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Comparing Learning Management Systems for Corporate Environment

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Description <p>The company was planning an implementation of a Learning Management System (LMS) to start using e-learning more widely. E-learning had previously been used a few times to roll out compliance trainings to the whole staff but those had been separate, outsourced projects. Two learning management systems were selected for comparison; Moodle, which is open source and one of the world's most widely used LMSs, and TotaraLMS, which is a Moodle-based distribution that has been developed especially corporate use in mind. The company IT department required the system to be able to support federated authentication using SAML, Security Assertion Markup Language.</p> <p>Test installations of both systems were set up on the same Linux server with their own sub domains. A solution using Moodle SAML Authentication plugin that could be implemented on both systems for the required federated authentication was investigated and later implemented on a production system. The integration to other company systems, , like Active Directory and Human Resources systems, for importing organization and user data and to export different reports were investigated and tested with test csv files. The course and user management features of the systems were tested and compared. Also customizing the visual appearance of the systems to present a consistent corporate image was tested. Additionally some e-learning content creation tools were tested to find an easy to use tool to facilitate the creation of e-learning content within the company</p> <p>TotaraLMS offers many features that are useful for a corporate LMS but even with them integration to other company systems requires proper attention. If the integrations are not done the full benefits of the system are not reached and Moodle could be a more suitable solution for basic e-learning.</p>		
Keywords (subjects) e-learning, Learning Management System (LMS), Moodle, TotaraLMS, learning technology, digital learning material		
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Tiivistelmä <p>Yritys oli suunnittelemassa oppimisympäristön käyttöönottoa hyödyntääkseen verkko-oppimista. Aiemmin verkkokursseja oli käytetty muutamia kertoja koko henkilöstölle suunnattujen vaatimustenmukaisuuskoulutusten toteuttamiseen ulkopuolisten toteuttamina projekteina. Kaksi oppimisympäristöä valittiin vertailtaviksi: Moodle, joka on vapaan lähdekoodin ohjelmisto ja yksi maailman käytetyimpiä oppimisympäristöjä, sekä TotaraLMS, joka on Moodleen pohjautuva, yrityskäyttöön muokattu jakelu. Yrityksen IT-osaston vaatimuksena oli, että järjestelmä tukee federoitua autentikaatiota ja SAML:a (Security Assertion Markup Language).</p> <p>Testijärjestelmät molemmista oppimisympäristöistä asennettiin samalle Linux-palvelimelle. Moodlen SAML Authentication lisäosaa käyttävään pääsynhallintaratkaisuun perehdyttiin molemmissa järjestelmissä ja se toteutettiin myöhemmin tuotantopalvelimelle. Tietojen tuomista ja takaisin raportointia testattiin testitiedostoilla muihin yrityksen tietojärjestelmiin, kuten Active Directory ja henkilöstöhallinnan järjestelmät, liittämisen määrittämiseksi. Kurssien ja käyttäjien hallintaominaisuuksia vertailtiin ja testattiin. Järjestelmien visuaalisen ulkoasun muokkaamista teemoilla testattiin yhtenäisen yritysilmeen saavuttamiseksi. Lisäksi testattiin verkko-oppimateriaalin sisällöntuotantoon tarkoitettuja työkaluja sisäisen sisällöntuotannon edistämiseksi yrityksessä.</p> <p>TotaraLMS tarjoaa paljon ominaisuuksia, jotka ovat hyödyllisiä yrityskäytössä olevassa oppimisympäristössä, mutta siitä huolimatta integraatio yrityksen muihin järjestelmiin vaatii huomiota. Mikäli integraatioita ei luoda, jää osa järjestelmän eduista hyödyntämättä, ja Moodle voisi olla parempi valinta yksinkertaiseen verkko-oppimiseen.</p>		
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Index of Abbreviations

ADFS	Active Directory Federation Services, a software component for federated single-sign-on in Windows Server.
Cron	A job scheduler in Unix-like operating systems used to automate system maintenance and administration tasks.
CSV	Comma Separated Values, a plain text file type to store tabular data and used in data exchange between systems.
LMS	Learning Management System, a system used in delivering e-learning.
LTI	Learning Tools Interoperability, an e-learning standard.
SAML	Security Assertion Markup Language, an xml-based standard for exchanging authentication and authorization data in federated authentication.
SCO	Sharable Content Object, a learning content module in SCORM.
SCORM	Sharable Content Object Reference Model, an e-learning standard.
SSO	Single sign-on.
xAPI	Experience API, an e-learning standard.

1 Introduction

Landis+Gyr is the global industry leader in energy measurement solutions for utilities in electricity, gas, heat/cold and water metering. The company was established in 1896 in Switzerland to produce high quality, state-of-the-art electricity meters and by 1924 it had overseas offices in New York and Melbourne. The first electronic meters came into market in early 1980's and in the late 1990's and early 2000's, along the development of communication technology and information technology, the industry has developed from stand-alone meters read periodically on-site into connected metering networks including smart meters, various communication methods and metering systems. During the first decade of 2000, Landis+Gyr, Hunt Technologies and Cellnet Technologies from the United States of America and Enermet from Finland were acquired by an Australian investment company, Bayard Capital, and aggregated under the Landis+Gyr name. In 2011, Landis+Gyr was acquired by the Toshiba Corporation and continues as an independent growth platform within Toshiba.

In modern business training both employees and customers is often critical to a company's success. Training at Landis+Gyr has historically focused on delivering technical trainings to staff and customers through traditional instructor-led training (ILT). Although ILT is an effective and adaptive training approach it also has some downsides. Most importantly access to it is not available as widely or often as necessary because availability is limited by the trainer and training location and staff/customer travelling resources. Scheduling trainings with primary duties of both staff and customers is also a limiter. E-learning can help to cover the gap in training need and access. Training approach is also not an either or choice and ideally e-learning will fit seamlessly with other training methods (traditional & blended) in the company's training selection. The company has previously used e-learning to roll out a few compliance trainings for the whole staff. These were acquired from external service providers as single projects and not a part of a wider e-learning strategy.

Wild & al. list four phases of e-learning implementation: organizational readiness, identifying the content, designing presentation and implementation. The first phase evaluates the organization's readiness and identifies the required investment to adopt e-learning. It includes evaluating the knowledge management practices and tools in the company, organizational culture and employee attitudes and technological infrastructure. The second phase is identifying the strategic knowledge requirements of the company, which can be factual, product related knowledge or more tacit knowledge about processes, best practices etc. The third phase is designing the presentation of e-learning, so it fulfills the characteristics of effective online learning. The fourth phase is the actual implementation of a learning management system and producing learning content for it. (Wild, Griggs, Downing 2002, 374-378.)

This work focuses on the e-learning processes to fit them to the company's needs and documenting the e-learning environment for future development and maintenance. The comparison of Learning Management Systems (LMS) focuses on the features of the systems and their suitability to corporate use. There is always some required customization work when implementing a new system and whether it can be performed in-house or if it requires external resources is key knowledge in planning an implementation project. Two systems are chosen for comparison but an overview of what an LMS is and different types of LMS's available are included for background. In addition some learning content production tools are introduced and evaluated to go with the LMS.

Even though the focus of this work is on the technical implementation it is only half of the real life work. The ultimate goal of effective, engaging learning experience should not be forgotten.

2 Learning Management Systems and E-learning

2.1 Definition and Benefits of E-learning

In this thesis e-learning is used to refer to training using electronic media and information and communication technologies. It is the most inclusive term of the set of possible terms, other terms used could be multimedia learning, web-based training, computer-based training, online education or virtual education. Each of these terms emphasizes some aspect associated with modern, technologically enhanced learning as opposed to instructor-led training (ILT) in a traditional classroom setting but between these opposite ends there is a whole spectrum of blended learning situations. The characteristics of traditional learning and e-learning may differ but the goal is the same as can be seen in Table 1 (Wild et al. 2002, 376.).

Table 1. Characteristics of traditional learning and e-learning

Characteristics of traditional learning	Characteristics of online learning
Engage learners fully	E-learning should be interactive
Promote the development of cognitive skills	E-learning should provide the means for repetition and practice
Use learners' previous experience and existing knowledge	E-learning should provide a selection of presentation styles
Use problems as the stimulus for learning	E-learning content should be relevant and practical
Provide learning activities that encourage cooperation among team members	Information shared through e-learning should be accurate and appropriate

The benefits of e-learning compared to traditional learning come from easier scheduling, more efficient use of resources and the possibility to personalize training material to different needs. This translates to financial benefits in corporate context as “just-in-time learning” (Wild et al. 2002, 373.).

2.2 E-learning Standards

E-learning standard development started with military and aviation industry to help produce platform independent, consistent and reusable training material. Their main aim is to protect and increase the return of investment on e-learning (Making Sense of Learning Specifications and Standards, 2002, 7). Thus many of the e-learning standards are technical and deal with the interoperability and reuse between learning objects and LMSs, not with pedagogical aspects or the quality of the learning content. A common concept in the learning standards however is the learning object; a self-standing, discrete piece of instructional content that meets a learning objective (Making Sense of Learning Specifications and Standards, 2002, 24). It is used as a building block to create larger wholes for learning.

Sharable Content Object Reference Model (SCORM) was developed together with United State's Department of Defence Advanced Distributed Learning (ADL), the Institute of Electrical and Electronics Engineers (IEEE), the Aviation Industry CBT (Computer-based Training) Committee (AICC), the IMS Global Learning Consortium, Inc., and the Alliance of Remote Instructional Authoring & Distribution Networks for Europe (ARIADNE). It was one of the first attempts at standardizing e-learning, its first version was published in 2001. It has gone through further development cycles and evolved into the Experience API (xAPI) which was released in 2013. The reception of SCORM versions has varied, for example Moodle supports SCORM 1.2 but never implemented SCORM 2004. The xAPI implementations are still in early stages. In SCORM a learning object is referred to as a SCO, Sharable Content Object. (Sharable Content Object Reference Model (SCORM) 1.2 Specification, 2001.)

Learning Tools Interoperability (LTI) is developed by the IMS Global Learning Consortium and its version 1.0 was published in 2010 and the most recent version is 1.2 from 2015. Members of the IMS Global Learning Consortium include academic institutions, departments of education, LMS vendors and development communities, learning content producers etc. Figure 1 illustrates how LTI is used to integrate remote tools and content to LMSs. LMS takes the role of Tool Consumer, while the source of the remote

resource is known as Tool Provider. (IMS Learning Tools Interoperability (LTI) Implementation Guide, 2014).

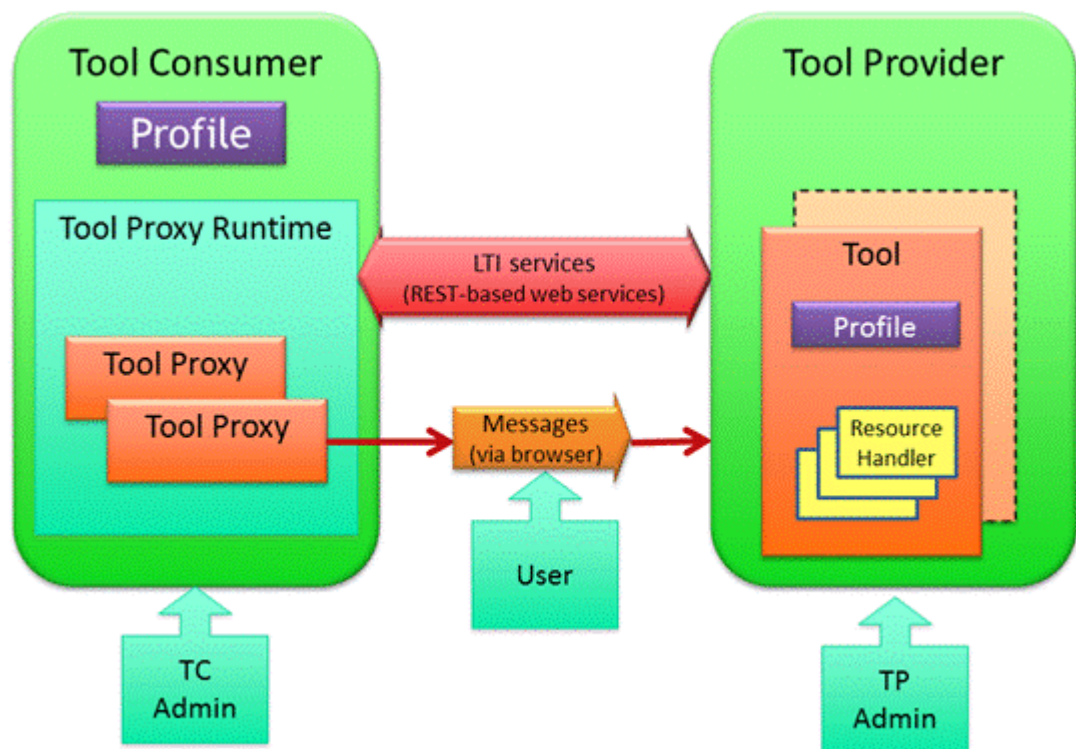


Figure 1. Overview of Learning tools Interoperability

As useful as standards are in enhancing the interoperability and reusability of learning content between different systems, they are still no guarantee of the quality or effectiveness of learning achieved by adhering to specifications and standards (Making Sense of Learning Specifications and Standards, 2002, 24).

2.3 Learning Management Systems

A Learning Management System (LMS) is used to manage and facilitate different aspects associated with learning: content, teachers, learners, records and the relationships between these. Learning Management Systems can be used with different types of learning approaches, from e-learning to ILT or blended. A LMS typically includes content management features for storing and delivering learning content as courses or learning modules to learners and various collaborative features like discussion boards to connect learners with teachers and other learners. Additionally it has tracking and reporting functionalities for maintaining records of learning achievements. LMSs may also contain integrated tools for creating learning content but usually learning content is created using external tools.

A term used generally as a synonym of learning management system is Virtual Learning Environment (VLE). However, a distinction can be made between the terms at least in the context of corporate learning management tools where VLE is seen as a platform for the actual learning while LMS is a wider concept around competence and talent management (Insights into Corporate Moodle 2012, 6). A corporate LMS extends beyond delivering learning content and managing students and courses; it includes learning plans and compliance and certification programs within the company.

Learning Management Systems can be categorized in different ways, the most obvious being the division to open source or proprietary tools. Many LMSs can be used in both academic and corporate contexts but most can be divided also by which context they are primarily designed for. Moodle for example is an open source LMS mostly used in academic contexts. While Moodle is also used in corporate contexts, custom distributions, like TotaraLMS and Paradiso, have been developed based on it especially corporate use in mind.

Whether open source or proprietary, academic or corporate, traditional LMSs are independent systems with possibly some level of integration to

other systems. An interesting approach to building LMSs functionality using Enterprise Portals is presented by Järvelä, Kareinen, Pötry and Fobugwe (2012). Instead of setting up a dedicated LMS they investigated ways of extending Liferay, an open source Enterprise Portal, to include LMS functionality. This provides a higher level of integration between e-learning and other corporate processes. SharePoint LMS takes the same approach using proprietary technology widely used in corporate contexts (SharePoint LMS, 2014.). Also Human Capital Management (HCM) systems like Success Factors often incorporate learning management system functionality.

2.4 Content Production Tools

Learning management systems do not generally include extensive content creation functionalities but accept many different kinds of content from pdf files and videos to SCORM packages. Adobe Flash has traditionally been the go-to technology for rich web content. However, Flash is no longer supported on a growing number of mobile devices. At the same time our expectations for rich web content is ever increasing. HTML5 is gaining ground as an alternative to Flash.

For many experts who act as the content producers in a corporate environment effectively exploiting technology in their teaching requires overcoming a number of technical barriers. Finding an easy to use content production tool for content creators and publishers who are not web/multimedia experts is not easy but important in facilitating content creation.

Content creation in a global company also poses many challenges in localizing content in multiple languages. The management of localization workflow with external localization company, review and finalization of localized content should be efficient.

3 Comparison of Moodle and TotaraLMS

Moodle is one of the world's most used LMS because it is available freely and has plenty of functionalities which can also be extended with plugins.

According to Momani (2010) Moodle is perceived as high value in education community as it is designed with both pedagogy and technology in mind.

Beside using the plugins available in the Moodle Plugins directory, custom plugins can be developed to fulfil the organizations need, like the archiving plugin Hatakka (2010) describes. However, tailoring the system to a specific use requires time and expertise or alternatively money.

Even if the software itself is open source, maintaining and customizing it is not and in the end it may be more cost efficient to buy a commercial product with support. As Stewart & al. points out the costs of implementing an LMS for e-learning is not limited to the licensing fees for the system and hardware and software cost necessary for running it but the costs from integrating to other systems, ongoing support and training users must be considered too (Stewart, Briton, Gismondi, Heller, Kennepohl, McGreal, Nelson, 2007, 1-2). Because of this corporate oriented variants like TotaraLMS and Paradiso LMSs with extended functionality and professional support have been developed based on Moodle.

Out of the two commercial distributions, TotaraLMS offers the TotaraLMS Seedlings as a free community edition for testing and development so it was selected to be compared to Moodle for Landis+Gyr use. Test servers in Moodle and TotaraLMS were set up on the same Linux server, with their own subdomains.

3.1 Installation and Maintenance

3.1.1 Installation Requirements and Version Dependencies

In appendix 3 the installation requirements of Moodle and TotaraLMS are listed for comparison. The basic server requirements of Moodle and TotaraLMS are the same. However, differences may be present because current TotaraLMS version is usually based on a slightly older version of Moodle than the latest. TotaraLMS is a Moodle based distribution and so it is also dependent on Moodle's versions. Currently Moodle is at version 2.9.2 and that is used in the Moodle installation in this work. As Figure 2 shows the TotaraLMS installation used in this work and its version information, the latest TotaraLMS Seedlings version is 2.7.0 which is based on Moodle 2.7.3. Repackaging and adding TotaraLMS specific functionalities means that TotaraLMS is always a bit behind the latest Moodle version.

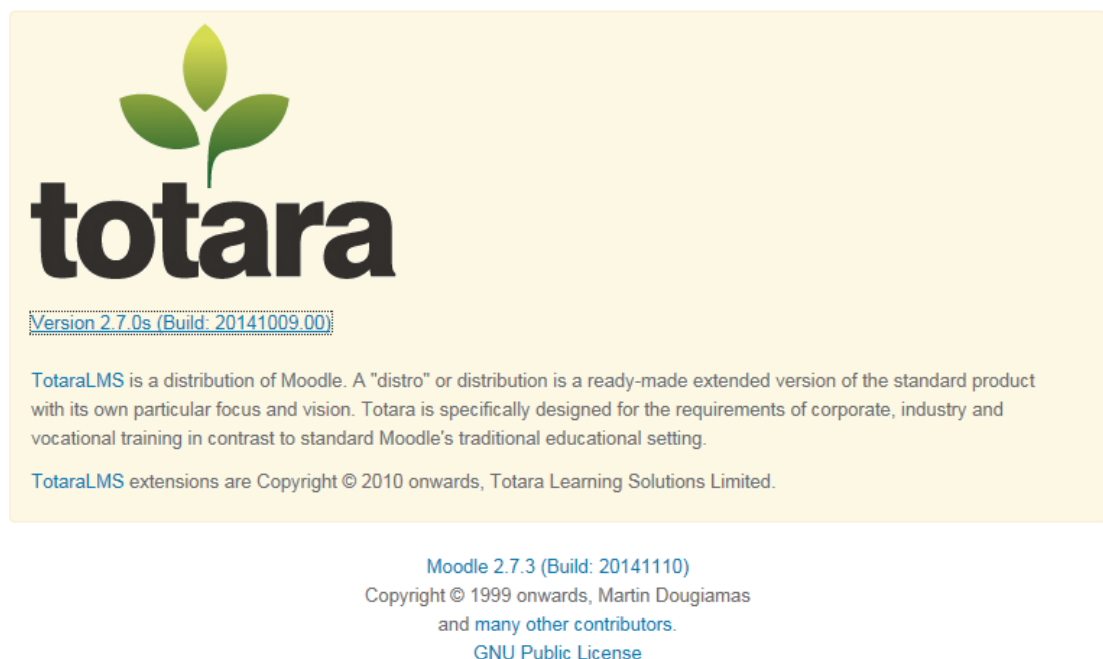


Figure 2. Version information on a TotaraLMS installation.

The hardware requirements depend on the expected amount of concurrent users. Concurrent users in this context means web server processes in memory at the same time and not simply logged in users. According to Moodle documentation a minimum of 256 MB memory is required and Moodle should be able to support 10 to 20 concurrent users for each 1 GB of RAM.

TotaraLMS documentation lists 4 GB as a recommendation for a site with 10 000 users of which 500 are expected to be concurrent. Both Moodle and TotaraLMS require storage minimum of 160 MB for the system core and additional storage for uploaded materials and backups. (Moodle documentation, 2015; TotaraLMS documentation, 2015.)

3.1.2 Installation Process

Installation procedure in both Moodle and TotaraLMS is the same.

1. Prepare the server. Make sure for example that the server is properly configured with the correct locales so that date, number and currency data is displayed correctly for each language.
2. Create directories on your server for www files.
3. Configure the domain used for your LMS from the wwwroot directory.
4. Copy the LMS installation package into the wwwroot directory and unpack it.
5. Create an empty database using the UTF8 character set and create a non-root database user with write access to the database.
6. Using your web browser, visit your domain to start the installation process. Here you specify which database the installation will use and also create an admin user account for the LMS. The installation script populates the database and creates the configuration file, config.php (Büchner, 2011, 19).
7. Set up a cron task to execute the file admin/cli/cron.php periodically e.g. every 1 minute. If the cron task is not set up, any timed LMS features will not work ((Büchner, 2011, 26).
8. Set the required PHP variables.

After the installation, the admin user can login into the site. The server environment check that is performed during installation process can be viewed afterwards in Site administration -> Server -> Environment. In the Server menu are also the Server Scheduled Tasks that are run when cron is executed.

3.1.3 Backups and Updates

Backup of a Moodle/TotaraLMS site consists of three parts:

- database
- uploaded data (moodledata/sitedata)
- system code.

Database and uploaded files change most so updates are important to be kept up to data. The system code is changed less often but backups are important especially if any customizations have been done to modify the code so that these are not lost in later upgrades. Regular weekly and daily server backups are outside the scope of this paper.

3.2 Configuration and Customization

3.2.1 *Integration to Other Systems*

Integration to other corporate systems is often a key issue when implementing new systems. In this area are the biggest differences between Moodle and TotaraLMS.

Organizational structures like positions, organizations, competencies and goals can be defined in TotaraLMS. While some of these organizational structures can be added to Moodle through plugins but not all.

Organizational structures can further be used to include people in different audiences or assign them different learning paths automatically and cutting the manual labor of LMS administration and trainers. These can also be managed manually but for large, global organization integration with HR systems or Active Directory would be more logical provided the hierarchies are already present in these corporate systems. For this the TotaraLMS Sync function can be used to build a direct integration to an external database or the information can be imported in csv files.

The organization csv import was tested with the example file in Appendix 4. The previously manually created organizations under main organization framework “Landis+Gyr” can be seen in Figure 3.

Landis+Gyr

Bulk actions

Name

> EMEA
Type: Region

> Finland
Type: Country

> Switzerland
Type: Country

> APAC
Type: Region

> Americas
Type: Region

> Global R&D
Type: Department

Figure 3. Manually created organization structure in TotaraLMS

The test file was manually created and uploaded to test the import functionality. The csv file field names can be customized if source system uses different field names than TotaraLMS. First, the organization import must be first enabled in TotaraLMS sync > Elements > Organization and configured which actions (add, delete, update) are allowed. Figure 4 shows the csv file uploaded and ready to be synchronized and Figure 5 a successful synchronization.

Element	Source	Configure source
Organisation	CSV	Source has configuration

Figure 4. CSV has been uploaded and ready to be synched in TotaraLMS

✓ Running totara_sync cron...Done!
View the results in the Sync Log [here](#)

Element	Source	Configure source
Organisation	CSV	Source has configuration

Run Sync

Figure 5. A successful organization synch in TotaraLMS

In organization structure after synchronizations in Figure 6 we can see that Canada has been added under the Americas region.

Landis+Gyr

Search Landis+Gyr

Bulk actions

Name

- › EMEA
Type: Region
- › Finland
Type: Country
- › Switzerland
Type: Country
- › APAC
Type: Region
- › Americas
Type: Region
 - › Canada
Type: Region
- › Global R&D
Type: Department
- › Landis+Gyr

Figure 6. Organization structure after running the organization synch in TotaraLMS

Organizational positions and users can be imported similarly. The positions of manager, developer, test engineer and project manager were imported by the file in Appendix 5 for testing this. After the positions were in place

users were imported by the file in Appendix 6 with basic user information like username, first and last name and also the organization and position.

There is also a possibility to map the import file field names to the field names used by TotaraLMS if it is not possible to configure those to match when generating file. Also the format of the uploaded file (separator and character set) can be configured in the element definitions from the default used for organization upload.

3.2.2 User Authentication

Moodle and TotaraLMS both have several external authentication options using for example LDAP, CAS, Shibboleth or Radius servers. Accounts and passwords can also be manually created by administration or users through email-based self-registration and stored in the LMS's own database. However, the Landis+Gyr IT defines that external authentication is done using SAML (Security Assertion Markup Language) and within the company network the single-sign-on is handled with Active Directory Federation Services (ADFS).

SAML enables organizations to set up federated authentication relationships (called Relying Party Trusts in ADFS) to use shared resources, for example extranet or LMS. It requires a directory service like Active Directory to maintain the user accounts and related information. SAML can be used to connect also different directory types than ADFS as for example Shibboleth also supports is. The figure in Appendix 1 shows the principle of federated authentication between organizations. When a user tries to access a Service Provider's system, the system contacts the Identity Provider with a SAML message to authenticate the user and access is granted if the response is correct. It shows how internal users also go through ADFS to access shared resources in the protected DMZ.

There is no direct support for SAML and ADFS in Moodle or TotaraLMS but a SAML authentication plugin is available. When SAML/ADFS authentication or some other external authentication method is used the user's passwords are never stored in the LMS database but an account is created to store course information, grades etc.

Initially three different user types were identified:

- internal users
- external users within federated organizations
- other external users.

Two of these groups, internal users and external users within federated organizations, can be handled with SAML and federated authentication services. For the third group, other external users, an alternative must be provided and it mostly depends on how large the group is estimated to be, whether it can be handled manually or if other options must be provided. Later the target of the project was changed so that the e-learning was to be offered only to internal users in the first phase. All Landis+Gyr internal users have an account in Active Directory so SAML with AD FS is used.

Once federation relationships are set up, users can use shared resources without creating new accounts. Figure 7 from Scavo (2011) illustrates the steps of the SAML authentication process that has three actors: Service provider (SP), Identity provider (IdP) and user.

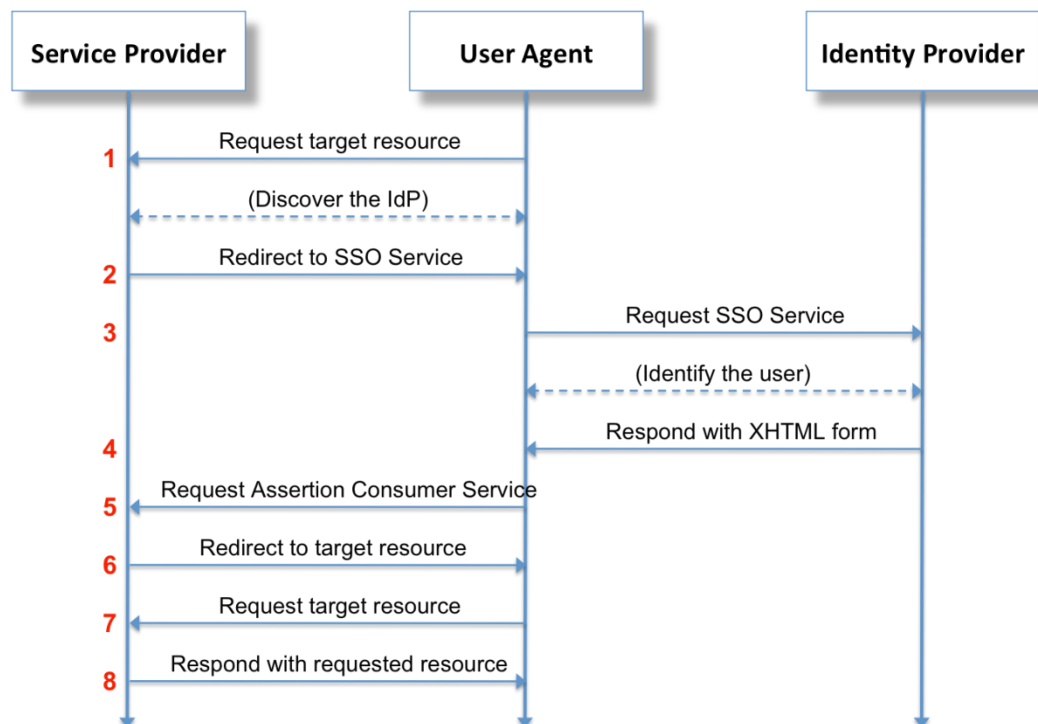


Figure 7. SAML SSO authentication phases

Implementing the SAML authentication on Moodle and TotaraLMS can be done with the SAML Authentication plugin that can be downloaded from the Moodle plugin repository. In addition the simpleSAMLphp must be installed on the server.

SimpleSAMLphp requirements

SimpleSAMLphp can be used for creating a SAML Service Provider or an Identity Provider. In this case it is used to create the Service provider and the company AD FS acts as the Identity Provider in the SAML exchange.

The simpleSAMLphp requires:

- PHP version 5.3.0 or newer
- Support for at least the following PHP extensions:
 - Always required: date, dom, hash, libxml, openssl, pcre, SPL, zlib, mcrypt
 - When authenticating against LDAP server: ldap
 - When authenticating against RADIUS server: radius
 - When saving session information to memcache-server: memcache
 - When using database:
 - Always: PDO
 - Database driver: (mysql, pgsql, ...)

SimpleSAMLphp installation is described in Appendix 8.

SAML Authentication plugin configuration

Once simpleSAMLphp is ready the SAML Authentication plugin must be configured in the LMS. Here the location of the simpleSAMLphp library and other variables are set and also the information passed in the SAML message can be mapped to the LMS user profile fields.

3.2.3 Theme Customizations

Moodle has a wide range of free themes for modifying its visuals. Also custom templates can be designed and purchased. Themes in TotaraLMS are built on the same basic structures as Moodle, for example TotaraLMS by default includes the bootstrap_base and Base themes that are included also in Moodle. However, since TotaraLMS includes some functionality not existing in Moodle, thorough testing is needed if using a theme designed originally for Moodle. There are also plenty of commercial theme designing and customization services available. The default themes in both Moodle and TotaraLMS offer the possibility to use a custom logo and change some colors but both are relatively limited for presenting a custom corporate branding image.

After testing different themes in Moodle, Essential theme was selected as the theme for further testing in Moodle. Essential is clean and has a wide range of customizable options and the desired level of corporate branding could be achieved without external resources.

Essential theme is also based on the responsive Bootstrap framework which is built to work in the latest desktop and mobile browsers (Bootstrap framework, 2015). Older browsers should also still display fully functional, even if differently styled, rendering of the site. Themes can be selected separately for default, legacy, mobile and tablet devices. However, when tested Essential worked well on most devices as a default theme, so alternatives were not required. Although mobile usage and accessibility are not first order requirements for the site, both should be easily supported with a Bootstrap based theme.

Themes in Moodle and TotaraLMS can have dependencies on other themes, which mean that both need to be installed for the depending theme to work. For example the Moodle default theme Clean depends on the bootstrap_base theme and the More theme requires the Clean theme. These dependencies can be checked on the plugins overview page in site administration. Dependencies are also checked when updating plugins, a separate validation

page with required downloads is displayed before installing updates and plugins.

TotaraLMS includes functionality built for it specifically that does not exist in Moodle and this affects the functioning of themes designed for Moodle in TotaraLMS. Even though it was possible to install the Essential theme on TotaraLMS, it did not function with features specific to TotaraLMS. For example in Figure 8 it can be seen that adding a rule to a dynamic audience is not functional. In Figure 9 the same audience rule dialog is shown in the default TotaraLMS theme.

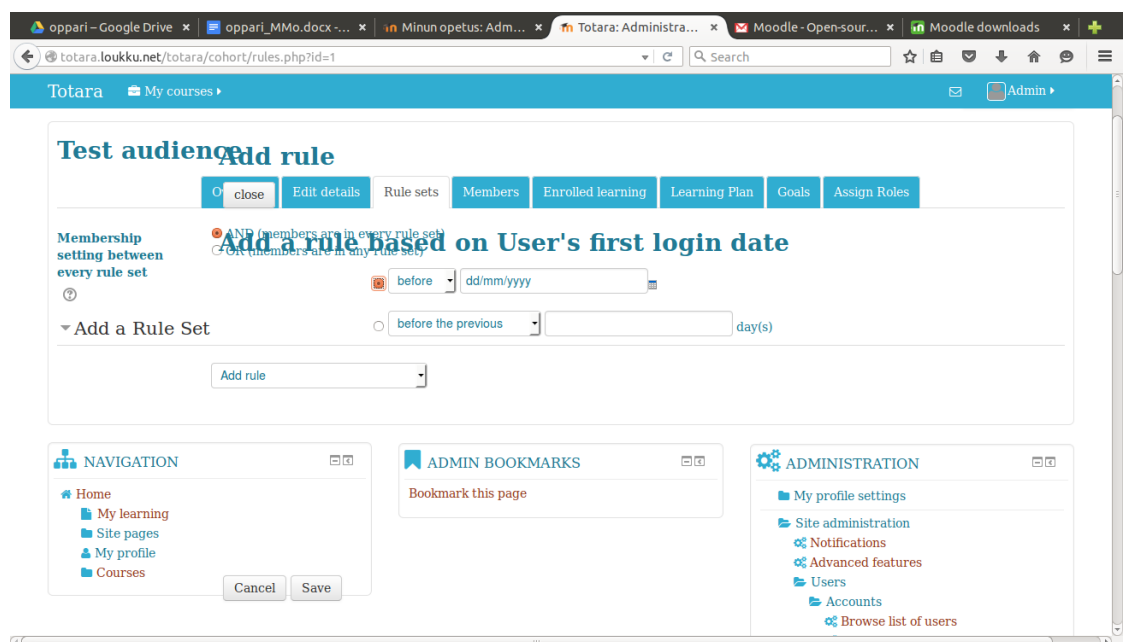


Figure 8. Non functional display of a TotaraLMS dialog in Essential theme.

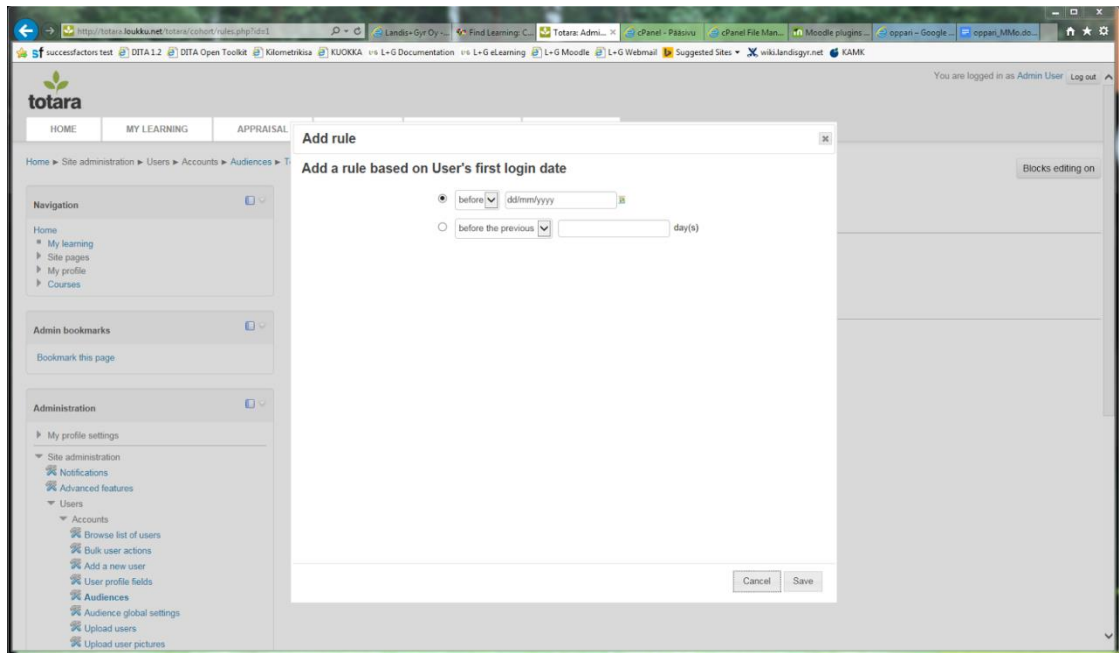


Figure 9. The same TotaraLMS dialog in default theme for comparison.

Testing another theme, Squared, designed for Moodle on TotaraLMS ran into problems already when installing the theme. The Squared theme depends on the Canvas theme that is included by default in Moodle, but has been removed from TotaraLMS and has not been tested with it. Canvas appears to be a depreciated theme and is no longer available for example in the Moodle plugin repository. In theory the Canvas theme could be installed manually to fulfill the Squared theme's dependence but it must be checked for its own dependencies on other themes and the base LMS version. Figure 10 shows a screenshot showing a required dependency on installing the Squared theme on TotaraLMS from Moodle plugin database.

This page displays plugins that may require your attention during the upgrade. Highlighted items include new plugins that are about to be installed, updated plugins that are about to be upgraded and any missing plugins. Additional plugins are highlighted if there is an available update for them. It is recommended that you check whether there are more recent versions of plugins available and update their source code before continuing with this Moodle upgrade.

Number of plugins requiring your attention: 1

[Display the full list of installed plugins](#)

Plugin name	Directory	Source	Current version	New version	Requires	Status
Themes						
squared	/theme/squared	Additional		2015011400	<ul style="list-style-type: none"> Moodle 2014041100 theme_canvas (2013050100) theme_base (2013050100) 	To be installed

[Reload](#)

[Upgrade Moodle database now](#)

Figure 10. Plugin check and required dependencies in TotaraLMS

The best option for TotaraLMS would be a custom theme made for TotaraLMS if the desired corporate branding cannot be achieved with the default TotaraLMS theme. The additional costs of purchasing a commercial TotaraLMS theme is easily spent in internal resources if a Moodle theme is thoroughly tested and customized for TotaraLMS.

3.3. Operation and Administration

3.3.1 User Management

In Moodle groups of learners can be organized as cohorts, which can also be used to enroll learners to courses. Typically, in a school context, students on the same level, e.g. fifth graders, would be defined as a cohort. Cohorts in Moodle are static groupings of users and users can be added manually or uploaded in a csv file. Cohort can be used to enroll its members to a course all at once.

Totara has audiences instead of cohorts. The difference is more than terminology as audiences have several features that separate them from cohorts. Audiences can be dynamic or set. For set audiences the members are selected manually and stay in the group until they are removed from it manually. A set audience could be created for example for the admin users of the system as there should not be too many to manage manually. Dynamic groups on the other hand have rules that define who is added to the group and users stay in the audience only as long as they fulfill the rules. Audiences are refreshed when the cron process runs on the server, typically every few minutes. Dynamic audiences can be based for example on the user's position or the completion status of a course. So for example if a user changes position within the company, they can be automatically added to an audience with course aimed for that position.

The dynamic audiences were tested by creating test audiences with different rulesets; these are seen in Figure 11. First an audience for a “Code of Conduct Training” was set up, with a rule that all users that have not completed the training are members.

Audience Name	ID	No. of Members	Type
Sales representatives	AUD0003	2	Dynamic
Code of Conduct Training Audience	AUD0004	11	Dynamic

Figure 11. Test audiences in TotaraLMS

Figure 12 shows the rule set which only has one rule. Rule sets can include multiple rules, like for the audience “Sales Representatives” in Figure 13. This rule set is based on both the position of user and the completion status of the program “Consumer products”.

▼ Ruleset #1

Membership setting between each rule in this rule set

- AND (members are in every rule set)
 OR (members are in any rule set)

User has not completed any of the courses in this list: "Code of Conduct Training" 🗑️ ✎ 🚫

Figure 12. Rule for Code of Conduct Training Audience

▼ Ruleset #1

Membership setting between each rule in this rule set

- AND (members are in every rule set)
 OR (members are in any rule set)

User has not completed any of the programs in this list: "Consumer products" 🗑️ ✎ 🚫

AND User's position name contains "Sales Representative" ✎ 🚫

Figure 13. Rule set for “Sales Representatives” audience in TotaraLMS

Audiences can be used to automate different user related actions in the LMS together with the course management features. In a large international organization with thousands of employees the manual workload would otherwise be considerable.

3.3.2 Course Management

There are significant differences in course management between Moodle and TotaraLMS.

In both courses can be grouped into hierarchical categories and course enrolment can be done manually by the administrator and self-enrolment by

the user. In addition Moodle has the cohort synchronization enrolment method and TotaraLMS audience based enrolments.

Three main course enrolment cases were identified:

1. compulsory courses for all staff (compliance trainings)
2. general courses open to all but not mandatory
3. courses directed to a specific group.

Self-enrolment would be suitable for courses that are open to all but not mandatory. Compliance trainings and other compulsory trainings could be handled in Moodle with cohort synchronization after a cohort with all the employees has been created manually. The TotaraLMS audience based enrolment could be used to handle both courses compulsory to all and courses for a specific group by creating dynamic audiences to select the users based on their position, course completion records etc.

For course management TotaraLMS also offers the possibility to set the visibility of categories based on audience and so filtering the course offering visible to the user. With Moodle there is no possibility to limit the visibility of categories by cohort or other user grouping.

Courses in TotaraLMS can also be organized in programs which consist of multiple courses or course sets. The program parts can be mandatory or alternative to each other and also course sets can have multiple courses with either all or one of the courses required to be completed.

The Course Metalink plugin metacourses can be used in Moodle to create bundles of courses that learners can be enrolled to all at once like the example in Appendix 2 shows. With additional plugin Meta-course group synchronization, learners enrolled through metacourses can also be grouped in the target courses separately if desired. The same courses can also still be enrolled to as single courses. It is not however possible to set the order of the courses or whether each of them is mandatory or optional.

In the example from TotaraLMS in Figure 14 there are two programs, one for “Consumer products” and one for “Industrial products”.

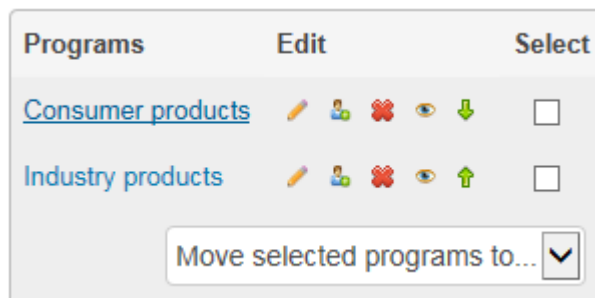


Figure 14. Test programs in TotaraLMS

Looking at the “Consumer products” program content in Figure 15, it has two course sets where the first one is required for all and for the second the learner can choose an area, in this case a product, for more in depth subjects. For example this could be used to set up a sales training for Sales representatives and allow them to select the product they are specializing in.

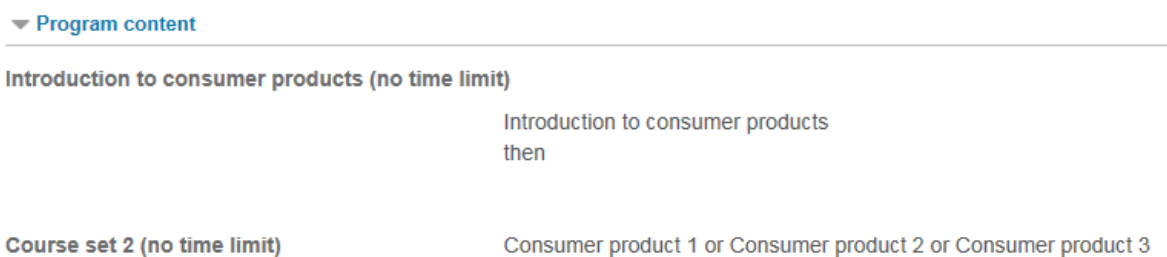


Figure 15. Contents of the “Consumer products” program in TotaraLMS

The program can also be assigned to users in the LMS based on organizational details like position or manager or by audience. This means that a person changing positions in the company can be automatically assigned to a program of courses based on dynamic criteria, automating course enrolment. In Figure 16 the example case shows how the audience “Sales representatives” is assigned to the program “Consumer products”. Once the program is assigned it shows in the users “Required learning” in the “My learning” page and the actual enrolment to the courses included in it happens when the user clicks “Launch course”.

Program assignments

Assign learners on-mass and set fixed or relative completion criteria
(Assign learners by organisation, position, audience, hierarchy or individual)


Audiences			
Audience name	Type	Complete	# learners
Sales representatives 	Dynamic	Set completion	2
Add audiences to program			
			Total: 2

Figure 16. Example program assignment in TotaraLMS

3.3.3 Reporting

Both Moodle and TotaraLMS have site and course level reporting functions but there are differences in the extent of those. Site reports in both Moodle and TotaraLMS mostly deal with site configuration, performance and activity logs. TotaraLMS includes quite a few reports by default that are used embedded in the system itself and these can be further customized. Additional user generated custom reports can be created by default in TotaraLMS while for Moodle that requires the addition of a plugin.

Creating a custom report in TotaraLMS

Custom reports are created in Site administration > Reports > Report builder > Manage Reports.

After the custom report is created it will show in the “My Reports” page of the users that are given rights to it. They can either view it by clicking open the report page or they can schedule it. The scheduling runs the report at specified times (daily, weekly or monthly) and the user can also specify in which format it is saved. By default the scheduled report is emailed to the user who created the schedule. If “Export to file system” has been enabled in the system the user can also choose whether they want the report to be emailed, saved to the folder or both.

Custom reports from TotaraLMS can be used to synchronize information to other systems just like Totara Synch can be used to import information from other systems. A custom report can be scheduled to be generated to a server folder which is accessible by sftp. Appendix 7 shows an example of a custom report for export to for example HR system on the completion of compliance training.

The report export folder in TotaraLMS is defined in the Reports -> Report builder -> General settings page. By default the “Export to file system” is disabled and a path to the folder which the file is written to is empty. Also the server settings must allow sftp access to the export folder.

3.3.4 Content Production Tools

Two content production tools were evaluated as a part of the project: Xerte Online Toolkit (XOT) and H5P. These are not integrated to Moodle LMS but are installed on a content server and available as web based tools.

Previously the learning materials for instructor-led trainings have been mostly PowerPoint presentations and also some training manuals with exercises. E-learning creates new requirements for the learning content as it is presented independently and not in the traditional training situation with interaction between trainers and learners. The advanced metering business is also highly technical and fast developing so the company employees need a lot a training to keep up with the developments of the field. On the other hand there is also a lot of expertise in the company and how to utilize that expertise is a major concern.

To facilitate learning content production by internal experts the chosen content production tools should have a low learning curve, as the users are not content production experts, and be easy to access. For this reason online tools were selected that would be available in the company network on a browser and would not require installation of client software on user’s computers.

The selected tools both produce HTML5 compliant content and Xerte also SCORM. For H5P xAPI and LTI support is planned but not available yet. However, standards compliance was not seen as a necessary requirement for the tools since the content was going to be used in internal trainings. Localization functionality of the tools was also considered when comparing, although internal trainings are mostly conducted in English. Easy export and import of localizable content would be a big benefit in a tool later when e-learning is introduced to customer trainings as they are required in multiple languages, for example software products and customer documentation is currently published in six languages in addition to English at Landis+Gyr. Neither of the tested systems offered advanced localization support meaning that each new language package would have to be created manually creating extra workload in the future. The localizations are planned to be handled outside the content creation tool, based on the storyboard created when planning the e-learning course. Figure 17 shows the e-learning content creation process including the possible localization phase.

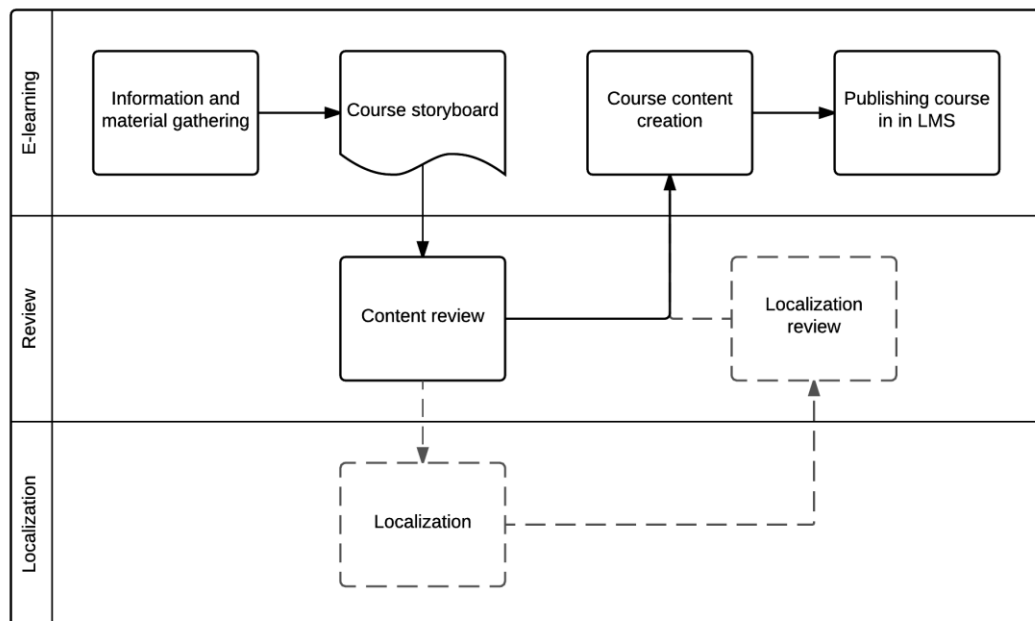


Figure 17. E-learning content creation process

Xerte Online Toolkits v2.0 is a suite of browser-based tools for creating interactive learning materials quickly and easily. Content can be delivered

to all devices using standards compliant HTML5 and a responsive template can deliver material to both small screens and large desktop computers. Xerte Toolkits is free software, released under the GNU Public License. Content is assembled using a web interface, and multiple users can collaborate on shared projects, making it possible to combine subject matter experts, media specialists and interactive designers in a content production team. Xerte project was originally started at the University of Nottingham and moved to the Apereo Foundation in 2014. (Xerte Online Toolkit, 2015.)

H5P project was created to fulfil the needs of the Norwegian National Digital Learning Arena (NDLA) in 2012 and continues as a MIT licensed community driven project. H5P is not a standalone tool and it requires a suitable platform to operate. Currently it is supported in Drupal and Wordpress. Also Moodle plugins for H5P are being developed and they would make it possible to add content creation functionality directly into Moodle and TotaraLMS. H5P provides different content types for creating online presentations and interactive learning materials on a web interface. Support for the xAPI and LTI standards in H5P is planned. (H5P, 2015.)

H5P was chosen as the content production tool because of an easy learning curve and active development. The content production server is currently set up with Drupal as the content management system and repository for the created content and installed with H5P plugin. The created content is presented in the LMS as embedded objects.

4 Discussion

The choice of a corporate LMS between Moodle and TotaraLMS depends on the desired level of functionality in the LMS. Moodle includes all basic functionalities for running e-learning courses as long as no integration to other corporate systems is required. TotaraLMS offers a lot more possibilities to integrate the LMS to other corporate systems and to automate data synchronization. Still, the open source Moodle offers the possibility to customize and extend the systems with plugins and to also develop custom plugins for exactly the needs within a corporation but it adds an extra phase to the implementation of the system.

The size of the company is also a factor in deciding between the compared systems. With about 5500 employees worldwide at Landis+Gyr the management of users manually would create significant workload and not make much sense. Authentication and SSO can be implemented on both systems with SAML/ADFS that was required by the company IT department. This means users can login into the system with their regular company user credentials directly and there is no need to manage user accounts manually or for users to create a new account for the LMS. TotaraLMS makes it also possible to automate course enrolments and other user tasks with dynamic audiences based on organizational structures, course completion and other criteria.

The support available to a system is a third important factor in corporate use. The evaluation was done using TotaraLMS Seedlings, but TotaraLMS Enterprise Edition includes professional service and support for the system. Moodle has an extensive open-source community that also offers support but professional support is also available through the certified Moodle Partners network.

Near the end of this thesis project a LMS installation based on TotaraLMS was implemented in the company. This was done to roll out some mandatory employee trainings as e-learning during the last quarter of 2015. The system implements the SAML/ADFS SSO solution described but does not have

integration to other company systems for synchronizing organizational data or reporting course completion data back to other systems. The integration was delayed by the change of corporate HR system that was implemented during the last year. This means that not all of the benefits of TotaraLMS can be leveraged immediately but the integration work continues.

The content server with H5P is also in production stage now and satisfies the current needs. If e-learning is launched to customer trainings also, instead of just to employees like now, it must be evaluated how much more work managing multilingual content through it will mean. The company has implemented a structured documentation system and DITA xml during the last year for customer and software documentation. It would be interesting to investigate if the structured documentation system could be used for e-learning content production in addition to the current documentation formats. Through it the single-sourcing and re-use of previously created content and the localization process support could benefit also the training content creation. Using the DITA Learning Extension and DITA Open Toolkit it is already possible to publish SCORM packages but not all functionality is supported.

Another area for further investigation would be how to visualize and present the complex metering systems visually in e-learning and how simulations can be used to improve learning results. Janitor & al. studied the learning results of students in Cisco's Networking Academy and found that hands on experience with practical configurations is essential to learning about computer networks. Elaborate lab environments are not always possible to set up or accessible but simulations have proved nearly as effective. (Janitor, Jakab, Kniewald, 2010, 351-352.)

The response to the LMS and first e-learning courses has been positive and obviously there has been a need for it in the company. Even though during the thesis project it has felt like getting new things to progress through the corporate bureaucracy has been painstakingly slow this gives confidence in the future adoption of e-learning and the systems related to it. The work around implementing e-learning continues in the company on two fronts.

First is the establishment of working integration to HR systems for data exchange. The second is establishing a body of relevant, good quality e-learning content that is available to the company employees.

Having worked in the company for several years before starting my studies, I knew the company and its products well right from the start. E-learning from the system administration point of view and e-learning content production were new areas where I needed to develop knowledge and experience. My thesis and current work in e-learning development have provided an ideal way to combine my studies and my previous experience in technical documentation.

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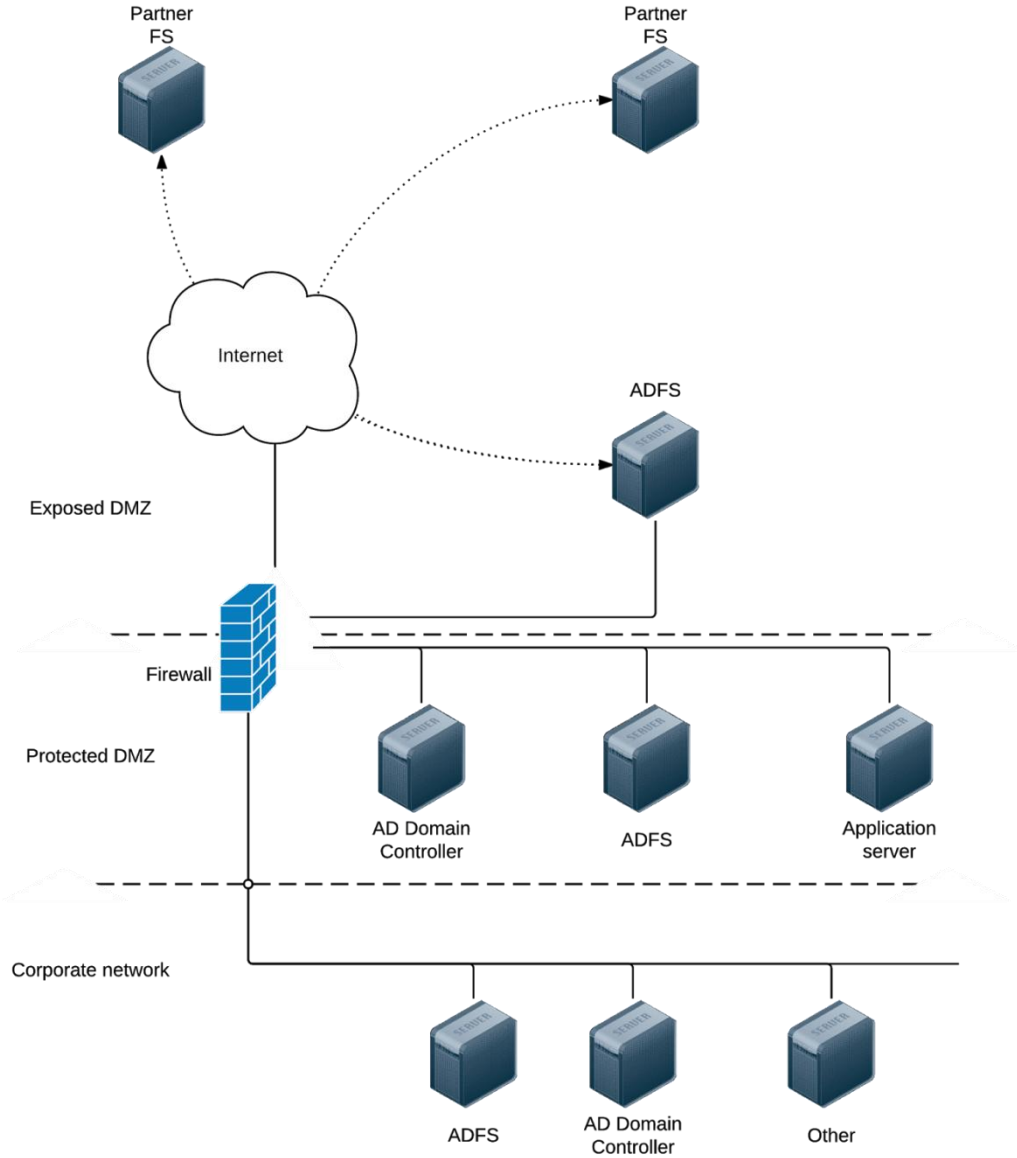
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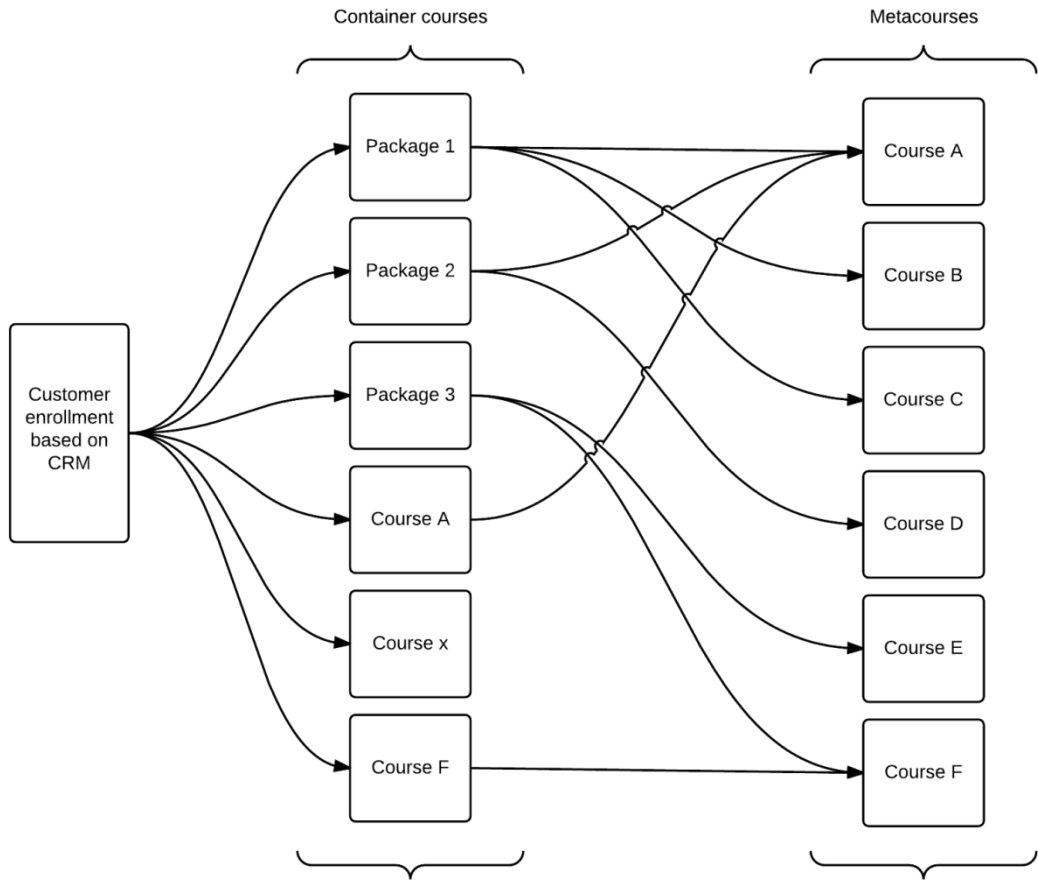
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Appendices

Appendix 1. Federated authentication



Appendix 2. Course enrolment with metacourses



Appendix 3. Moodle and TotaraLMS installation requirements

Moodle	TotaraLMS
<p>A supported server OS: Linux or Windows recommended, also tested on Solaris 10, Mac OS X and Netware 6</p>	<p>A supported server OS: Windows or Linux (Ubuntu, Debian, Suse, Redhat), or another Unix variant</p>
<p>PHP version: minimum PHP 5.4.4 On Windows always use latest PHP 5.4.x or 5.5.x PHP 7 is NOT supported</p> <p>Required PHP modules: iconv curl (for networking and web services) ctype zip simplexml spl pcre dom xml json</p> <p>Recommended extensions: mbstring openssl (required for networking and web services). tokenizer xmlrpc (required for networking and web services) soap (required for web services) gd (required for manipulating images) intl extension is recommended the appropriate extension for your chosen database is required</p> <p>Other PHP extensions may be required to support optional Moodle functionality, especially external authentication and/or enrolment</p>	<p>PHP version: 5.4.4 minimum</p> <p>Required PHP modules: iconv, curl, ctype, zip, simplexml, spl, pcre, dom, xml, json, gd</p> <p>Recommended PHP modules: mbstring, openssl, tokenizer, xmlrpc, soap, intl, zlib, opcache PHP Memory limit of at least 256MB</p>
<p>Supported Databases, latest version recommend: PostgreSQL, min. 9.1 MySQL, min. 5.5.31</p>	<p>Supported databases: Postgres 9.1 or greater Mysql 5.5.31 or greater MariaDB 5.5.31</p>

<p>MariaDB, min. 5.5.31 Microsoft SQL Server, min. 2008 Oracle Database, min. 10.2</p>	<p>MSSQL 2008 or greater</p>
<p>Supported web server software: Apache recommended IIS</p>	<p>Supported web server software: Apache 2.x.x or IIS (nginx should also work)</p>
<p>Other: Ghostscript should be installed for pdf annotation. Moodle upgrade: Moodle 2.2 or later (if upgrading from earlier versions, you must upgrade to 2.2.11 as a first step)</p>	<p>Other: System clock synchronised with internet time servers. Functional outbound email</p>

Appendix 4. Organization import csv

"idnumber","timemodified","frameworkidnumber","shortname","fullname","parentidnumber","description","typeidnumber"

"1","","1","","Landis+Gyr","0","","0"

"11","","1","","EMEA","1","Europe, Middle East and Africa","2"

"12","","1","","APAC","1","Asia Pacific","2"

"13","","1","","Americas","1","North and South America","2"

"14","","1","","Global R&D","1","","3"

"111","","1","","Finland","11","","4"

"112","","1","","Switzerland","11","","4"

"131","","1","","Canada","13","","4"

Appendix 5. Positions import csv

idnumber;fullname;frameworkidnumber;timemodified

1;Manager;1;

2;Developer;1;

3;Project manager;1;

4;Test engineer;1;

5;Sales representative;1;

Appendix 6. User import csv

idnumber;timemodified;firstname;lastname;username;deleted;orgidnumber;
posidnumber

10;;Mandy;Manager;mandyman;;131;1

11;;Pekka;Pomo;pekkapom;;111;1

12;;Teemu;Tester;teemutes;;111;4

13;;Tammy;Tester;tammytes;;131;4

14;;Kimmo;Koodari;kimmokoo;;111;2

15;;Keijo;Kehittäjä;keijokeh;;111;2

16;;Pirkko;Projekti;pirkkopro;;111;3

17;;Sam;Sales;samsal;;131;5

18;;Mikko;Myyjä;mikkomyy;;111;5

Appendix 7. Example report for export

"User's Fullname", "Course Name", "User's Organisation Name", "User's Position", "Completion Status", "The completion date"

"Admin User", "Code of Conduct Training",,, Complete, "30 Nov 2015"

"Dave Developer", "Code of Conduct Training", Canada, Developer, "Not yet started",

"Mandy Manager", "Code of Conduct Training", Canada, Manager, "Not yet started",

"Pekka Pomo", "Code of Conduct Training", Finland, Manager, "Not yet started",

"Teemu Testeri", "Code of Conduct Training", Finland, "Test engineer", "Not yet started",

"Tammy Tester", "Code of Conduct Training", Canada, "Test engineer", "Not yet started",

"Kimmo Koodari", "Code of Conduct Training", Finland, Developer, "Not yet started",

"Keijo Kehittäjä", "Code of Conduct Training", Finland, Developer, Complete, "30 Nov 2015"

"Pirkko Projekti", "Code of Conduct Training", Finland, "Project manager", "Not yet started",

"Sam Sales", "Code of Conduct Training", Canada, "Sales representative", "Not yet started",

"Mikko Myyjä", "Code of Conduct Training", Finland, "Sales representative", "Not yet started",

Appendix 8. SimpleSAMLphp installation

Download simpleSAMLphp from <https://simplesamlphp.org/>

Upload it to the installation folder and unpack.

Configure the server environment for simpleSAML -> path to the installation folder, location of the www folder and rights.

Configure simpleSAMLphp config.php

Configure php (if necessary)

Access the simpleSAMLphp installation page -> all the lights at the bottom of the page should be green, if not check the php set up.

Configure as Service Provider.