# Open Badge Network

**Proposal on Competency Alignment and Directory**

<table>
<thead>
<tr>
<th>Outcome 03-A2 – Competency Directory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Document information</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Declared due date of deliverable</td>
</tr>
<tr>
<td>Reviewed due date of deliverable</td>
</tr>
<tr>
<td>Actual submission date</td>
</tr>
<tr>
<td>Actual review completion date</td>
</tr>
<tr>
<td>Organisation name of lead contractor</td>
</tr>
<tr>
<td>Revision</td>
</tr>
<tr>
<td>Updated at:</td>
</tr>
<tr>
<td>Author</td>
</tr>
<tr>
<td>Johannes Konert</td>
</tr>
<tr>
<td>Reviewer</td>
</tr>
<tr>
<td>Tim Riches</td>
</tr>
</tbody>
</table>

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.
# Table of Contents

0 Aims and Objectives .................................................................................................................. 3  
   Executive summary ................................................................................................................ 3  
   Glossary .................................................................................................................................. 3  
   Terms used in this document ................................................................................................. 4  
Update notes (August 2016) ...................................................................................................... 4  

1 Requirement Analysis and Results .......................................................................................... 6  
   Desired Functionality ............................................................................................................. 6  
   Functionality out of scope of O2A3 ...................................................................................... 6  
   List of problems in alignment of OB to competencies ......................................................... 6  

2 Relevant related work ............................................................................................................... 7  
   Categorization of badges ...................................................................................................... 7  
   Competency Frameworks and Standardized Competencies ................................................ 7  
   Resolving ambiguity by semantic metadata ......................................................................... 8  
   Semantic definition of competency frameworks .................................................................. 9  

3 Proposed solution concept ...................................................................................................... 12  
   S1: extInLOC ......................................................................................................................... 13  
   S2: InLOC-Dir ....................................................................................................................... 14  
   S3. InLOC-App (optional) .................................................................................................... 14  

4 Implementation alternatives .................................................................................................... 14  
   S1: extInLOC Implementation ............................................................................................. 14  
   S2: InLOC-Directory Implementation .................................................................................. 16  
   S3: InLOC-Application (for Conversion of CFs to InLOC JSON-LD) Implementation .......... 16  
References .................................................................................................................................. 17
0 Aims and Objectives

The intellectual output O2A3 aims at:
Investigating and aggregating the desired functionality of Open Badges (OB) concerning their relation to (official) standardised Competency Frameworks (CF) (e.g. EQF aligned-ones like e-Competences)

This paper (as part of the output) aims to:
- Briefly discuss the alternative (technical) solutions
- Make a proposal (first draft) of how such a connection of OB to CF may look like conceptually
- Propose an implementation plan

Executive summary

This draft proposes an approach towards the technical interoperability of OpenBadges with unambiguous definitions of competencies based on semantic web meta-data (using the JSON-LD linked data format). The overall goal is to allow systems to detect similarity of defined badges and graph-based dependencies of the competencies linked to the OpenBadges. This could be achieved by using the unique IRI identifiers of JSON-LD defined competencies for the criteria and alignment fields in BadgeClasses (either directly or via an extension).

Based on the desired functionalities from the community the major problems to address were identified. Beside the resolving of ambiguities (mentioned above) to allow earners and displayers to display similarity of badges, find badges that amend each other or contain others, such a solution will also assist issuers in defining badges. For this use case a directory is proposed that is filled by the community and allows searching, updating and traversal of the graph-like structure of defined competencies (and competency frameworks) to use the JSON-LD format export to be used in OpenBadge definitions.

Finally, it can be stated that basically none of the manifold existing competency frameworks by now is available in a machine-readable semantic-web format (only ESCO has a XML download). Thus a strong recommendation exists to increase the effort in future projects that framework definitions must as well provide their results in a semantic format like RDF or JSON-LD. Based on this fact, the proposal suggests as well an end-user application as a third component. This application could assist in creating a JSON-LD conform format of existing competency frameworks that later on could be used in OpenBadges (and to be added to the directory).

Glossary

CF: Competency Framework. A scheme and logical structure of different competencies, e.g. with dimensions, levels and skill/knowledge examples aligned to them.
InLoc: Integrating Learning Outcomes and Competences. A semantic standard defined in the EU project InLOC
JSON: JavaScript Object Notation. An exchange format for hierarchical key:value data
JSON-LD: A JSON format specification especially for linked data (LD)
LD: Linked Data. A distributed approach to semantic web that allows machine readable resolving of ambiguities and meaningful (typed) links among semantic concepts
LO: Learning outcome. An observable individual’s action as example and indicator of the presence of one (or more) competencies
OB: Open Badge

Beside the glossary, each abbreviation is introduced at first occurrence with the full expression.

Terms used in this document

**Badge, Open Badge:** This document focuses on competence badges¹ (demonstration of knowledge, skills, competence) if not otherwise explicitly mentioned. Still, the approach is feasible for other open badge types likewise.

**Alignment:** Badges can be aligned to existing standards of which they represent a part of all of the learning outcomes, skills, knowledge, attitude (in general: competencies) defined there. The OB Standard v1.1 has the criteria-field and alignment-field of a BadgeClass². If generally writing about aligning badges to competencies both possibilities are meant, if not otherwise explicitly mentioned.

**Competency:** For the discussion and definitions in this document it seems suitable to reduce the concept of a competency to some measurable (observable) ability of an individual. Such a competency is evidenced by exemplary actions that indicate the presence of such a competency with an individual, and they can be called observable learning outcomes (LO). This document does not discuss several dimensions, interdependencies and measures based on skills and knowledge, but it is the aim to find a technical approach that allows representation of all different competency framework structures. Likewise, LO and competencies are seen quite interconnected and if this document writes of competencies to be represented technically, it includes the aligned learning outcomes as well, if not otherwise stated.

Update notes (August 2016)

Based on this reviewed proposal (first draft) the implementation was further discussed with experts from the Open Badge Network Europe and beyond, e.g. Nate Otto (Badge Alliance) and Simon Grant (Cetis LLP). The gained insights lead to several adaptations of the currently implemented prototype. These will be documented in detail in the second draft (due Nov 2016) and are briefly summarized here to keep readers up to date (not reviewed):

² [http://openbadgespec.org/#BadgeClass](http://openbadgespec.org/#BadgeClass)
1. Use schema.org format to express InLOC
   InLOC is a proper format to express competencies and their related learning outcomes, but it is unused and isolated. Several web companies like Mozilla and Google emphasize the use of schema.org to express semantic data and amend websites with these data to be better machine readable. Thus, our efforts concentrate on implementing the well-thought structure of the InLOC as schema.org extensions (only parts as proof-of-concept) and use the schema.org expressions as equal representatives of InLoc structures (and learning outcomes).

2. No extension to the Standard is needed for alignment and criteria
   The goal to let OpenBadges point to the competencies they refer to, can be achieved as well by using the existing fields. Thus, the existing AlignmentObjects point to human readable websites (HTML) as before, but these will be amended by machine readable semantic data. This embedded information can be parsed by machines. Several standards allow such embedding of micro-data, e.g. inline as HTML-Tag attributes or in the head of a document as JSON-LD embedded data. This micro-data can reference the schema.org extensions.

3. The competency repository component will crawl semantically correctly enriched websites
   Still, the majority of released competency frameworks exists in human readable formats like PDF or HTML-websites without semantic data added. For the prototype and second draft proposal we propose a schema.org extension as a way to amend such existing websites with micro-data that can be used/read by machines. Such a machine is part of the competency repository, called a crawler, that visits registered competency websites regularly and collects the embedded microdata and adds it to its own database. A proof-of-concept will be provided with our prototype. This said, Open Badge authors (creating a badge) need to copy and paste the URLs pointing to the competency definitions into their Open Badge AlignmentObject URL-field. Similarly, the URLs pointing to evidences/examples of competencies (learning outcomes) can be copied to be used in the criteria-field of Open Badge standard. The problem remains, that currently criteria-field only allows one URL (not a list as it is with alignment). In case several criteria-definitions need to be used in one badge (usually the case for learning related badges), this emphasizes the need to create either a standalone website that contains all criteria-information (and microdata with URLs pointing to their definitions) or otherwise extend the Open Badge standard with a new field that allows a list as it is with alignment. Such a new field of the standard could be called (learning) outcomes. We highly see the disadvantage of such a extension for the standard usage, but see as well the benefits to strengthen the use of Open Badges to express learning outcomes, competencies and thus be used in the educational and occupational contexts.

Overall, the intermediate conclusion is that the Open Badge standard does not need an extension to allow machine-readable alignment. The websites, where the existing standard-fields’ URLs point to, need to use (other) existing standards (like schema.org microdata) to express the alignment in a machine readable way.
1 Requirement Analysis and Results

All project partners were asked to contribute their input to the following questions:

a) Is there anything you think is of relevance from project history about competencies in open badges?
b) What requirements do you have for a support of competencies in open badges?
c) What do you think is definitely too much (or too complex) and should not be considered in our approach to connect OB to competencies?

The received answers from seven project partner employees and two external associated partners from OB community were qualitatively analysed, grouped and aggregated into requirement lists and non-desired functionality (listed below). From this list definitions of existing problems with OB and competency alignment are derived from which some are proposed to be addressed in future work in O2A3.

Desired Functionality

DF1. Computational detection of badges that relate to the same competencies (unambiguous)
DF2. Computational detection of alignments and similarity of competences between several existing CFs
DF3. Decentralized solution
DF4. Support for a community wide directory of competency frameworks (CF) to add, search and update existing CFs. Ability to export the found competencies to be used in OB directly
DF5. The alignment of OB to competencies remains optional (and backwards compatible)
DF6. Provide some standardized vocabulary (multi-language support)
DF7. Plugins for Learning Management Systems (LMS)/frontends to allow direct usage of competency catalogues (frameworks) on badge definition

Functionality out of scope of O2A3

NF1. Realize an unambiguous relation of OB to Credit Point Systems (CP) like ECVET
NF2. Create a centralized solution to host/list all possible competencies
NF3. Create a structure (e.g. taxonomy) to represent/suit all possible CFs into it
NF4. Abstract or translate existing CF defined competency IRIs into a new schema
NF5. Find a complete mapping to LRMI\(^5\) or xAPI\(^6\) or Schema.org eduAlignment\(^7\)

---

\(^3\) Formulation was slightly changed for report clarity

\(^4\) [http://openbadgenetwork.com/](http://openbadgenetwork.com/)

\(^5\) [http://lrmi.net/](http://lrmi.net/)

\(^6\) [http://experienceapi.com/](http://experienceapi.com/)

\(^7\) [http://schema.org/educationalAlignment](http://schema.org/educationalAlignment)
List of problems in alignment of OB to competencies

In relation to the defined use cases (O2A1) of badge issuers, earners and displayers (viewers, audience) the following problems emerge from the desired functionalities (DF*) and functionalities expected to be out of scope (NF*):

P1. An issuer wants to make clear which officially defined competencies are certified by the OB
P2. An earner wants to see for desired badges which competencies have to be evidenced to earn a badge
P3. An earner (or consumer) wants to compare badges, identify similar ones (or identical concerning the competencies aligned to it), or wants to identify badges he/she can apply for due to earlier earned badges that proof all needed competencies
P4. A displayer wants to calculate some weight/importance of badges based on competencies the badge is aligned to
P5. A displayer wants to aggregate badges and identify badges that summarize/contain all the competencies of a subset of other badges
P6. A displayer wants to display the similarity and overlapping of badges concerning aligned competencies

For the project outcome O2A3 the focus is on proposing solutions for P1 and P2 (bold in list) as it can be argued that a solution for resolving the ambiguities in aligning badges to competencies will also contribute to solutions for detecting similarity (P3, P5, P6). If possible the proposed solution will consider the information about competency level/grade and weight as well to support P4 solutions even though in NF1 it is clearly stated that an alignment to credit values is not a focus.

2 Relevant related work

Categorization of badges

To support earners as well as issuers to find out about existing badges, the OpenBadgeAlliance started an initiative to collect existing badges in a directory in 2015. If information about the alignment-field or criteria-field of BadgeClasses is compared, the directory could assist in finding similarity between badges. This is not yet part of the directory due to the free text format allowed in the mentioned badge fields.

Competency Frameworks and Standardized Competencies

The problem of comparability gains more and more attention in a globalized world where students and employees move across borders and need credit for their certificates, skills and knowledge or competencies gained somewhere else. Thus, for education and business sectors several specific

---

8 Named in alignment to the three activities EARN, ISSUE, and DISPLAY of Open Badges, http://openbadges.org/
9 https://badgealliance.github.io/openbadges-directory/
competency frameworks evolved and equality (or at least similarities) between some of them (but far from all) have been defined. Compare e.g. EQF\textsuperscript{10}, eCompetencies\textsuperscript{11}, ECVET\textsuperscript{12}, CGMA\textsuperscript{13}, UK CCCF\textsuperscript{14}, DCF\textsuperscript{15}, SUNY GLQF\textsuperscript{16}, ESCO\textsuperscript{17},Tuning Reference Points\textsuperscript{18}, DigiComp\textsuperscript{19}, ..

While the discussion is moving on whether or not one standardized framework (taxonomy) can be defined where all possible competencies of all educational sectors and businesses can be defined (see discussion of the OpenBadgeAlliance Taxonomies Working Group\textsuperscript{20}), it can be concluded that a OB alignment to competencies need to be flexible enough to support several CFs in parallel and even detect/support the cross-linkage between similar (or same) competencies from different CFs.

**Resolving ambiguity by semantic metadata**

Ever since the world wide web existed, mankind worked hard to define machine readable linked structures that are still manageable (and readable) by human beings at the same time (cf. Tim Berners-Lee talk about the next web and linked data\textsuperscript{21}). Standards like Standard Generalized Markup Language (SGML), the subset eXtensible Markup Language (XML), Resource Description Framework (RDF) and its derivative for web usage RDFa\textsuperscript{22}, Web Ontology Language (OWL) and recently JavaScript Object Notation Linked Data (JSON-LD\textsuperscript{23}) to name a few. The general problem is to find a balance between being too generic (and thus the concepts expressed by semantic annotation are too simple to be of use) and too specific (then the solution is not usable in manifold application fields).

The recent movement towards linked data (LD) with a distributed design (RDFa, JSON-LD) is based on unique resource identifiers (IRI\textsuperscript{24}). IRIs allow explicit unambiguous reference to a concept or instance defined in a different context (domain). As such it is easy to cross-reference meaning. Linked data is decentralized and in each namespace new concepts can be defined. Thus it is easy to create a vocabulary and a valid schema for one’s own scope. Still, with IRIs it is possible to reference concepts (and data) outside the own scope, e.g. by using standardized LD attributes like isSimilarTo\textsuperscript{25} or educationalAlignment\textsuperscript{26}.

\textsuperscript{10} https://ec.europa.eu/ploteus/en/compare  
\textsuperscript{11} http://www.esc.edu/suny-real/global-learning-qualifications-framework/  
\textsuperscript{12} http://www.ecvet-team.eu  
\textsuperscript{13} http://www.cgma.org/Resources/Tools/Pages/cgma-competency-framework.aspx  
\textsuperscript{14} https://www.gov.uk/government/publications/civil-service-competency-framework  
\textsuperscript{16} http://www.esc.edu/suny-real/global-learning-qualifications-framework/  
\textsuperscript{17} https://ec.europa.eu/esco/portal/home  
\textsuperscript{18} http://www.unideusto.org/tuningeu/  
\textsuperscript{19} https://ec.europa.eu/jrc/en/digcomp/governance  
\textsuperscript{20} http://etherpad.badgealliance.org/taxonomy-wg-10-8-2105  
\textsuperscript{21} https://www.ted.com/talks/tim_berners_lee_on_the_next_web?language=en  
\textsuperscript{22} http://rdfa.info/  
\textsuperscript{23} http://json-ld.org/  
\textsuperscript{24} Formerly only based on ASCII characters (URI), extended by international characters (IRI)  
\textsuperscript{25} https://schema.org/isSimilarTo  
\textsuperscript{26} https://schema.org/educationalAlignment
In summary, the linked data approach can be used to link OBs to competencies defined somewhere else. As RDFa is for augmentation of HTML by semantic means, JSON-LD is the suitable format for (computer) systems exchange and interoperability for linked data. Especially since OpenBadges are committed to JSON-LD support since version 1.1 (released May 2015).

Semantic definition of competency frameworks

The remaining problem is a machine readable and web exchangeable version of the (manifold) competency frameworks mentioned above. After intensive research none of the frameworks was found to be exportable in a OWL, RDF or JSON-LD format. Thus, to the best of our knowledge no such solution exists yet. Still, efforts towards such solutions exist. In example, the ESCO CF offers a machine-readable download in XML or CSV. Is can be argued that computational use of competency frameworks to compare qualification certificates like diplomas, work experience, recommendation letters and OpenBadges would be of much benefit for the interoperability of educational, occupational, voluntary work systems in Europe.

The problem of ambiguities in terms, keywords, tags and their relation is addressed by the SOKOS Simple Knowledge Organization System (SOKOS), a RDF standard of the W3C Semantic Web Working Group. SOKOS allows the standardized semantic linkage of terms, e.g. in thesauri or folksonomies. It’s applicability to the competency alignment problem is of less value as it does not explicitly distinguish evidences (LO) and their links to competencies.

In the project InLOC ELM 2.0: Integrating Learning Outcomes and Competences, from the ICT Standardisation Work Programme of the European Commission’s DG Enterprise and Industry, the problem of semantic meta-data for learning outcomes and competencies was addressed. With Integrating Learning outcomes and competencies (InLOC) the project committee released a European standard which is able to express all existing CFs in a semantic and machine readable form. They provide suggestions on representations in XML, RDF and more recently in JSON-LD.

InLOC provides several examples on how to apply InLOC to CFs. The EU CF eCompetence Framework 2.0 for occupations in ICT contains five responsibility areas (PLAN; BUILD; RUN; ENABLE; MANAGE), each with several dimensions. One dimension (3) defines the competency levels while another (4) defines the knowledge and skill examples for a specific competency.

---

27 http://openbadgespec.org/
28 https://ec.europa.eu/esco/portal/download/, the website states to allow RDF download as well, but could not be found. Instead an API is offered to access ESCO as linked-data (see https://ec.europa.eu/esco/portal/escopedia/ESCO_API)
29 https://www.w3.org/2004/02/skos/
30 https://www.w3.org/TR/2009/REC-skos-reference-20090818/#L879
31 http://www.cetis.org.uk/inloc/Home
Figure 1: e-Competency Framework mapping to InLOC concepts

Figure 1 illustrates the mapping of a part of it (competency A.2) to InLOC definitions (red), InLOC associations (orange), and InLOC structure (yellow). Basically the structure is most of the time one (full) document to be mapped to InLOC. Figure 2 illustrates the InLOC associations (relations) resulting from the table as a graph. InLOC has as well a defined multi-language support which allows translations of text-labels and descriptions of LO or competencies. For details refer to the source.

Source: http://www.cetis.org.uk/inloc/attachments/A-2_LOCrels.png

http://www.cetis.org.uk/inloc/InLOC%2bexplained%2bthrough%2bexample#InLOCexplainedthroughexample-ThenedistinctionbetweendefinitionsandstructuresofLOCs
While InLoc has its strength in the semantic definition with more specific constructs than a pure RDF triple, it lacks an implementation. A much smaller, but more recent project, is conducted by University of

---

35 Source: http://www.cetis.org.uk/inloc/attachments/e-CF.png
Potsdam. Based in the Neo4j GraphDB they created an implementation that is a RDF compatible competency database. Currently the project heads towards implementing similarity detection based on language processing. While the text based approach can be criticised, it is definitely a good assisting approach to help humans in defining competency similarities (e.g. made explicit with InLOC semantics). Moreover, the project implementation of a working server infrastructure with REST conform interfaces may be a valid base for the anticipated competency directory of the OBN O3A2 (see below).

3 Proposed solution concept
To address the problems P1 and P2 of clarifying which officially stated competencies a badge is aligned to, may be addressed by three separate solutions.

S1. extInLOC: Extension for OpenBadge Standard v1.1 to support linked data for competencies (InLOC)
S2. InLOC-Dir: Community directory for InLOC JSON-LD defined competency frameworks
S3. InLOC-App: Assisting (web) application (or service) to create a InLOC JSON-LD representation of existing competency frameworks

The three solutions use the JSON-LD based InLOC format as exchange format (or a similar semantic one). If other formats become popular, it is possible (with reasonable effort) to write adapters that convert from this format to InLOC and vice versa, as InLOC proved to be e.g. RDF-compliant and one format (JSON-LD) can be converted to the other (RDF) and thus to upcoming semantic formats, too. Possibilities for implementation are discussed in the next section. First, a brief description of the three solution components and their interoperability is given.
S1: extInLOC

The extension will not corrupt the existing OpenBadge standard, i.e. existing parsers and systems will work continuously even with the extended JSON-LD conform OB data (but will probably ignore this additional information). The extension is expected to allow

- BadgeClass:criteria\(^{39}\)
- AlignmentObject:url\(^{40}\) (as used in BadgeClass:alignment[])

...to point to InLOC representations of learning outcomes (criteria) or competencies (AlignmentObject). Because InLOC data can still contain a description, title, and an IRI to a (better human readable) source, OB displayer can still offer links to more information for humans. Whether or not the same elements are used in both fields is not the scope/issue of the extension and up to the issuer (and community). By such a link to

\(^{39}\) http://openbadgespec.org/#BadgeClass

\(^{40}\) http://openbadgespec.org/#Alignment
unambiguous IRIs, competencies algorithms can detect overlapping and identical badge definitions based on InLOC (ignoring any titles and descriptions for comparison).

**S2: InLOC-Dir**

The directory is strongly inspired by the OpenBadgeDirectory\(^{41}\). It will allow registration of InLOC schema IRIs by community members. The directory can then based on the InLOC starting point crawl all connected InLOC definitions by itself and add them to the index. The directory can update the definitions by re-crawling the IRIs to stay up to date. Users of the (web) frontend of the directory will have the ability to search for entries by e.g. text similarity, issuer, popularity, similarity, competency level, prerequisites..etc. An essential feature of the directory is the direct export of InLOC JSON-LD format to be used in the extInLOC extension field(s) for OBs.

**S3. InLOC-App (optional)**

The application (app) will assist issuers and/or competency framework providers to define existing CFs in InLOC format. The assistant will allow a graphical setting of (object) definitions and associations. Whether or not the application itself allows storage of the result under a public available IRI or offers download to publish the file(s) on one’s own IRI seems to be of equal practice. Such an application (or several of it) are expected to be optional for the scope of the project as our main goal is the proposal of a structural solution. For a proof of concept such an app is not absolutely necessary.

### 4 Implementation alternatives

**S1: extInLOC Implementation**

<table>
<thead>
<tr>
<th>Proposal A: use existing URL fields</th>
<th>Proposal B: create OB extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>The OpenBadge Standard expects in BadgeClass:criteria one URL and in AlignmentObject:url one URL. It is possible to point within criteria to one URL to an InLOC JSON-LD definition of a InLOC structure defining all learning outcomes needed for this OB. Likewise BadgeClass:alignment contains an array [] of AlignmentObjects. Each of these AlignmentObjects can relate in its url-property to an InLOC JSON-LD definition of a InLOC structure containing the reference to existing defined</td>
<td>The OpenBadge standard v 1.1 defines a possibility to create extensions(^{42}). The AlignmentObjects are not (yet) JSON-LD compatible, thus not extendable. The extension would thus extend BadgeClass with properties for InLOCcriteria and InLOCAlignment. Both properties will contain an IRI or directly and InLOC JSON-LD document (object) which defines the schema that references the needed competencies.</td>
</tr>
</tbody>
</table>

\(^{41}\) https://badgealliance.github.io/openbadges-directory/

\(^{42}\) http://openbadgespec.org/extensions/
<table>
<thead>
<tr>
<th>competencies (as well defined in InLOC JSON-LD).</th>
</tr>
</thead>
</table>

**Advantage of B:** existing URLs in the fields BadgeClass:criteria or AlignmentObject:url can still be offered as links for human beings (for further information) while the InLOC extension data is used for processing. Additionally, the difference of the format for criteria (one URL) and alignment (array of objects) will be removed and both extension fields will use the same format.

**Drawback of B:** existing parser systems that by now use the existing fields URL for similarity calculation cannot benefit from the unambiguous IRIs as these are used in (new unknown) property fields.
S2: InLOC-Directory Implementation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The OpenSource MediaWiki(^{43}) can be used to allow all community-members to create pages and sub-structures to document existing CFs and competency/LO definitions. The representation as InLOC JSON-LD are added as links to the IRIs.</td>
<td>The existing GitHub project code for OpenBadgeDirectory(^{44}) is released unter MLP 2.0 licence. The code could be forked, adapted to list and crawl InLOC JSON-LD entries instead of badges.</td>
<td>Based on modern SingleWebApplication frameworks and components (node.js, hapi.js, AngularJS, REACT, ..) a REST API could be developed that allows several clients to add and request the directory. A web-fronted could offer search (and graph traversal) features suitable for InLOC data.</td>
</tr>
</tbody>
</table>

**Advantage:** lowest implementation effort, open for any further requirements/directory structures  
**Drawback:** missing auto-update of data, no easy filter and search functions beyond text-matching

**Advantage:** basic features already exist, both projects might benefit from future code improvements  
**Drawback:** Code structure might not suit needs for graph-based data structure of InLOC. (and is more implementation effort)

**Advantage:** most elaborate solution approach with an independent API to be used by further systems, least overhead as no code is written for other purposes  
**Drawback:** most effort to code and maintain

S3: InLOC-Application (for Conversion of CFs to InLOC JSON-LD) Implementation

<table>
<thead>
<tr>
<th>Proposal A: web-based application with direct hosting</th>
<th>Proposal B: ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>For node.js there exists a module for JSON-LD parsing (and creation). This can be used to write a more restrictive module that only creates (and validates) InLOC JSON-LD format. A web-fronted could be created responsive to be usable with mobile clients as well, even though it is expected that most users will be desktop-based as definition of a competency structure in InLOC will require a lot of copy&amp;paste as well as definition of objects (&amp;properties).</td>
<td>(to be defined)</td>
</tr>
</tbody>
</table>

**Advantages:** An assisting application with a graphical interface is expected to strongly support the acceptance and spread of InLOC for competency definition, not only for OpenBadges, but as well all

---

\(^{43}\) https://www.mediawiki.org/  
\(^{44}\) https://github.com/badgealliance/openbadges-directory
| other systems that need competency definitions without ambiguities for machine based processing. **Drawbacks:** The effort for a generic InLOC definition assistant is not to underestimate and appears to be far beyond the scope of the projects O2A3 scope. |

**References**

References are made directly in the text as footnotes. Due to the novelty of the issue no scientific publications concerning the cited standard and systems were found. Last access date is in all cases the date of submission mentioned in the document header, if not otherwise stated.