PuMuKIT]. The high-level service architecture vision can be seen in Figure 2.1 below.
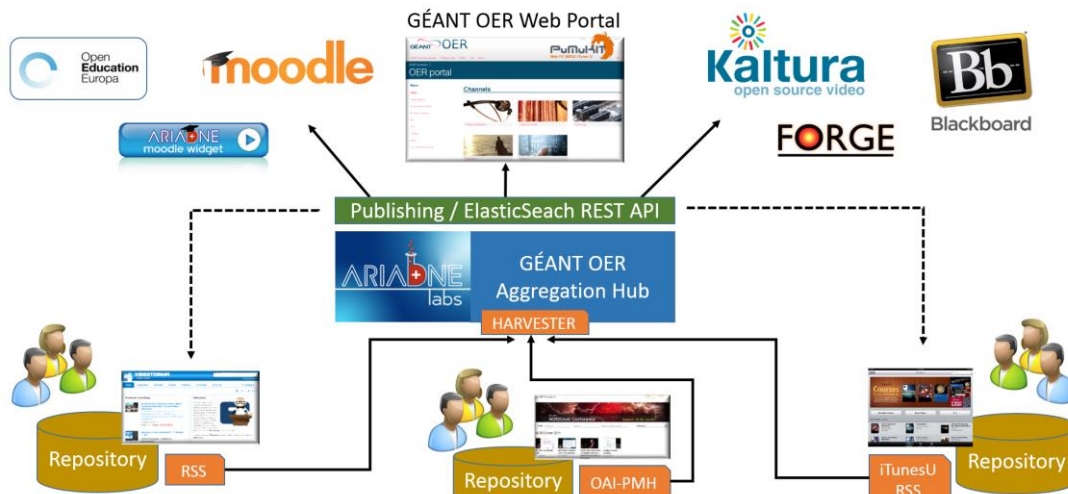
Figure 2.1: GÉANT eduOER service vision

The eduOER service (aggregator and front-end portal) is addressed to content providers, content consumers, and end users.

2.3 Aggregation Architecture

The following diagram (Figure 2.2) depicts the architecture of the aggregation engine for the GÉANT eduOER service.
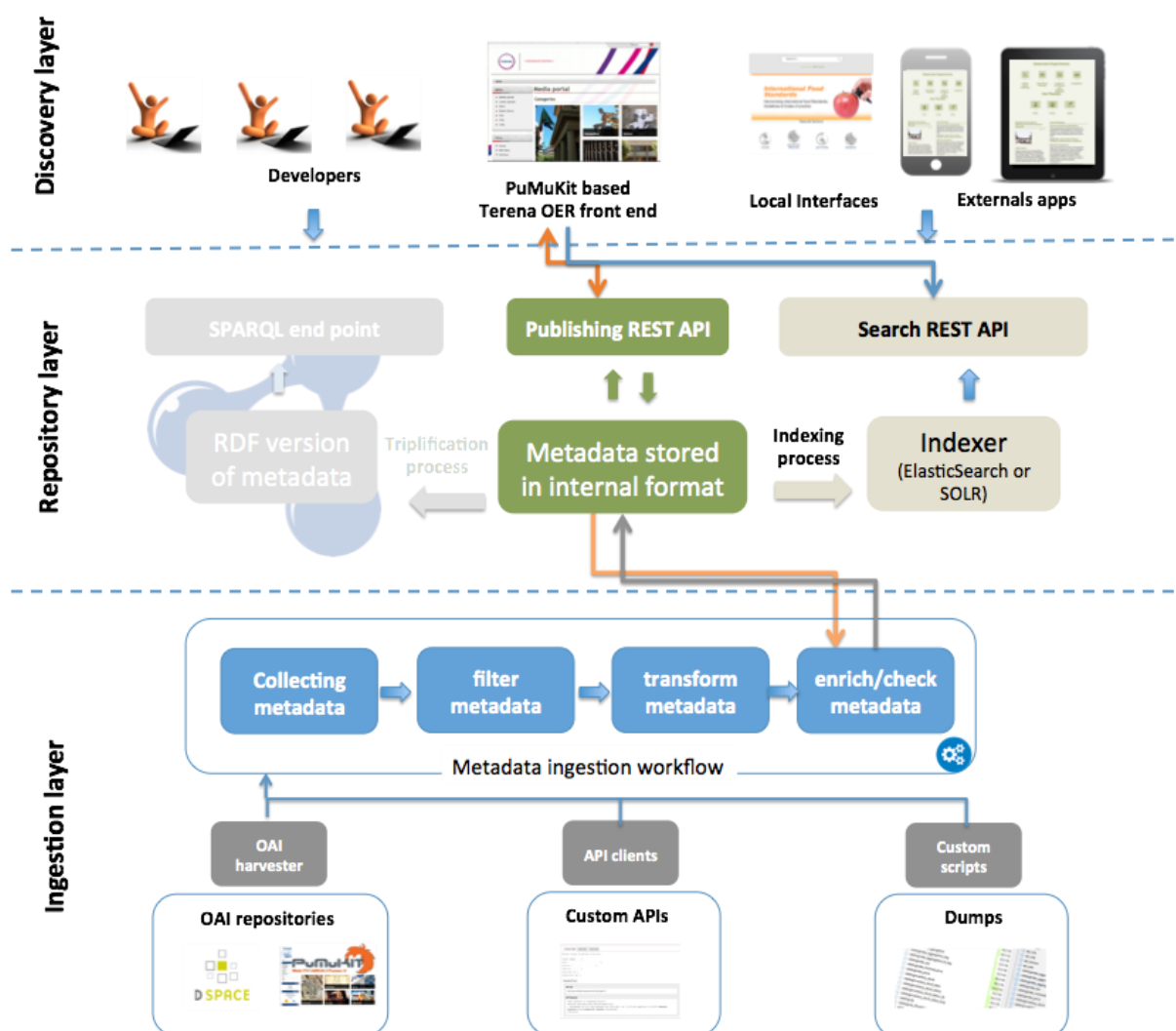
Figure 2.2: GÉANT eduOER service aggregation architecture

The architecture for the GÉANT eduOER aggregation engine service is composed of three layers:

- Data ingestion, responsible for the aggregation and processing of metadata.
- Data repository, responsible for the storage, indexing and publishing of the metadata records.
- Data discovery, which allows the discovery of the content.

The architecture is open and scalable and is developed using several widely adopted open source tools and standards. The different layers are decoupled in order to support modularity and high availability of the eduOER front-end services and open application programing interfaces (APIs). More specifically, the proposed architecture enables:

- The support of a number of different content workflows for the creation, curation and publishing of metadata records. For example, the operating organisation can introduce a validation step in the workflow without radically changing the architecture by just introducing a new open source tool that will connect to the repository layer.
- Automatic and periodic ingestion and processing of metadata records from diverse sources.
- The suggestion of resources by the users through a mechanism that can be integrated with the data discovery application.
- The enrichment of the ingested metadata using manual, semi-automated and automated methods.
- Publishing of high-quality metadata records to external systems.
- The development of numerous front-end applications/local interfaces and thus the high dissemination of the eduOER content.

As depicted in the architectural diagram (Figure 2.2), the architecture can be extended to support, in addition, the publishing of educational metadata in linked data format and their exposure through a SPARQL end point that can be used by external systems and developers. This is not yet in the scope of the eduOER service development but it shows how the architecture could evolve in this direction.

2.3.1 Data Ingestion Layer

The data ingestion layer is responsible for the ingestion of content from various diverse sources that publish the metadata through custom APIs, RSS feeds, OAI-PMH protocol and dump files. This layer is totally decoupled from the other layers of the architecture in order to ensure the efficiency and the high availability of the eduOER service. The ingestion layer is a workflow consisting of several steps for the processing of metadata records. More specifically, it includes steps for each of the following:

- Transformation of metadata records from the input format to the IEEE Learning Object Metadata (LOM)-based Application Profile (AP) of the eduOER.
- Identifying the metadata records and the learning objects as well.
- Validating the metadata against the eduOER AP.
- Filtering the metadata records.
- Enrichment of the metadata records (e.g. adding the missing language attributes and assigning semantic tags).
- Learning Object (LO) URL checking of the metadata records.

At each step of the ingestion workflow, log files are created, stored and indexed and a visual dashboard is provided to the service operations team to easily monitor the process and diagnose issues.

2.3.2 Data Repository Layer

The data repository layer:

- Stores all the processed and ingested metadata using the IEEE LOM-based data model.

- Performs text-based analysis.
- Exposes the processed metadata through RESTful APIs so the external systems can consume the metadata records.

The metadata records of the repository layer are accessed frequently by the tools of the ingestion layer to check their quality. All the metadata records stored in the metadata repository are indexed using an open source search engine (such as ElasticSearch) and published through a search API. The search API is presented and documented in a specific site of the eduOER service. External systems and developers are able to access the Land Library data using either the search and/or the metadata publishing interfaces.

The data ingestion and repository layers work in two modes, namely, the data acquisition and the data maintenance mode. The former is responsible for the acquisition of the data (new, updated) whereas the latter is responsible for the checking and enrichment of the metadata records.

The repository layer supports multilingual indexing of the records by using multilingual vocabularies and taxonomies. To support coherent content discovery, mappings of the different taxonomies to a common taxonomy are used to extend the index.

2.3.3 Data Discovery Layer

The data discovery layer includes all the front-end applications that consume the publishing and search APIs of the data repository layer. The following modules can be developed in standard front-end systems (e.g. PuMuKIT or Drupal) to interact with the repository layer:

- A data discovery module that supports keyword searching and faceted browsing. This module uses the ElasticSearch-based search API provided by the repository layer.
- A data publishing module that allows the publishing of web resources suggested by the users of the eduOER portal.

The discovery layer uses the multilingual extensions of the indices in order to support searching and browsing of content in the various languages of the interface. The use of an automatic translation mechanism for the free-text elements of the metadata records can be explored at a later stage of the eduOER continuous service development.

2.3.4 Metadata Aggregation Workflow

The metadata aggregation workflow is depicted in Figure 2.3 below.
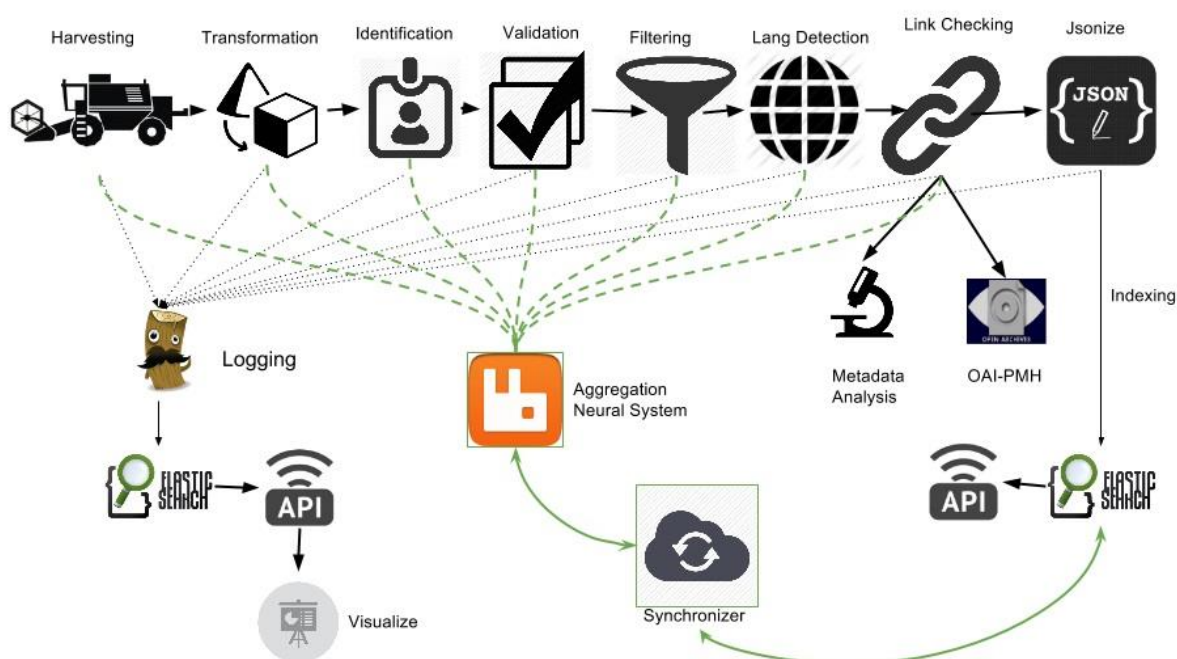
Figure 2.3: Metadata aggregation workflow

Summary descriptions of the technology used in each workflow step are provided below.

Repositories Catalogue

The ARIADNE Registry tool is used for the repositories catalogue [ARIADNESvcs]. The repositories' information is exposed using RSS, SPI, SQI and OAI-PMH protocols.

Harvesting

The ARIADNE Harvester [ARIADNEHar] has been developed to manage harvesting of one or more OAI-PMH targets in as automated a way as possible. The development has been mainly driven by the European eContent+ projects, which use IEEE LOM-based metadata and require validation against a predefined Application Profile. The tool is agnostic about the type of metadata to be harvested (Dublin Core (DC), LOM, etc.) and can be configured and extended for advanced use, such as creating validation reports, pushing metadata through a custom storage connector using an arbitrary protocol, and on-the-fly transformation of XML metadata to another structure.

Transformation

A simple Java-based transformer is used in this step [Transformer]. Additionally, a web application called MINT is used to facilitate the XSL creation process [MINT].

Identification

A Java-implemented identifier-creator software program is used [ARIADNEId]. The identifier creation is based on metadata content for the LOM metadata schema. The identifiers created are global (aggregation level), unique and persistent (content-based persistency).

Validation

The ARIADNE Validation Framework is used [ARIADNESvcs]. The Validation Framework has been implemented as a Java Library, is available online through a REST API, and has a web interface. A provider can use it to validate a specific record or the whole OAI-PMH target.

Filtering

A Java-implemented filtering mechanism is used at this step [XMLFilter]. It uses XPath expressions as filters.

Lang Detection

Lang Detection is a Java-implemented, XML element, content language detection program. It detects text language using naive Bayesian filtering and injects the detected language as an attribute to the specific element.

Link Checking

A Java-implemented link-checking mechanism is used at this step [LOMLinkChk]. It supports DC and LOM schema link checking. It checks the URL contained in the respective element for its availability. The link-checking mechanism offers a REST API for communicating the results to the eduOER portal.

Jsonize

This is a Java-implemented XML to JavaScript Object Notation (JSON) transformer. It maps eduOER XML Application Profile-based XML records to an internal JSON presentation in order to efficiently index it to ElasticSearch.

Aggregation Neural System

This is a RabbitMQ-based message queue that aggregates the messages each workflow step creates. The Aggregation Neural System goes hand in hand with the Synchronizer.

Synchronizer

This is a Java-implemented RabbitMQ client that reads the messages created and performs various tasks (such as record update and deletion) on the ElasticSearch Index.

Metadata Exposure

The aggregated metadata are exposed using OAI-PMH, a custom ElasticSearch-based REST API with JSON responses, a custom SOAP service and Solr. A thin client called ARIADNE Finder is also used as a standalone and lightweight search tool that lets users search learning material and browse the

results. From the end-user point of view the tool allows a keyword search to be made at the beginning and then the results to be refined by selecting facets and values either to include relevant results or to exclude results that are of less importance.

Metadata Statistics Analysis

This is a Java-based statistical analyser for metadata repositories/federations [MetadataAnalytics]. It can be used for statistical analysis over XML records. It can analyse records residing either on a filesystem or through an OAI-PMH target. It is schema independent, meaning that it can analyse all kinds of metadata in XML format. The analysis results are stored in CSV formatted files. The statistical metrics calculated are: frequency, completeness, dimensions and entropy.

Statistics Exposure

An ElasticSearch-based API is used for exposing metadata statistics results.

Log Creation, Indexing and Exposure

All the above steps are extended to create logs where the various events are registered. A Logback library is used for logs creation. After the logs are created, Logstash is used as a tool for managing events and logs. It can be used to collect logs, parse them, and store them for later use (such as for searching). After the log parsing has finished, ElasticSearch is used to index the parsed logs, so the ElasticSearch API can be used to search the indexed logs, get statistics, etc.

Visualization

Finally, Kibana, a data vizualisation plug-in for ElasticSearch, is used to provide a user-friendly way to view, search and visualize the log data.

2.3.5 Internal Data Model

The repository layer stores all the identified and processed metadata records in an internal data model that is based on a standard metadata schema for educational applications, namely the IEEE Draft Standard for Learning Metadata Object [IEEELOM].

A JSON binding of the IEEE LOM-based AP is used internally in the repository to facilitate the processing and indexing of metadata. This is done mainly for efficiency reasons, as parsing data in JSON format is much faster compared to XML format. An example of such an internal metadata schema is presented in Figure 2.4.
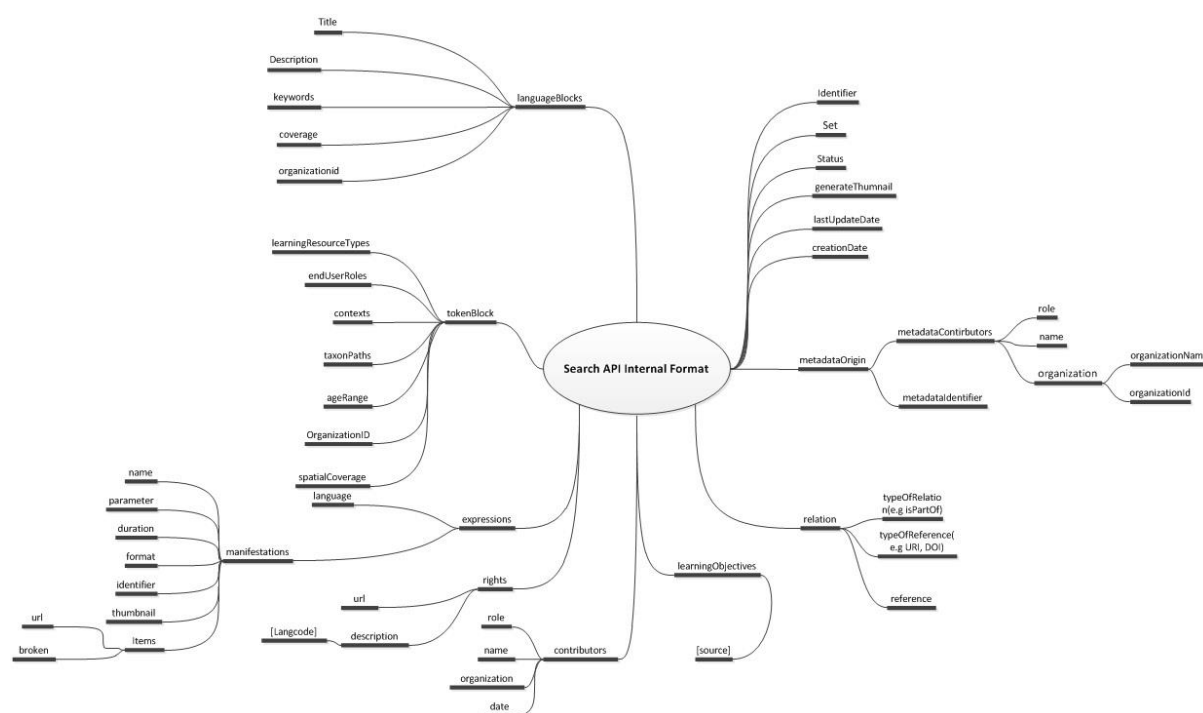
Figure 2.4: Internal metadata schema

2.3.6 Software Interfaces for Interacting with External Systems

eduOER has the following software interfaces for interacting with external systems.

OAI-PMH

The metadata aggregator supports the publishing of all the metadata through the OAI-PMH protocol. The metadata are exposed in IEEE LOM format. The OAI-PMH target can be used by:

- Other components of the eduOER architecture, such as the eduOER portal, to get all the metadata records.
- External referatories of learning resources such as the Open Discovery Space [OpenDiscSpace].
- Open Education Europa [OpenEdEu].

Specialised Search API

In order to provide a more flexible and scalable solution for covering more information needs and search options, a REST service has been developed on top of the ElasticSearch indexer which allows easier metadata integration. The specialised Search API is a RESTful API that allows several search options over the indexed metadata records (JSON files) following the internal data model of the aggregation engine. Specifically, it allows the user or application to: make a simple search, search within specific fields, make a temporal search, fetch specific items and carry out complex queries.

OER Metadata Records Status API

As already mentioned (see Section 2.3.4) the metadata aggregation workflow is an automated process that can aggregate and process metadata records for OERs from diverse sources. The periodicity of the process can be set by the administrator of the workflow per each collection. In order to inform external systems about the status of the metadata aggregation repository, a simple REST interface has been developed. More specifically, the OER aggregation workflow publishes the status of the metadata records that have been ingested and processed through a simple REST interface that informs external systems which metadata records have been recently ingested, which have been updated and which have been deleted from the metadata aggregation repository. Based on this information, the external system can get all the updated or new records either directly, using the catalogue of the repository layer, or through the search API.

An example of such a manifest file that could provide this information is shown in Figure 2.5 below. Using this file the remote system can get from the metadata aggregation repository the records that should be ingested or updated in the local database.

```
{
  "_index": "geantoer_metadata_aggregation",
  "_type": "LinkChecking",
  "_id": "TNC:TNC_350576011",
  "_score": 1,
  "_source": {
    "message": "2016-01-26.14:11:10.000 TNC TNC_350576011 Livelink 200",
    "@version": "1",
    "@timestamp": "2016-01-26T12:11:10.000Z",
    "type": "LinkChecking",
    "host": "snf-681892",
    "path": "/home...",
    "date": "2016-01-26.14:11:10.000",
    "repository": "TNC",
    "Identifier": "TNC_350576011",
    "Status": "Livelink",
    "Status_Number": "200"
  }
}
```

Figure 2.5: Example of metadata record status

OER Metadata Publishing API

In order to support the suggestion of OERs through the eduOER portal, the aggregation engine needs to provide a simple publishing REST interface, other than OAI-PMH, that allows the submission of individual metadata records to the repository layer. The submitted records follow the internal data model and are in JSON format.

2.3.7 Aggregation Engine Software Licence

All the components of the GÉANT eduOER aggregation engine are available as open source software under Version 3 of the GNU General Public Licence.

The aggregation engine has been developed using the ARIADNE metadata aggregation tool, made by the ARIADNE Foundation [ARIADNE], a not-for-profit association that aims to:

- Carry out basic and applied research that will improve creation, sharing and reuse of knowledge through the use of technology.
- Develop and deploy methodologies and software that will provide flexible, effective and efficient access to large-scale knowledge bases.
- Apply the results of its research and development activities to help preserve multicultural and multilingual knowledge assets and collections.
- Explore how these research and development results can be adopted and sustained so that they support educational and research communities.

2.4 Services for Content Providers

All the GÉANT eduOER services offered to content providers are available from the content providers pages of the eduOER service website [eduOERCPSvcs].

Each service is described below.

2.4.1 eduOER Metadata Analytics Service

The eduOER metadata analytics service is a web application that offers a deeper insight into the metadata content based on statistics. This service is intended to be used by potential metadata providers who want to gain a deeper knowledge of their metadata, identify bad metadata curation practices and get a more descriptive picture of their metadata (how specific elements are used, etc.). After uploading their metadata and configuring the specific statistical analysis, users can get the results either as CSV files or as visualizations created directly from the web application. For more information regarding the statistical measures and how the service works, please refer to the Metadata Analytics Web Application information page [eduOERCPSvcsMA].

2.4.2 eduOER OAI-PMH Target Service

The eduOER OAI-PMH target service offers a potential metadata provider the ability to expose their metadata using OAI-PMH protocol instead of having to set their own. The newly added metadata are exposed as a new OAI-PMH set to potential metadata harvesters.

2.4.3 eduOER Mapping and Transformation Service

This service helps content providers map and transform their metadata, using the eduOER Application Profile (or any other application profiles they may choose). The workflow is as follows:

- The content provider uploads a sample of their metadata into the MINT mapping tool.
- The tool automatically recognises the native schema of the metadata and lets the content provider define the semantic mappings between the source and target schemas.
- An XSLT mapping file, implementing the mapping rules, is generated.
- The mapping file can then be used as the input to the internal eduOER transformation mechanism.

(For more information about the MINT mapping tool, please visit the wiki page [MINT].)

2.4.4 eduOER Metadata Validation Service

Once the metadata are mapped and transformed into the necessary schema (or if they were already compliant), the content provider can validate the entire repository, both in syntactic and semantic terms, against this schema using the metadata validation service. All the content provider has to do is either upload the relevant metadata XML file or provide the OAI-PMH target URL, and they will receive the relevant validation report.

2.4.5 eduOER Visualization Service

During the entire eduOER metadata aggregation workflow, a content provider can use the eduOER metadata aggregation dashboard to monitor, at each and every step, the progress and the results of the aggregation workflow. They can follow the progress of the complete eduOER federation or exclusively of their own repository. In addition, the eduOER metadata analysis dashboard can also be used to get an insight into the harvested metadata. This way, all interested parties (aggregation analysts, data providers, etc.) can get a rough estimation of the overall metadata quality.

2.5 Services for End Users

The starting point for all the end-user services, user scenarios and profiles is the For Users page on the eduOER service website [eduOEREUSvcs].

The eduOER service offers an infrastructure to collaborate, innovate and share knowledge in order to foster the development of Internet technology, infrastructure and services used by the research and education community.

The service enriches learning, expands the use of open educational resources online and their reuse, saves costs and offers quality, effective learning. The service supports online courses and blended learning, which combines face-to-face learning with additional online materials.

The specific services provided to end users are described below.

2.5.1 Multimedia Web Portal

Usually, OER repositories are focused on text- and picture-based resources, but the tools needed to browse large collections of video and audio are clearly different from those needed to browse text-based OER collections. The goal of the eduOER multimedia portal is to provide the best user experience when browsing and searching audio or video OERs.

The GÉANT eduOER front-end portal is based on the PuMuKIT platform developed by University of Vigo. The production portal is available at [eduOEREUSvcsMWP] and shown in Figure 2.6 below.

The service development team is also looking after a development staging version of the portal for testing new features and fixing bugs [eduOEREUSvcsMWPDev].
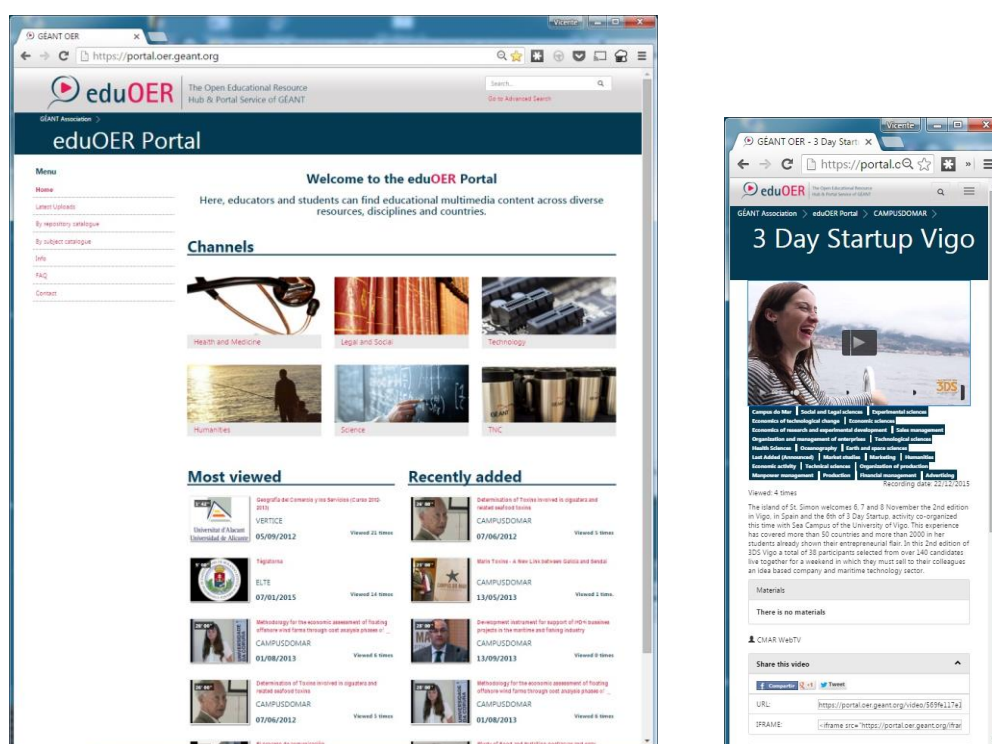
Figure 2.6: eduOER multimedia web portal with responsive design for mobile use

Although the web portal is fully public and can be used by any end users, there is no intention to convince all potential users to leave the institutional portals they are familiar with and switch to eduOER instead. The aggregated metadata set of eduOER can be harvested back by any national or institutional repository portals via the search API and standard protocols, hence any portal can be enriched with open content via eduOER without pointing their users away.

2.5.2 LMS Integration Module

A learning management system (LMS) integration module for the eduOER service is expected to be developed after April 2016. This will be implemented by the Moodle plug-in or widget of the PuMuKIT web portal as the easiest option. This feature will allow system integrators to embed

eduOER open content in LMS systems and facilitate search, find and reuse of multimedia OERs without the end users leaving the LMS environment.

2.5.3   Search Widget for Portals Using the PuMuKIT Platform

A generic GÉANT eduOER PuMuKIT plug-in for search and data ingestion that can be integrated into national/institutional web portals (those using the PuMuKIT platform, in the first instance) will also be developed. Via this search widget, eduOER can be present at any institutional, national or thematic repository portal.

2.5.4   Mobile Applications

Nowadays, a service without a mobile application interface is simply a non-starter for end users, for students particularly. A first stage of a mobile-oriented interface is already available thanks to the responsive web portal, which is able to fully adapt its layout to small screens.

On the other hand, developing mobile applications is not within the remit of GÉANT or any of its members. The REST API interface of eduOER makes it possible, as a second stage, to develop mobile applications on top of the service. It is planned for GÉANT to run a student competition or open call where the end-user-service community can actively engage in mobile application development (Android, iOS, etc.), led by the community for their particular needs.

2.5.5   MOOC Support

eduOER also supports MOOCs in a number of ways, depending on how the MOOC provider integrates eduOER into the MOOC creation workflow. It can:

- Provide learning objects that can be part of the MOOC regular learning materials. The combination of several learning objects creates a combined learning unit for the course.

- Provide supporting materials that are not part of the course to enrich the learning experience and expand the students' knowledge.

- Offer multilingual support; most MOOCs are offered in one language (usually English). This service will allow students to retrieve and use supporting materials in their own language.

3 Roadmap

The development roadmap consists of potential service developments on both the back-end engine and the front-end portal of the GÉANT eduOER service architecture.

3.1 Pre-Production Version v.1.0: Features at Service Launch

The official pre-production version of the GÉANT eduOER service, v.1.0 (Figure 3.1), is planned to be announced at the GÉANT Symposium on 8–9 March 2016 in Vienna, Austria. Live service demonstrations will be given. The list of available services is given below.

Back-end services:

- Harvesting via OAI-MPH and RSS (various versions) protocols.
- OAI-PMH target service from any XML file provided.
- Schema validation.
- Metadata mapping (LOM, Dublin Core, etc.) and transformation.
- Mandatory, recommended and optional metadata fields.
- Metadata monitoring and visualization.

Portal:

- Responsive multimedia-oriented portal.
- Simple and faceted search.
- Embedded video player (facility to watch external videos in the OER portal).
- Most-viewed videos.
- Recently added videos.
- Channels by knowledge area (Science, Technology, Humanities, etc.).
- By Repository (i.e. contributing institution) catalogue.
- By Subject catalogue.
- Social sharing (easy Facebook, Twitter, etc. sharing).
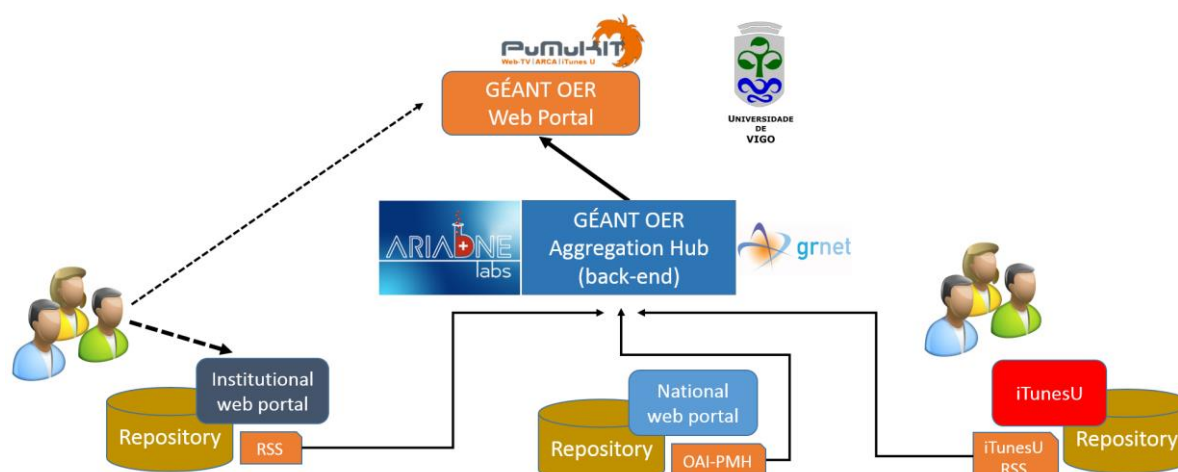- Related videos.

Figure 3.1: Pre-production version v.1.0

3.2 Mid-Term Plan Version v.1.x: Planned Features

After the launch of the pre-production version of the eduOER service by the end of Phase 1 of the current GÉANT Project (GN4-1), it is not yet known what form eduOER development effort will take in the next phase (GN4-2). However, it is expected that eduOER will be operated by GÉANT as is. Any further planned service development must be funded by the GÉANT membership or the eduOER service community from alternative sources. The planned features in the mid-term are summarised below and shown in Figure 3.2.

Back-end services:

- Automated alerts to publishers.
- Thumbnail creation as a service.
- Adding Persistent Identifiers (PIDs) to objects; connect to the European Persistent Identifier Consortium (ePIC) service.
- Home-for-homeless repository; connect to Zenodo.

Portal:

- Full portal language filter (show only videos in the desired languages).
- Federated login and personal portal features: "MyPortal" (personal playlists, favourites, etc.).
- Personalised recommendations.
- Multilanguage.
- Moodle integration via PuMuKIT.
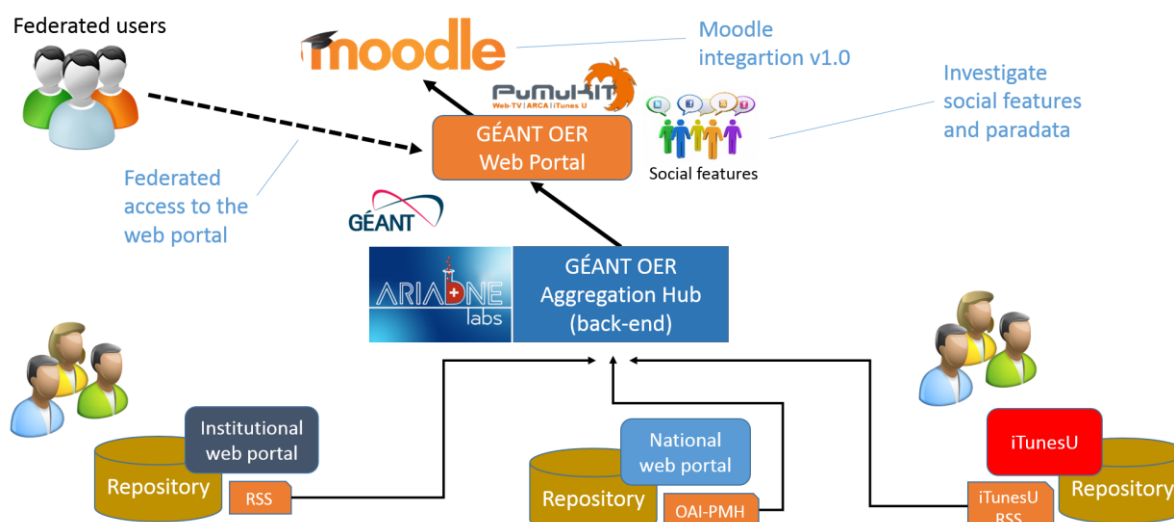- Variety of Creative Commons (CC) licences.

Figure 3.2: Planned features of version v.1.x

3.3 Long-Term Plan Version v.2.x: Expected Features

For the longer term, the authors are investigating additional funding possibilities, including EC projects independent of GÉANT, for the eduOER service developments and enhancements. The long-term features should include the following (also shown in Figure 3.3):

Back-end services:

- Harvesting and re-sharing paradata (user comments, ratings, etc.) from portal.
- Adding automated metadata translation between languages; Google translate.

Portal:

- Paradata-ready user interface (UI): ratings, comments, social features.
- Integrated peer review process.
- Improved faceted search UI:
  - Figures of the object under each option. e.g. [ ] English (344), [ ] French (45).
  - Multi selection: e.g. [x] English, [ ] French, [x] Spanish.
- LMS integration: Moodle, Blackboard.
- Video management platform integration: Canvas, Kaltura.
- Accessibility.
- PuMuKIT search widget (easy search from any PuMuKIT-based repository).
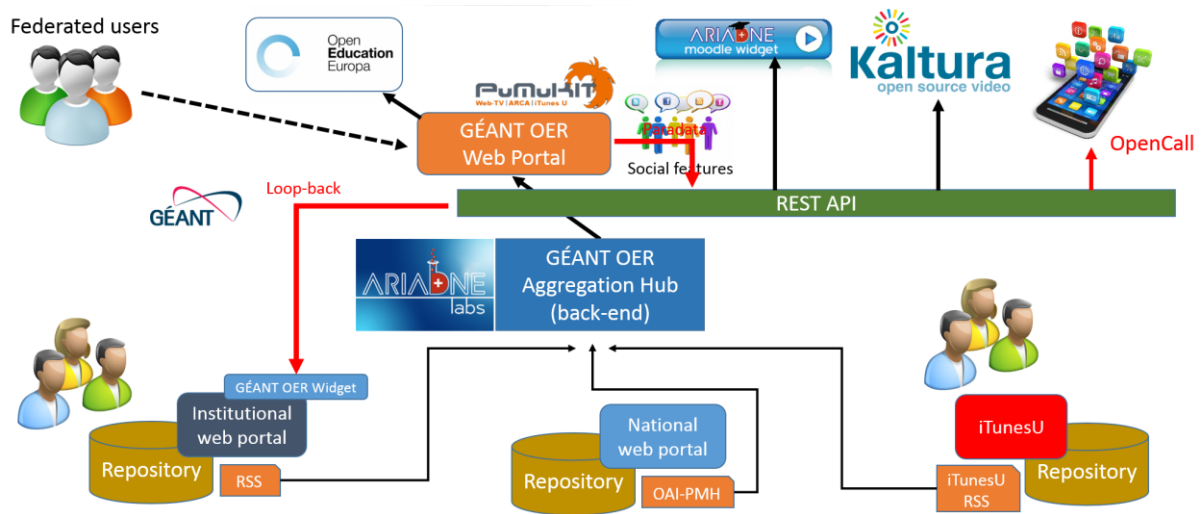- Mobile applications.

Figure 3.3: Planned features of version v.2.x

4 Value Proposition

As already mentioned, the GÉANT eduOER hub and portal service harvests and aggregates metadata from research and education (R&E) content repositories and facilitates the search, find and reuse of open content across multiple disciplines, institutions, countries, and languages.

This chapter's objective is to present the added value of the eduOER service, to show how it is unique and differentiated from similar initiatives, and to analyse the specific benefits the service gives to its customers.

4.1 Reason to Act

As education is increasingly acknowledged as being key to economic, social and environmental progress, so the open education community currently enjoys support from various institutions and foundations. A large number of open educational resource (OER) initiatives, referatories and platforms have been created in recent years. Nevertheless, there are cogent reasons for now launching another OER initiative, by NRENs, including:

- Many of the European NRENs are active in open education (OE) activities and have made a significant contribution to the deployment and availability of OE digital technology and content.

- NRENs are in a privileged position to produce/provide infrastructure and develop/support new technologies (e.g. search technologies, metadata harmonisation, federated access, portal creation).

- NRENs have direct access to and a panoramic view of all educational institutions, thus they can easily identify user needs, and be aware of where OERs are located/created.

- NRENs are in the process of engaging with educators and produce openly licensed content (course development), especially in the area of ICT and networking, for the teachers and the new generation of the knowledge economy.

- NRENs are in a good position to spread the word about new methods of teaching/learning to academic/research institutions.

The main outcomes of the eduOER hub and portal service are:

- The audio-visual multimedia content itself, addressed to end users, combined with advanced search features.

- The metadata tools addressed to content providers.

- The aggregation and exposure open source software.

- The collecting of paradata (in the roadmap) – the service will aggregate users' responses, such as comments and ratings about the OER. This will help future users to pick and choose materials best suited for their needs, based on the experience of past users.

The main strengths of the eduOER service are:

- The trusted circle of NREN members, primarily serving higher education – often schools – and research institutions of all sizes with network connectivity and access federation in Europe and worldwide.

- The GÉANT community and its major role and visibility in the academic and research world.

- The open source technologies of ARIADNE and PuMuKIT.

4.2   Customer Experience

The key customer experiences are:

- **For students/researchers:** better access to an extensive pool of multimedia multilingual OER that can enrich learning, especially video lectures.

- **For content providers:** better visibility of their content, in some cases presenting content that has never been linked or findable before; metadata harvestable by other services; metadata quality control; metadata analytics and visualization; tools for improvement of their metadata.

- **For professors:** better access to teaching material. The service supports online courses and supports blended learning, which combines face-to-face learning with additional online materials.

- **For Massive Open Online Course (MOOC) creators:** material, tools and modules to build MOOCs. The project provides learning objects that can be part of the MOOC's regular learning materials. The combination of several learning objects creates a combined learning unit for the course. It can also provide supporting materials that are not part of the course to enrich the learning experience and expand the students' knowledge.

- **For the institution**: learning materials shared with other institutions, promotion of the use and reuse of learning materials, promotion and increased exposure of the institution to the public and to potential students.

- **For other aggregators:** availability of open source software and more OER metadata.

- **For other content consumers:** eduOER Moodle widget and eduOER search application programing interfaces (APIs).

4.3   Benefits

The cost benefits of the service are detailed in the next chapter. Some of the unquantifiable benefits expected are:

- Better access to academic content for everyone.
- Increased use of OER (a contribution to democracy, a human right, a fair return to the tax payer, a means to improve knowledge).
- Increased number of online/video learners.
- Improved digital skills for better jobs in the growing digital economy (Europe has a shortage of digital skills today).
- Increased number of "digitally confident" teachers and professors.
- Increased number of lifelong learners in Europe and globally (The University of Life).
- Better visibility of European universities globally (Neellie Kroes 25.9.13: "while digital technology and content has improved, and countries around the world, from the US to Asia, are starting to reap the benefits out of it, Europe is falling behind").
- Better visibility of the European e-Infrastructures.
- Better access to relevant content for the GÉANT community.
- Improved metadata quality.

4.4   Alternatives

Nowadays, there are several initiatives related to the aggregation of OERs. The main projects and initiatives are presented in the following paragraphs.

ARIADNE Foundation

The ARIADNE Foundation [ARIADNE] is a not-for-profit association. ARIADNE members have developed a number of tools, standards and specifications that can be used to build an OER federation service. A demonstrator of the online federation services that can be set up using the ARIADNE tools can be found at the link referenced at [ARIADNE].

ARIADNE is a member of the Global Learning Objects Brokering Exchange (GLOBE) Alliance and contributes towards the development of a global learning infrastructure that can be accessible to all.

The GLOBE Alliance

The Global Learning Objects Brokering Exchange (GLOBE) Alliance [GLOBE] is a one-stop shop for learning resource broker organisations, each of them managing and/or federating one or more learning object repositories. GLOBE makes a suite of online services and tools available to its members for the exchange of learning resources.

GLOBE provides a discovery service for more than 800,000 learning resources. The discovery service is based on an aggregation engine that is built using the ARIADNE tools.

OER Commons

OER Commons [OERCommons], developed by the Institute for the Study of Knowledge Management in Education (ISKME) [ISKME], is a freely accessible online library that allows teachers and others to search and discover OERs and other freely available instructional materials. It provides access to resources that can be used by several educational levels, including higher education. It supports the aggregation of content from several sources through a metadata ingestion process connected to the OER Commons repository.

The online service provided by OER Commons is a very useful resource for studying good practice in terms of user experience and the tools and methods that can be used to build OER federation services.

Learning Resource Exchange of the European Schoolnet

The Learning Resource Exchange (LRE) [LRE] from European Schoolnet [EuSchoolnet] is a service that enables schools to find OERs from many different countries and providers. The principle upon which the LRE is based is very simple. The LRE collects descriptions (i.e. metadata) of OERs and compiles them into a searchable catalogue that can be consulted by users of connected e-learning platforms.

The LRE aggregates metadata obtained by several approaches. Metadata are acquired from existing metadata repositories, automatically generated, or manually produced by human indexers. The LRE brings users to the providers and all further actions involving the use of the resource (such as downloading, interacting with applets or playing videos or games) occurs in the content providers' or users' environments.

TAACCCT Project

The Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant Program is a $2 billion program of the US Department of Labour that provides community colleges and other eligible institutions of higher education with funds to expand and improve their ability to deliver education and career training programs that can be completed in two years or less, are suited for workers who are eligible for training under the TAA for Workers program, and prepare program participants for employment in high-wage, high-skill occupations. Through these multi-year grants, the Department of Labour is helping to ensure that the USA's institutions of higher education are helping adults succeed in acquiring the skills, degrees, and credentials needed for high-wage, high-skill employment while also meeting the needs of employers for skilled workers. The Department is implementing the TAACCCT program in partnership with the US Department of Education.

The TAACCCT program is the largest OER initiative in the world. A discovery service for all the OERs published in the context of the TAACCCT program is provided by the Open Professionals Education Network (OPEN) at the URL provided at [OPEN].

Learning Registry

The Learning Registry [LearningReg] is an effort jointly funded by the US Department of Education and the Department of Defence. The effort began in 2010 and creates a set of technical protocols for the exchange of data in support of educational goals by multiple providers. It is not a portal, but a platform for aggregating metadata and other data about learning objects.

The Learning Registry provides access both to commercial and open educational resources. However, the framework and technical approach are of great interest for OER initiatives.

Open Discovery Space

Open Discovery Space [OpenDiscSpace] is an EU-funded project that aims to serve as an accelerator of the sharing, adoption, usage and repurposing of the already rich existing educational content base. It will demonstrate ways to involve school communities in innovative teaching and learning practices through the effective use of e-learning resources. It will promote community-building between numerous schools in Europe and empower them to use, share and exploit unique resources from a wealth of educational repositories, within meaningful educational activities. In addition, it will demonstrate the potential of e-learning resources to meet the educational needs of these communities, supported by the European Web portal: a community-oriented social platform where teachers, pupils and parents will be able to discover, acquire, discuss and adapt e-learning resources on their topics of interest. Finally, it will assess its impact and document the whole process into a roadmap that will include guidelines for the design and implementation of effective resource-based educational activities that could act as a reference to be adopted by stakeholders in school education.

One of the main outcomes of the Open Discovery Space project will be an online OER discovery service with community functionalities [OpenDiscSpacePortal] that will provide access to more than 0.5 million educational resources. The OER aggregation service is built using an evolution of the ARIADNE tools. The front end is developed using the open source content management system (CMS) Drupal [Drupal].

Gooru

The Gooru platform [Gooru] is a free, teacher-curator multimedia search engine for primary- and secondary-level education. It provides teachers and students with the ability to search for free and open educational resources and develop collections of multimedia resources, digital textbooks, videos, handouts, games, and quizzes, specifically around science, maths, social studies and language arts. The data model used is based on the suggestions of the Learning Resource Metadata Initiative [LRMI].

Although it is not focused on higher education, the Gooru case is of interest to the GÉANT eduOER team due to the tools and APIs that are provided to the developers.

4.5 Advantages

The GÉANT eduOER service is going beyond the set-up of a single portal. It aims to deliver an open infrastructure for aggregating multimedia OER that can be used by the GÉANT community to support educational activities. It saves development and service integration time, reduces potential security breaches, and reduces the overhead of dealing with each and every repository or aggregation service one by one. eduOER will open the door for many new OER-related services for GÉANT members such as the development of an OER microsite for a specific topic and/or specific collections. Such OER discovery microsites can be integrated in any portal of the GÉANT members so they can build an OER section powered by GÉANT.

Table 4.1 below presents a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis for the eduOER service.

Strengths	Weaknesses
- European-level OER service operated and managed by NRENs - One-stop shop for primary NREN stakeholders (academia) - Metadata aggregation only - Key building block for value-added services (e.g. MOOCs)	- Lack of control over the quality of the content - Lack of consensus on information models and metadata schemas within the community - Mixed demand for learning content: higher education or lower education; thematic or specialised content - Mixed demand for object types: lecture recording or learning object
Opportunities	**Threats**
- Reaching the critical mass (keep the barrier low for small institutional repositories) - Being able to participate in global federation (e.g. GLOBE) - Providing/transfering knowledge within the academic community	- Low-priority service for some of the NRENs, some reluctance to take up - Strong competitors coming from outside the GÉANT community (commercial products)

Table 4.1: SWOT analysis

4.6 KPIs

The following table shows the Key Performance Indicators (KPIs) of the GÉANT eduOER service.

KPIs	TERENA Pilot, by May 2014 Expected / Reality	GN4-1 SA8 T3, by April 2016 Expected / Reality (Q3)
Number of repositories connected	5 / 7	15 / 16 (Q3)
Total number of objects on the portal	10,000 / 22,860	40,000 / 57,300 (Q3)
Connection to / integration with other platforms	1 / 0	3 / 1 (Q3)
Total number of views on videos	n. a.	100,000 / n.a. (Q3)

Table 4.2: Key Performance Indicators of GÉANT eduOER

5 Cost-Benefit Analysis

This preliminary cost-benefit analysis (CBA) of the eduOER service was carried out in accordance with GÉANT's internal decision procedures and official CBA form in December 2015. It is included here for completeness, although it repeats some of the information already given.

5.1 Background Information

5.1.1 Organisational Overview

Between 2010 and 2013, the former TERENA task force TF-Media brought together NRENs and other organisations to share information and knowledge about multimedia services, with special focus on lecture recording, multimedia management and distribution for higher education. TF-Media was one of the first task forces in this field where the ratio of non-NREN participants to NREN participants went above 50%. Despite the great interest and the clear increase in lecture recordings, TF-Media struggled to organise the community together behind one single tool or service. However, by the end of 2013, some NRENs showed an interest in developing a European-level service for national and/or institutional content repositories that brings value to the individual institutions by sharing information about their open content across the community.

According to GÉANT's latest (2014) *Compendium of NRENs in Europe* survey [Compendium], about 16 NRENs run a multimedia content repository at the national level and more than 10 other NRENs plan to establish one. Market research shows that almost every larger university in Europe has their own content repository and the smaller ones often use public cloud services (such as YouTube or iTunesU) to store and distribute recorded lectures, training, or other multimedia learning materials for courses.

Facilitating the search, find and reuse of open multimedia learning materials across institutions, disciplines, languages and countries is the main objective of the GÉANT eduOER service. The service offers a larger set of free educational resources to a wider audience that enables and pushes forward collaboration at new levels. The service enables institutional repositories to develop, be open and together reach the critical mass that justifies the open education movements in Europe and worldwide.

Some of the key TF-Media participants initiated the GÉANT eduOER service idea that was first piloted by a small TERENA project in 2014. The nine-month-long development project cost about EUR 40k and resulted in the eduOER portal service pilot, which had more than 7 content providers

connected, almost 23,000 objects collected, and 4 different languages covered by January 2015. It proved the technical feasibility of such a service and that there was sufficient interest among the selected repository owners to share their learning objects.

Starting from May 2015, the eduOER service was picked up by GN4-1 Project SA8 Task 3, led by GRNET. The aim of the Task is to bring the GÉANT eduOER service to the next level and pre-launch the production instance. The Task has about 25 project months' (PMs') effort over a year and about EUR 170k total budget.

5.1.2 Community Need

Given that eduOER is a metadata aggregation hub and exchange facility, the community need must be analysed from the repository owners' perspective. These repositories all have their own user communities and reasons for existence; eduOER has nothing to do with that.

The European NREN community is therefore in an excellent position to facilitate how open educational resources can be findable and accessible, and more effective in helping students, serving minority populations, improving the teaching and learning process, and potentially lowering the cost of higher and adult education.

The national and institutional repository owners need a European-level metadata harvesting and aggregation service that facilitates the search, find and reuse of multimedia learning materials. This aggregation point can then join other, higher-level aggregators and services (e.g. GLOBE, OpenEducationEuropa, OpenAIRE [OpenAire], etc.) with minimal overhead and marginal costs.

5.1.3 Drivers for Change

On 14 November 2014 the eduOER pilot project participants produced a position paper titled *GÉANT Association NRENs and Open Education – NREN Community Statement on Open Education* [Statement]. The paper has been discussed and approved by the General Assembly and sent to the European Commission as a contribution by the GÉANT community to the open education policy.

The paper includes the main drivers and detailed description of the political, social and technological environment.

5.1.4 Outcomes

The GÉANT eduOER service – the main result of the investment – is an open educational resources (OER) metadata aggregation hub and portal service with the aim of facilitating access to digital multimedia content at the European level in the form of repositories, infrastructures and services.

GÉANT eduOER hub for content providers

- Educational repositories and relevant content providers are invited to disseminate and share the metadata (i.e. the information about the content) of their open educational resources via the GÉANT eduOER hub. It not only harvests and aggregates metadata from various sources

but also provides value-added services to the connected repositories in order to discover, analyse, validate and enrich their metadata.

GÉANT eduOER web portal for end users

- The front-end portal addresses the end users – educators and students – who directly benefit from open education. It facilitates the search and find of open educational multimedia content across multiple disciplines, countries and languages in order to reuse, revise, remix or redistribute.

5.2 Description of Alternatives Considered

5.2.1 Option 1 – Do Nothing

The administration of the former TERENA task force TF-Media was partly funded by the GN3 and GN3plus projects' Networking Activities (NAs) over its four-year lifetime. The TERENA OER development pilot cost about EUR 40k in the form of direct investment from the TERENA budget, contributed by the membership, while the GN4-1 Project SA8 Task 3 service development task has a total budget of about EUR 170k over a year, partly funded by the European Commission.

Option 1, "Do Nothing", would mean the total loss of these existing efforts and investments in creating a long-term sustainable GÉANT eduOER service.

5.2.2 Option 2 – 1st alternative

The GÉANT eduOER service must be taken to the next level, from piloting stage to full production, under the GÉANT service portfolio. This needs a clear strategy and commitment to a consistent funding scheme that is currently established under GN4-1 Project SA8 Task 3. It is expected that the GÉANT eduOER service will be pre-launched and service operations supported by the end of the project in May 2016.

The first alternative would be to keep the eduOER service running under the GÉANT service portfolio, hosted and operated by GRNET out of the Okeanos Cloud. This would mean no further continuous service improvement, only service maintenance and operations. The estimated cost of running the service in the cloud delivery model is about EUR 30k annually.

Two opportunities have been identified to cover this cost with a simple revenue stream. However, these options need to be investigated further.

- The repositories connected to the eduOER hub benefit from its services. They do not have to establish connections and negotiate protocols, schemas and translations to each and every other repository with which they want to share metadata. Instead, such a technical negotiation is done only once with eduOER, saving the repositories time and effort. eduOER could therefore charge a small fee to maintain its services.

- The global eduOER front-end portal is available for free. However, some universities, campuses or research institutions may benefit from their own multimedia portal. eduOER can provide a hosted version of the portal to the institutions in a customised way. It would not just be an empty portal: all the content shared via the eduOER hub could automatically be included in there too. This is a value-added service. eduOER could therefore charge institutions a small fee for the hosted portal versions.

5.2.3 Option 3 – 2nd alternative

The GÉANT eduOER service must be continuously developed further, in accordance with the defined service roadmap, in order to be able to provide its full benefits to the community. The limited funding available under GN4-1 was sufficient to develop the main features of the service and secure the hosting and basic operations in the GRNET cloud. However, the service roadmap includes many more functions and features that are highly valuable to the service community. This needs further strategic investment in the longer term.

Such development would need additional funding, preferably contributed by the European Commission via joint projects. It is estimated that the new service developments to complete the version v.1.x features will cost EUR 160k in 2017 and a further EUR 150k and EUR 50k in 2018 and 2019 to reach version v.2.0, at least. The cost-benefit analysis below takes into account this expenditure.

5.3 Costs

The list below indicates the costs of the continuous service development and operation of the GÉANT eduOER service supported by the GRNET Cloud. A summary is provided in Table 5.1.

- The CAPEX of the one-time TERENA development pilot in 2014 was about EUR 40k.

- Under GN4-1 SA8 the service components have been migrated over GRNET; VMs are hosted in the GRNET Cloud. The estimated OPEX of VMs in the GRNET Cloud is EUR 5k annually.

- The University of Vigo (UVigo) supports the portal software PuMuKIT under a third-party contract. The estimated cost is EUR 3k annually.

- GN4-1 SA8 Task 3 has a budget of EUR 170k, of which EUR 110k is in 2015 and EUR 60k is in 2016.

- The service operations and support provided by GRNET have an estimated OPEX of EUR 25k annually, including operations and management overhead.

- Marketing and communications required from GÉANT Association is estimated as EUR 3k annually.

- New service developments to complete the version v.1.x features are expected to cost EUR 160k in 2017 and a further EUR 150k and EUR 50k in 2018 and 2019 to reach version v.2.0, at least.

Cost Type	Further information	Manpower Costs		2015	2016	2017	2018	2019
		Rate	Days					
Capital costs				€ -	€ -	€ -	€ -	€ -
	Initial pilot development			€ 40,000	€ -	€ -	€ -	€ -
				€ -	€ -	€ -	€ -	€ -
				€ -	€ -	€ -	€ -	€ -
				€ -	€ -	€ -	€ -	€ -
Recurring Cost								
	VM hosting environment			€ -	€ 5,000	€ 5,000	€ 5,000	€ 5,000
	Software support and maint.			€ 2,000	€ 3,000	€ 3,000	€ 3,000	€ 3,000
				€ -	€ -	€ -	€ -	€ -
Manpower costs								
	Service development, new features	500	500	€ 110,000	€ 60,000	€ 160,000	€ 150,000	€ 50,000
	Service operations and mgmt	500	200	€ -	€ 25,000	€ 25,000	€ 25,000	€ 30,000
	Marketing and comm.	500	50	€ -	€ 2,000	€ 3,000	€ 3,000	€ 3,000
				€ -	€ -	€ -	€ -	€ -
Program Total Costs By Year				€ 152,000	€ 95,000	€ 196,000	€ 186,000	€ 91,000
Program Grand Total	€ 720,000							

Table 5.1: Estimated total costs

5.4 Benefits and Impacts

Benefits and impacts are realised on the national/institutional repositories connected to the GÉANT eduOER service. The critical success factors for the GÉANT eduOER service can be measured as shown in Table 5.2 below.

CSFs	TERENA Pilot, by May 2014 Expected / Reality	GN4-1 SA8 T3, by April 2016 Expected / Reality (Q3)	Prediction for 2016–2019
Number of repositories connected	5 / 7	15 / 16	Reach 120 repositories
Total number of objects on the portal	10,000 / 22,860	40,000 / 57,300	Reach 400,000 objects
Connection to / integration with other platforms	1 / 0	3 / 1	Reach 10 connected services
Total number of views	n.a.	n.a.	Reach 100,000 view per year

Table 5.2: Critical success factors

The benefits listed below and summarised in Table 5.3 are projected per service beneficiary (i.e. connected repository). These figures are based on estimations backed by the repositories that have connected to eduOER during the pilot and service development phases. For a detailed CBA, these figures must be revised later.

- There is no need to develop various harvesting interfaces/protocols. It is enough to join GÉANT eduOER once. The estimated CAPEX saving is about EUR 1,500 per interface per repository.

- More objects can be displayed on the institutional portals via GÉANT eduOER. The financial benefit of enriched content is estimated as about EUR 700 per repository.

- GÉANT eduOER supports participation by less-developed repositories. The manpower saving there is estimated as EUR 3,000 per repository.

- Using the central GÉANT eduOER portal instead of developing or acquiring an institutional portal for those who have not got one can have a saving of EUR 1,500 per institution.

- It is assumed that the number of repositories joining GÉANT eduOER will grow steadily: 7 (2015), 14, 28, 56, 112 (2019). The total number of connected institutional/national repositories by 2020 could be more than 200.

Benefit Area	Further information	Confidence factor	Project Year --->	2015	2016	2017	2018	2019
Cost Reduction	one harvesting interface	45%		€ 10,000	€ 20,000	€ 40,000	€ 80,000	€ 160,000
				€ -	€ -	€ -	€ -	€ -
Incremental Income	more objects in repository	55%		€ 5,000	€ 10,000	€ 20,000	€ 40,000	€ 80,000
				€ -	€ -	€ -	€ -	€ -
Manpower Reduction	lowering barriers to enter	60%		€ 20,000	€ 40,000	€ 80,000	€ 160,000	€ 320,000
				€ -	€ -	€ -	€ -	€ -
Decreased Overhead	central portal	55%		€ 10,000	€ 20,000	€ 40,000	€ 80,000	€ 160,000
				€ -	€ -	€ -	€ -	€ -
				€ -	€ -	€ -	€ -	€ -
				€ -	€ -	€ -	€ -	€ -
Total Benefits Per Year				€ 45,000	€ 90,000	€ 180,000	€ 360,000	€ 720,000
			Confidence Factor adjustment	€ 24,750	€ 49,500	€ 99,000	€ 198,000	€ 396,000
			Benefits Claimed for Analysis	€ 24,750	€ 49,500	€ 99,000	€ 198,000	€ 396,000
			Program Grand Total Benefit	€ 767,250				

Table 5.3: Estimated total benefits realised by the repository owners

5.5 Cost-Benefit Summary

The charts in Figure 5.1 and Figure 5.2 show the discounted cash flow and the discounted payback realised by the GÉANT eduOER service community as a whole. As stated above, these figures are based on estimations backed by the repositories that have connected to eduOER during the pilot and service development phases. For a detailed CBA, these figures must be revised later.
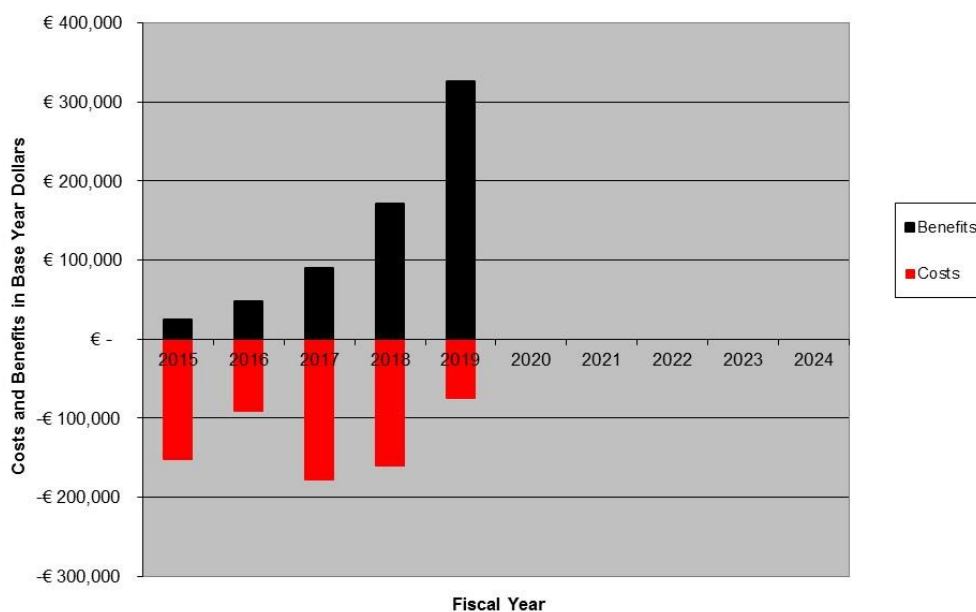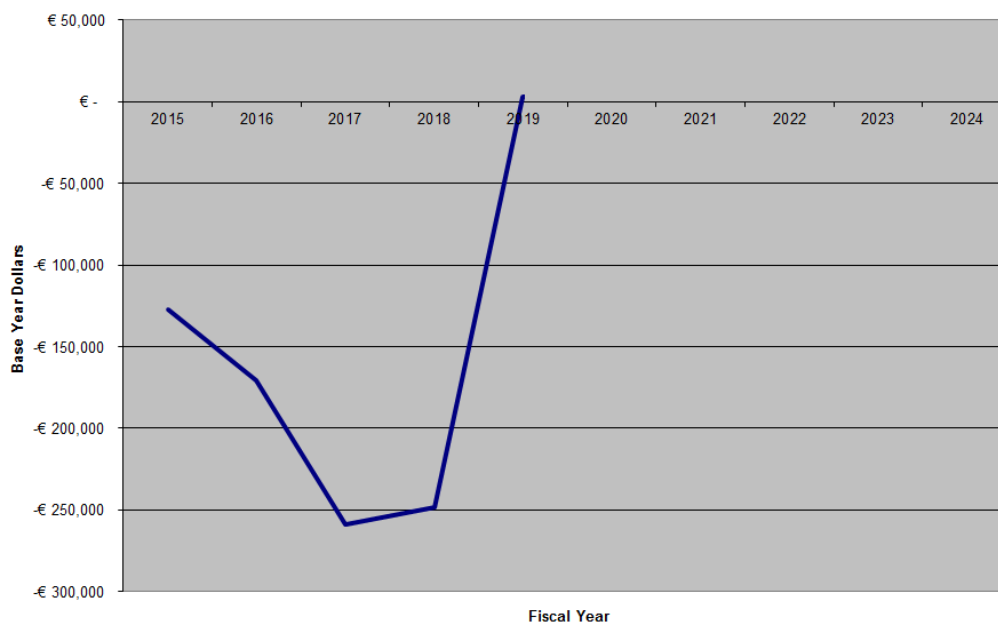
Figure 5.1: Discounted cash flow

Figure 5.2: Discounted payback

5.6   Conclusions

The focus in open educational resources continues to be largely on increasing access to digital content in the form of repositories and infrastructures. To encourage the wider take-up and use of open educational resources, more consideration needs to be given to how technology can support educational institutions in offering open education facilities in a financially sustainable manner, and to developing methods and practices that enable learners, teachers and institutions to best engage with OER.

5.6.1   Recommendation

Based on the cost-benefit analysis presented above, the following is recommended:

- The GÉANT eduOER service development and the service launch in production must be carried out and completed as planned in the GN4-1 Project description of work.

- Furthermore, in order to realise the full benefits of the service and to make the expected impact on the connected service participants (national and/or institutional content repositories run by NRENs and other organisations), the GÉANT eduOER service must be continuously maintained, developed and operated for at least five more consecutive years (up until 2020).

- It is also recommended that the development of the eduOER service be continued and expanded to its full potential, e.g., including collection of paradata. The collection of paradata is very important for supporting the learning analytics performed by the eduOER services. Both statistics and paradata are of interest to the OER originator (person and/or institution). The customised portals and the paradata collection functions together can offer value-added features and help the development of personal learning curves.

5.6.2   Supporting Reasons

The reasons for this recommendation are as follows:

- The overall estimated return on investment realised by the GÉANT members and/or their members and customers will exceed the financial costs of executing this project at GÉANT over five years.

- As the European population is aging, the demand for learning materials for lifelong learning is increasing and with it, the importance of making high-quality OER easily accessible to life-long learners.

6 Marketing and Engagement

This section outlines the eduOER marketing strategy, and summarises the extent of engagement achieved to date.

6.1 PR and Marketing Strategy

6.1.1 Introduction

This section explains the main communication strategy for the eduOER service and includes its promotion and dissemination in European countries. The strategy was first produced at the end of the TERENA OER pilot, and has been revised ahead of the service launch in March 2016. It covers the launch, the follow-up marketing actions until the end of GN4-1, and beyond.

To summarise the intended users and aim of the service for the purposes of this section: the service is targeted mainly at content producers and providers: National Research Education Networks (NRENs), higher education institutions (HEIs), teachers, lecturers and students.

The aim of the eduOER service is to create a portal with a searchable metadata repository, allowing students, educators and independent learners to access digital learning resources (educational objects, courses, videos, Massive Open Online Courses (MOOCs), etc.) for free. eduOER will allow knowledge dissemination and interoperability between European institutional education repositories, which will give users free access to knowledge and learning object materials produced in the different European countries. eduOER will allow users to share, create, evaluate and distribute educational content at international level, reducing geographic barriers to accessing knowledge.

As already mentioned, to reach potential users the marketing strategy includes the utilisation of different communication channels that should be used in a coherent way, sharing different messages and adapting media contents to each different communication channel's characteristics. The promotional media content will be disseminated mainly through the website and social media channels in the form of text, photos, videos, illustrations, animations, infographics, etc.

This section includes some of the communication activities, tools and human resources needed to implement the proposed communication strategy. The strategy is divided into different areas, covering the key concepts and guidelines involved in achieving consistent communication across the different channels:

- Goals.
- Target audiences.
- Key message and style.
- Channels of communication.
- Media content production and creation.
- Tasks and human resources.
- Evaluation.

6.1.2 Goals

The main communication goal is to obtain awareness of and engagement with the open educational resources (OER) topic from European content producers and providers. The communications should encourage the different stakeholders to adopt and join eduOER, providing new educational objects and aggregating new institutional metadata repositories.

A communication strategy will be crucial to inform, announce and promote the service, to become better known by all the stakeholders. This strategy will also help to create, operate and maintain a participative community around the OER subject. On this point, Web 2.0 and social media platforms will be the key to communicating regularly to a wider audience at lower costs.

eduOER will promote and implement interoperability between educational repositories across the European countries. This service should align the best practices and standards of metadata and paradata usage and aggregation, encouraging the use and reuse of learning object materials and maximum value for available public money by reusing open learning resources.

6.1.3 Target Audiences

Several stakeholders compose the target audiences for this service. The more important ones are illustrated in Figure 6.1 below; the order of importance follows a clockwise direction, with the most important, NRENs, at the top. Each communication should always be adapted to these target stakeholders.
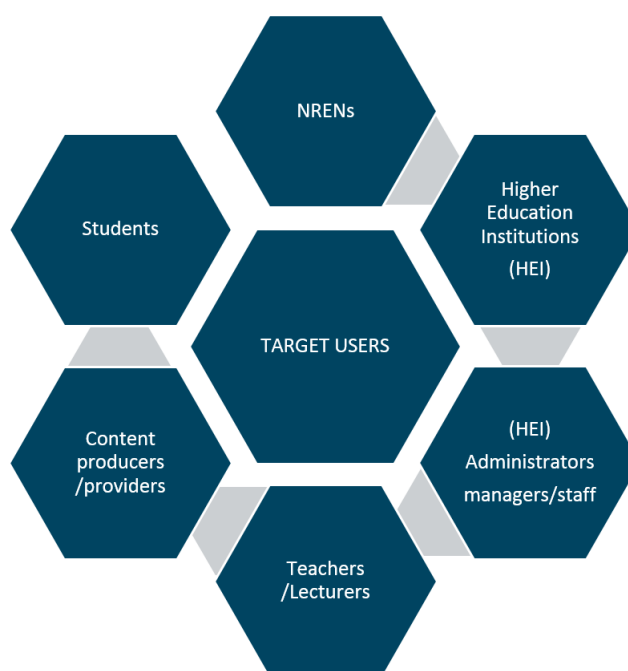
Figure 6.1: Target service users and audiences of eduOER promotions

NRENs will have the most import role in eduOER service dissemination, aligning processes, best practices, standards, policies and implementation strategies in European countries. They will be the key to service adoption, since they have privileged relations with higher education institutions and decision makers.

6.1.4 Key Messages and Style

The key messages are the main concepts that GÉANT wants the audience to remember from the communication campaigns. These messages should be carefully selected and provide helpful, useful and instructive information, across the different communications materials and activities.

The communication process should work as a whole, using the same communication language in all the communication channels. Table 6.1 below describes the service organic identity elements and communication style, which should be consistently used across the different communication channels. These topics will be used as guidelines for all the media content production.

Organic Identity	Description
Service	- eduOER portal service - Initiative under GÉANT's responsibility - Global learning object referatory - Searchable educational content - Interchangeable metadata and paradata - Free access to educational contents produced in European countries

Organic identity	Description
Corporate identity	• Service name (eduOER) • Slogan • Logo • Chromatic behaviour (use of colours) • Typography (fonts and lettering) • Style and institutional templates
Style	• Modern • Young • Technological
Language	• English as standard language • Direct language • Simple and concise messages
Tone	• Formal • Institutional/corporate • Informative and promotional • Entertainment
Target	• People between 18 and 75 years old with higher education
Platforms	• Personal computers (Mac, PC) • Mobile phones • Tablets
Channels	• Institutional site (eduOER portal) • Blog (Wordpress) • Newsletter (mailing list) • Social media • Service flyer
Key messages	• eduOER project news and highlights • User awareness and engagement content • Service promotion • Helpful, useful, instructive OER information • Curate OER-related information • Use interesting narrative • Human interest stories • Arresting and appealing imagery

Table 6.1: Key messages and style

6.1.5 Channels of Communication

This communication strategy is divided into two main types of communication:

- Non-media communication (events, face-to-face meetings and exhibitions).

- Media communication (electronic media).

Figure 6.2 below illustrates in a simplified way the different media communication channels used to reach eduOER users.
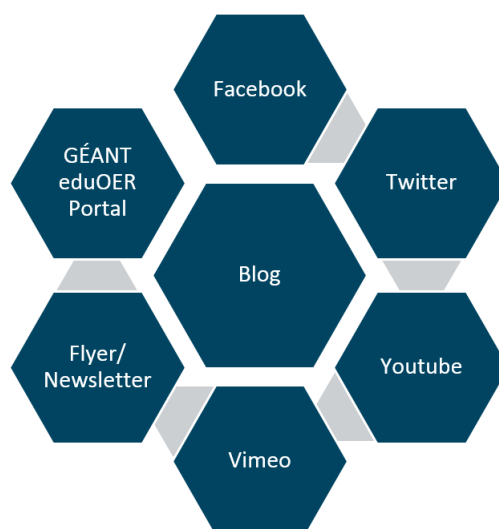
Figure 6.2: Communication channels

6.1.6 Media Content Production and Creation

To create and support a community of peers around the OER subject and engage eduOER users, the service will need to create new media content on a regular basis (weekly, monthly). Social media channels will be the most important and the most time-consuming, since they need regular content creation and maintenance. The created content should be shared among the different social networks whenever possible (blog, Facebook, Twitter, YouTube, Vimeo).

The blog will allow easy maintenance and upload of new content in a fast and effective way; it will be easier to update and share content in a central location, where the users can find all the useful information about the service. The blog will be helpful for fast content writing, publishing and sharing of information. A blog will also help to improve the service with user comments, interactions and observations. Whenever possible the blog should be integrated with the other communication channels (Facebook, Twitter, YouTube, Vimeo) for more information about the service.

The social media channels should feed helpful, useful, relevant and entertaining content to eduOER users. Below are some examples of media content that may work in a social media communication strategy.

- Service news and information.
- OER-related content.
- Case studies.
- White papers.
- Interactive e-books (manuals, proceedings, good practices).
- Newsletters.
- Promotional videos/animations.

- Slide presentations.
- User-generated stories.
- Good practices.
- Photographs.
- Infographics.
- Podcasts.
- Tutorials.
- Awards.
- Quiz/Surveys/Polls.

Actions

Actions to take before service launch include the following (those marked ✓ have either been done or will be in place before the launch):

1. Create a corporate identity: ✓
   a. Service name.
   b. Logo.
   c. Slogan.
2. Create social media accounts (eduOER): ✓
   a. LinkedIn.
   b. Facebook.
   c. Twitter.
   d. YouTube.
   e. Vimeo.
   f. Blog.
   g. Follow the accounts of other projects and services with the same interests.
   h. Connections between different social media channels.
3. Create the service promotional video. ✓
4. Create the service flyer.
5. Create a communication timeline plan.

These are described in more detail below.

Actions to take after the service launch include:

1. Create and maintain a media content strategy.
2. Maintain and support social media activities in the different channels (create, publish, share, comment).
3. Maintain and support web presence (blog and eduOER portal).
4. Create new media content to feed regular communications.
5. Maintain a community of peers around the OER subject.

Corporate Identity

The creation of a solid corporate identity will be a plus to promote eduOER to target users. The creation of a logo and a slogan is proposed, to promote the service all over the globe. These elements can then be included in the different service communications, digital documents and activities. These elements will allow users to easily identify eduOER from the other existing portals and repositories. Corporate identity is one of the strongest elements associated with a service and will help to promote the service worldwide, even when the GÉANT eduOER team is not present.

Logo

The logo will be related to multimedia open educational resources and should illustrate the variety of educational content searchable and findable in eduOER.

The actual logo developed for eduOER is shown in Figure 6.3 below.

Figure 6.3: eduOER service logo elements

Slogan

The service logo can be complemented by a brand-new slogan that explains the advantages behind eduOER. The slogan will help to explain the service concept in just a few words and create engagement and service stakeholders' recognition. The suggested slogan is: "Search – Find – Reuse".

Promotional Video

Before the service launch a short promotional video should be created that illustrates how the service works in practice, and what the advantages are to the eduOER community. The video should create awareness and engagement with potential users. The video production will help to disseminate the eduOER service all over the world, showing visually the advantages of a shared open education repository in Europe. The video should cover eduOER portal service infrastructure, workflow, objectives, advantages, supported learning objects, media examples, participants and partnerships.

The video will use a modern audio-visual language and at the same time be entertaining and informative. The duration should not exceed two to three minutes, keeping the messages short, simple and engaging. The creation of a computer graphics animation is proposed, using a vector-based modern animation, integrated with other digital motion graphics elements and techniques. The video must provide dynamic content information, with fast and concise messages. In the end it should provide a "call to action" to involve and lead users to try and test eduOER services.

Service Flyer

The service flyer will cover service description, objectives and goals, infrastructure, advantages and the service's target users. The flyer will inform new users and institutions how to contribute to and join this European initiative. It should include illustrated images from the web portal search engine home page, corporate identity elements and other visual elements that help to better explain the service to the eduOER community.

Information will not exceed more than two A4 pages, including cover and back, containing only the key elements mentioned above. The flyer will also have a reference to the social media channels (Facebook, Twitter, YouTube, Vimeo and blog) for more information about the service and better interaction with the rest of the eduOER community. Partners, institutions and repositories should also be mentioned, to show the engagement from the different service stakeholders. The flyer will be available for download on the different communication channels and should also be available, as a printed version, for distribution at GÉANT/NREN events and meetings around the globe.

6.1.7 Evaluation

Each different communication channel must be evaluated in order to optimise the messages and redefine the main communication goals for each channel. Regular (e.g. annual) reports should be prepared. This information is a useful tool in corporate communications to measure the planned activities and ensure that the tools and activities have the right level of time, human and financial resources allocated to achieve the proposed communication plan. Evaluation examples are given below:

- eduOER portal views and traffic (Google Analytics).
- Blog views and interactions (Google Analytics).
- Facebook metrics.
- Usage statistics.
- Shared content by users.
- Likes and comments in social media.
- Emails with opinions, error and reports.
- Face-to-face feedback (events, workshops, meetings).
- Web 2.0 opinions and feedback.
- Social media influence measuring tools (Klout).
- Polls and surveys to understand what the community wants to know about and what kind of messages they expect to receive from eduOER.

6.2 Engagement

This section summarises the extent of engagement achieved to date in terms of online presence, connected repositories, presentations given and schools outreach.

6.2.1 Online Presence

Service Website

The service website facilitates engagement with potential content providers and targeted users. The Wordpress site is available at the URL provided at [eduOER].

The website provides useful information about the eduOER service. It includes service functionalities, background history of the project, news and updates, the partners involved, a list of repositories, technical information, and terms and conditions.
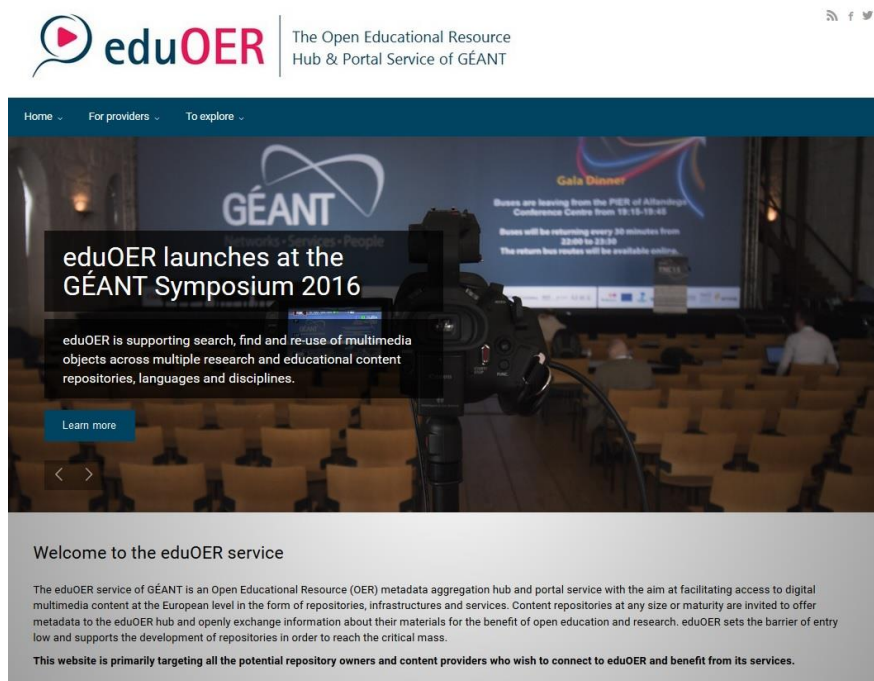
Figure 6.4: GÉANT eduOER service website

Wiki Page

A Wiki page is also available to store the up-to-date service documentation [eduOERWiki].

The Wiki page provides advanced technical information about the service. It includes information about the aggregation workflow, search API, OAI-PMH protocol, Application Profile and metadata integration.
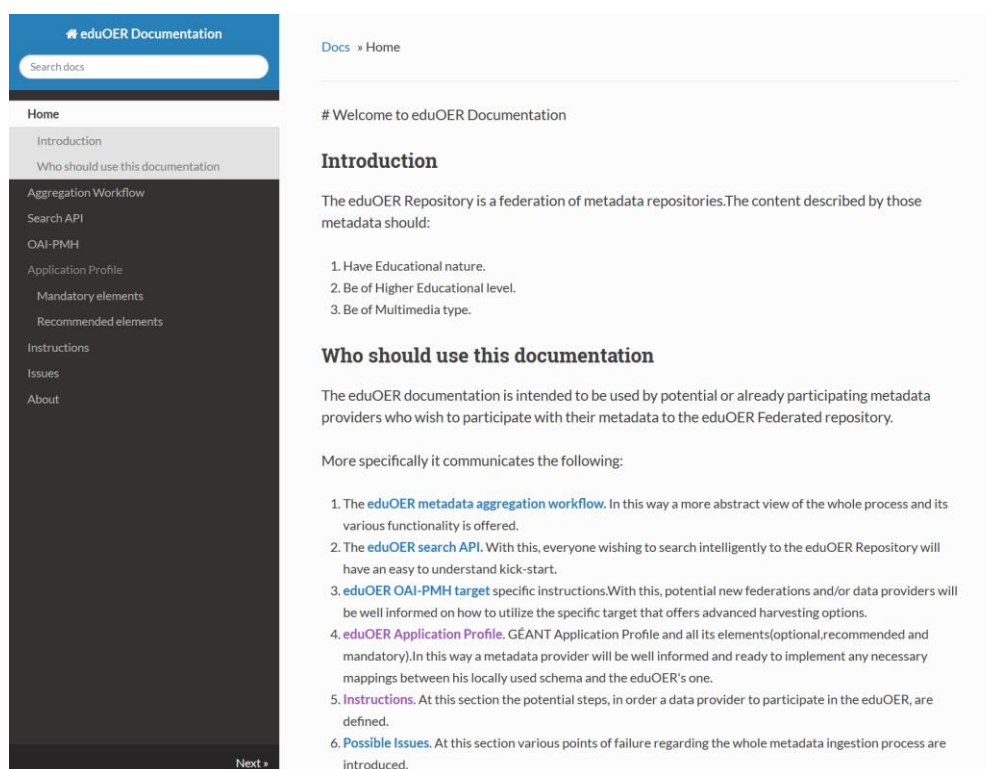
Figure 6.5: Wiki page for service documentations

End-User Portal

The end-user service portal is based on the open source PuMuKIT platform, developed by the University of Vigo. The portal is available at the URL provided at [eduOEREUSvcsMWP].

The eduOER portal provides access to multimedia educational resources from different countries, disciplines and languages. The portal works as an aggregator, allowing users to search and find multimedia educational resources from different repositories, for free.
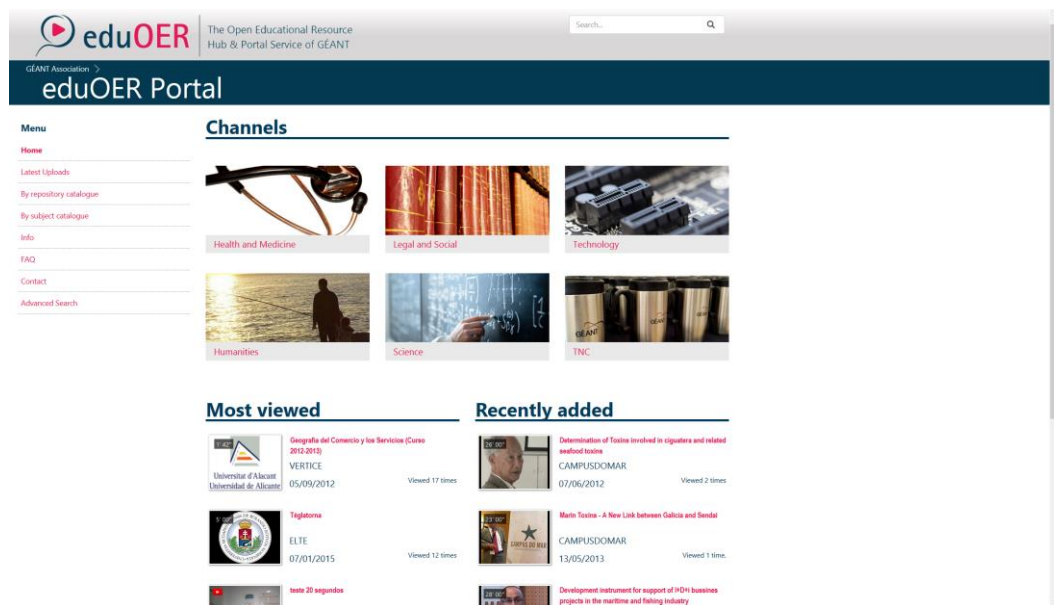
Figure 6.6: eduOER multimedia portal

GitHub

The Github space for feature requests and bug reports is available at the URL provided at [eduOERGitHub].
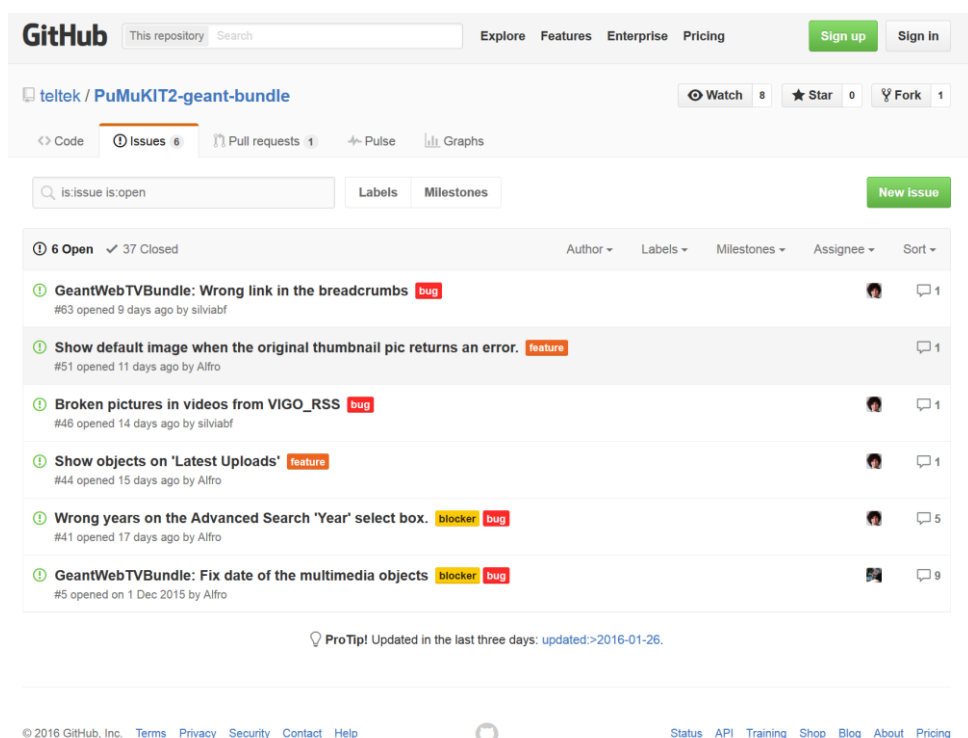
Figure 6.7: GitHub ticketing for bugs and features

6.2.2 Connected Repositories

The GÉANT eduOER service community is growing exponentially. The list of repositories successfully connected to the GÉANT eduOER hub can be seen on the live monitoring dashboard [eduOERDash].
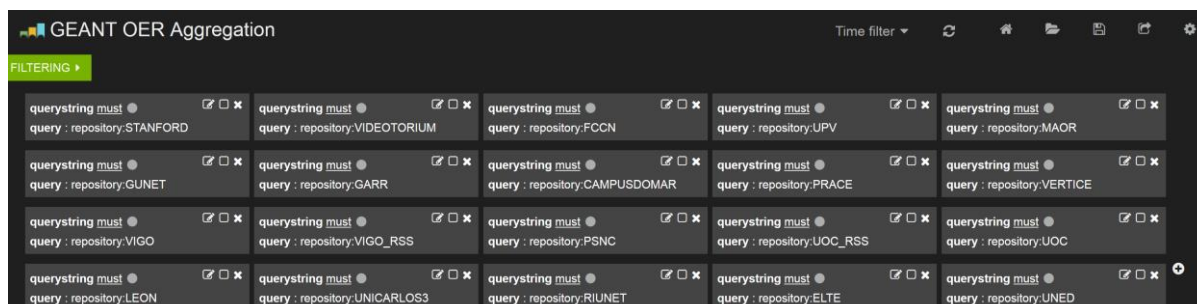
Figure 6.8: List of repositories connected to the eduOER hub (example)

Up to the publication date of this deliverable, 20 repositories are being harvested by GÉANT eduOER, collecting about 57,300 objects (OERs) in total. On the portal front-end, 16 repositories are displayed successfully (the other repositories are either missing some mandatory elements or some other technical problem has occurred). The list of repositories shown on the portal can be found at the URL provided at [eduOERReps].

6.2.3 Presentations and Other Outreach

Presentations

The following presentations have been given by the eduOER service development team during the course of the GN4-1 Project, or are planned to be given after its completion:

- Peter Szegedi: "NRENs for Open Education: GÉANT Open Educational Resource Hub and Portal", TNC'15 Conference, Lightning Talk, 15–18 June 2015, Porto, Portugal [PresTNC15]

- Peter Szegedi: "GÉANT Association NRENs for Campuses", RENATER JRES Conference, 8–11 December 2015, Montpelier, France [PresJRES]

- Ilias Hatzakis: "GÉANT eduOER service briefing and demonstration", GÉANT Symposium 2016, 8–9 March 2016, Vienna, Austria

- Eli Shmueli: "Education OER: a pan-European meta-data aggregator", OER16 Conference, 19–20 April 2016, Edinburgh, UK

- Peter Szegedi, Eli Shmueli: "GÉANT eduOER service", Intrenet2 Global Summit, 15–18 May 2016, Chicago, USA

- Kirsten Veelo, Alexander Blanc: "Learning to share – How do you share open educational resources?", TNC 2016, 13-16 June, 2016, Prague, Czech Republic

Schools Outreach by GARR

In Italy, GARR started to show the OER's possibilities during the structural development project GARR-X Progress, financed by the tender for the national Action and Cohesion Plan. Thanks to the project, GARR offered network connectivity to high schools using optical fibre and also proposed a training path dedicated to teachers. A remarkable number of schools in the south of Italy are now connected to GARR using 100 Mbps links and they can grow their teaching and learning capacity using the high potential offered by their fast network access. The OERs are a high-value resource for schools with a low budget. Enabled by a high-performance network, OERs can become an essential tool for teachers. During the course, GARR explained the main concept of Open, what Open Access is, what open educational resources are, and how to create a new one. The OERs are also a bridge between universities and Sshools. Now, thanks to the training, video lessons, proposed by universities, are used as a support tool in high-school teaching, to prepare students for their undergraduate studies. The GÉANT eduOER service will be a valuable resource that will enable the use of resources outside of the national borders. Italian schools that trust in the universities environment will use OERs also for European foreign language teaching.

The output related to this activity includes:

- "Intensive professional refresher course for APMs" [GARRAPMCourse]
- "How to use open educational resources in teaching [GARRTeaching]
- "Open educational resources: intensive course for Reggio Calabria" [GARROER]

7 Conclusions

The GÉANT eduOER service will be officially launched and first demonstrated to the broader GÉANT community at the GÉANT Symposium on 9 March 2016 in Vienna, Austria. The user feedback will be collected and analysed by the time of the final GN4-1 project review. To date, the main conclusions of the GN4-1 project SA8 T3 eduOER service development task are as follows:

eduOER addresses the main challenges of searching and finding good quality, properly licensed, openly accessible educational contents and learning objects – especially multimedia types – across repositories, countries, disciplines and languages.

The main benefits of eduOER are twofold. The primary benefits are realised by the repository owners and content providers that connect to the eduOER hub and exploit its back-end services. The secondary benefits are realised by the end-user communities of the connected repositories and also by those users who have no access to such repositories and usually search globally on the web.

- eduOER provides an open infrastructure hub for multimedia repository owners and administrators to make their content searchable, findable and exchangeable across silos. It saves them development and service integration time and effort, and enables repositories to enrich their content offerings as well as offer value-added services at a low cost via a simple interface (API) to eduOER.

- eduOER provides a metadata-rich, multimedia-optimised web portal for all users searching open research and educational content globally on the web. It provides better access to content that is hidden from web search engines – sitting in institutional repositories – and also provides interlinking and cross-pollination between objects that are in closed commercial service silos (e.g. links between educational videos stored in YouTube and iTunes channels).

eduOER is a service that is best operated and managed by GÉANT and the National Research and Education Network (NREN) organisations. NRENs are in a good position to develop and aggregate institutional multimedia repositories.

In order to realise the full benefits of the eduOER service and to make the expected impact on the primary service community (national and/or institutional content repositories run by NRENs and other organisations), the GÉANT eduOER development team recommends that the service be continuously maintained, operated and if possible developed further by the NREN community under the umbrella of the GÉANT collaboration.

Appendix A Subcontracting

Some specific technical parts of the GÉANT eduOER service development – mainly related to the front-end portal features – were subcontracted to the lead developer of the open source PuMuKIT web portal, the University of Vigo (UVigo), in accordance with the conditions below.

A.1   Summary of the Subcontracted Work

The main motivation for developing the OER metadata repository (European-level aggregation point or referatory) and an OER portal (federated single access web front-end) service is to support the NRENs and their stakeholders (i.e. the broader GÉANT community) in engaging with open education by providing value-added support services.

The GÉANT OER service intends to aggregate metadata (not the content) at the European level and helps universities and NRENs stepping to the next level (reaching critical mass, e.g. in terms of the number of objects) towards exposing their OER to global repositories.

The technical content of the Work is defined in Section A.2 below. The Contractor is responsible for ensuring that the Work delivered to the GÉANT Association contact person is of good technical quality.

All software components, their technical documentation, and appropriate licences must be provided.

All verbal communications and written documentation must be made in the English language.

A.2   Objectives

The Contractor will be responsible for supporting the transition of the current OER web portal's pilot instance from UVigo to a production-ready portal at GRNET. The Contractor must make sure that:

- All the software components of the portal and their licences (if applicable) are openly available to GRNET.

- The software dependencies are clearly specified, taking into account the technical specifications of the GRNET Cloud infrastructure host.

- Up to 8 hours of remote technical training on how to install, maintain, and expand the software are provided to GRNET, as appropriate.

GÉANT Association will make sure that GRNET provides all the technical information to the Contractor about the GRNET Cloud infrastructure that is necessary for successful transition and deployment.

The Contractor will be responsible for the migration of the OER web portal's pilot from the current implementation, based on PuMuKIT 1.7, to a production-ready new implementation based on PuMuKIT 2.1

The Contractor will be responsible for providing state-of-the-art second-line operations support for the OER web portal until the termination of this contract. This includes:

- The definition of the operations procedures and workflow.

- The appointment of contact persons with clear roles and responsibilities.

The Contractor will also remain responsible for maintaining a development instance of the OER web portal at UVigo's premises and perform the software development, deployment, integration and testing tasks as follows:

- The improvement of the faceted search feature.

- The technical investigation into an LMS integration module for the GÉANT OER service. This may technically be implemented by the Moodle plug-in (widget) of the PuMuKIT web portal, subject to decision of the Contractor.

The Contractor must provide a shared GitHub space accessible by the GÉANT Association and its appointed members for joint code development and tracking of records.

The Contractor will also contribute to the preparation and review of the technical documentation of the overall OER service with special attention to the user experience and media-accessing procedure of the web portal.

A.3 Contribution Commitments to the Project

The successful transition of the current OER web portal's pilot instance to the GRNET Cloud must happen by 30th of October, 2015. It must be proven to the GÉANT Association contact person that the portal is up and running in the public domain and the necessary procedures for the state-of the-art second-line operations support are established.

The final production portal, the working prototypes of the LMS integration module and the generic GÉANT OER plug-in to PuMuKIT-based web portals shall be successfully demonstrated to the GÉANT Association contact person by the 15th of April, 2016. Based on the technical review, potential platform integration components and smaller modifications (bug fixes) requested shall be implemented by the 30th of April 2016.

The main coordinator and leader of the Work described in this Appendix is Anxo Sanchez (UVigo) with the technical support of Vicente Goyanes (UVigo). The main responsibilities are:

- Organising and coordinating the Work with the potential contributors, including the GN4-1 project SA8 Task 3 partners.

- Delivering all software, written contribution and documentation to the GÉANT Association contact person and its appointed members by the deadlines defined in the table of deliverables [not included here].

- Functionality, stability and scalability testing with the connected LMS/portals and demonstration of the new software features.

A.4   Evaluation Criteria

The Work will be reviewed technically by selected GÉANT Association experts. The technical reviewers will examine the following properties:

- Technical quality of all written contributions.

- The stability of the software.

- The scalability of the software platform and the security of the code.

Based on the result of the technical review, the Contractor is responsible for implementing any requested changes properly.

Appendix B Initial Repositories

This is the list of repositories that joined eduOER in the pilot and development phase (before the actual service launch) for testing purposes. The latest list can be found at the URL provided at [eduOERRepsLatest].

Brief descriptions of repositories connected to eduOER are provided below:

Videotorium (NIIF) – Hungary [Videotorium]: multimedia sharing portal developed and maintained by the Hungarian NREN, NIIF Institute. Videotorium was launched in 2010 and its repository consists of more than 10 thousand recordings. The portal's goal is to serve the Hungarian and international research and education community by providing them with an easy-to-use interface for searching, sharing and storing their multimedia content. Videotorium has many benefits that common video-sharing portals don't. The recordings can be enriched with additional presentations, attached documents, and last but not least, a wide variety of metadata. Videotorium has an OAI-PMH interface for metadata exchange. The integration process needed some preparation of the communication interface, according to the prerequisites of the eduOER aggregation engine – mandatory LOM fields: keyword, video thumbnail; the URL for the LOM object should point to the multimedia content itself. After these modifications were done, the aggregation process was completed successfully.

Eötvös Loránd University's Digital Institutional Repository – Hungary [EDIT]: a repository for one of the biggest Hungarian universities, ELTE. It stores educational content, not only in video format (however, the eduOER service only accepts video content). The content management interface of the repository is generated by the e-learning system DSpace. The ELTE repository has an OAI-PMH interface for metadata exchange. The preparation for the integration process needed some addition to the exported metadata scheme (the URL elements point to the metadata, not the actual video content). Since then, the connection to the repository is up and running.

Epodrecrzniki.pl (PSNC) – Poland [Epod]: a modern open source educational MOOC platform and repository to create and share e-books and educational multimedia content, mainly for primary- and secondary-level education. The platform is managed by the Ministry of National Education of Poland, and developed and hosted by Poznan Supercomputing and Networking Centre (Poland). Most of the content in the repository is prepared by several universities in Poland. Epodrecrzniki.pl is the largest educational content repository in Poland. The number of page views of the platform website reaches several millions per day. All digital content included in e-books in the repository is available online under free licences. Apart from text content, the repository contains high-quality graphics, audio, video, interactive quizzes, and online applications. All the content is WCAG 2.0 compliant. Extended metadata schemas are used in the repository to semantically describe all educational materials. The

origin metadata has been mapped and transformed in order to be used in the eduOER service. The multimedia objects collected in Epodreczniki.pl are now available in the eduOER front-end portal.

PRACE (e-infrastructure) [PRACE]: the Partnership for Advanced Computing in Europe. It provides access to 6 leading-edge high-performance computing (HPC) systems (supercomputers) to researchers and scientists from academia and industry. The PRACE Advanced Training Centres (PATCs) produce high-quality training material dealing with high-performance computing; their metadata are now integrated into eduOER.

The National Distance Education University (UNED) – Spain [UNED]: has as its mission the public service of higher education through the means of distance education.

RiuNet – Spain [RiuNet]: the institutional repository of the Polytechnic University of Valencia (UPV), Spain. RiuNet is managed by the Library of the Polytechnic University, whose objective is to offer Internet access to the university's scientific, academic and corporate collections in order to increase their visibility and make them accessible and preservable. RiuNet reflects the commitment of the University within the framework of the Budapest Open Access Initiative, the Berlin Declaration on Open Access and the University's Institutional Policy on Open Access.

TNC (GÉANT) [TNC]: organised by GÉANT, "The Networking Conference" is the largest and most prestigious European research networking conference, with more than 700 participants attending this annual event. TNC brings together decision makers, managers, networking and collaboration specialists, and identity and access management experts from all major European networking and research organisations, universities, worldwide sister institutions, as well as industry representatives.

Open Academic Courses – Crete [OpenCourses]: a project of the University of Crete, Greece, implemented under the Operational Programme "Education and Lifelong Learning", co-financed by the European Social Fund. The project aims to develop open digital academic courses which will be available via the institutional platform to the students of the University of Crete and the general public.

Appendix C Service FAQs

These questions have been taken from the FAQs page of the eduOER portal [eduOERFAQ].

Q: What kind of content will I find at the eduOER front-end portal?
The eduOER front-end portal gives access to multimedia content (video lectures, webinars, conferences, multimedia, text, etc.) provided by various educational institutions and National Research and Education Networks (NRENs).

Q: Why eduOER?
NRENS advocate that simply providing open access to education systems is not sufficient. Instead, the FAIR (findable, accessible, interoperable, reusable) principle of content (the Data FAIRport initiative) is the appropriate way to address open education. That way, "federated access" to "openly licensed" educational content, in as rich a "searchable" way as possible, is the key to ensuring the full benefits of open education.

Q: Who is behind this effort?
The eduOER portal is supported by GÉANT, the leading collaboration on e-infrastructure and services for research and education, and has been created via the collaboration and sharing of knowledge between several NRENs. You can find more details about the participating organisations here.

Q: We represent a higher education multimedia content repository. How can we share/expose our content through the eduOER front-end portal?
Educational repositories and relevant content providers are invited to expose and share metadata (i.e. the information about the content) of their open educational resources via the eduOER Hub. The eduOER Hub is the back-end engine behind the eduOER web portal. It also provides value-added services to the connected repositories in order to discover, analyse, validate and enrich their metadata. You will find guidelines for participating here.

Q: What kind of services do you provide to content providers?
The eduOER service provides a large number of services to content providers such as metadata analytics, validation, mapping and transformation against selected application profiles, monitoring via dashboards, etc. You can find details here.

Q: Why OER by NRENS?
Many of the European NRENS are active in open education activities and have made a significant contribution to the deployment and availability of open digital technology and content. Apart from that, NRENS are in a privileged position to produce/provide infrastructure and develop/support new technologies, (e.g. search technologies, metadata harmonisation, federated access, portal creation). Additionally, NRENS are in a good position to spread the word about new methods of teaching/learning to academic/research institutions.

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[eduOER]	https://oer.geant.org/
[eduOERCPSvcs]	https://oer.geant.org/services-for-content-providers/
[eduOERCPSvcsMA]	http://services.oer.geant.org/MetadataAnalytics/faq.html
[eduOERDash]	http://services.oer.geant.org/monitoring/#/dashboard/ elasticsearch/GEANT%20OER%20Aggregation
	NB If this link gives a "webpage cannot be found" error, replace the "/20%-%20/" segment of the URL to "/#"in your browser address field.
[eduOEREUSvcs]	https://oer.geant.org/for-users/
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[Videotorium]	http://videotorium.hu
[XMLFilter]	https://github.com/vogias/XMLFilteringMechanism/wiki

Glossary

AAI	Authentication and Authorisation Infrastructure
AP	Application Profile
API	Application Programing Interface
CAPEX	Capital Expenditure
CBA	Cost-Benefit Analysis
CC	Creative Commons
CMS	Content Management System
CSV	Comma Separated Value
DC	Dublin Core
EC	European Commission
eduOER	GÉANT's pilot European Open Educational Resource portal service
ePIC	European Persistent Identifier Consortium
GLOBE	Global Learning Objects Brokering Exchange
HEI	Higher Education Institution
HPC	High-Performance Computing
ICT	Information and Communications Technology
IEEE	Institute of Electrical and Electronics Engineers
JSON	JavaScript Object Notation
KPI	Key Performance Indicator
LMS	Learning Management System
LO	Learning Object
LOM	Learning Object Metadata
LRE	Learning Resource Exchange
MOOC	Massive Open Online Course
NA	Networking Activity
NREN	National Research and Education Network
OE	Open Education
OER	Open Educational Resource
OAI-PMH	Open Archives Initiative – Protocol for Metadata Harvesting
OPEN	Open Professionals Education Network
OPEX	Operating Expenditure
PATC	PRACE Advanced Training Centre
PID	Persistent Identifier
PM	Project Month
R&E	Research and Education
RSS	Rich Site Summary

REST	Representational State Transfer
SA8	GN4-1 Service Activity 8, Real-Time Applications and Multimedia Management
SOAP	Simple Object Access Protocol
SPARQL	SPARQL Protocol and RDF Query Language
SPI	Simple Publishing Interface
SQI	Simple Query Interface
SWOT	Strengths, Weaknesses, Opportunities, Threats
T3	SA8 Task 3 Open Educational Resource (OER)
UI	User Interface
UPV	Polytechnic University of Valencia
URL	Uniform Resource Locator
UVigo	University of Vigo
VM	Virtual Machine
XML	eXtensible Markup Language
XSL	eXtensible Stylesheet Language
XSLT	Extensible Stylesheet Language Transformation