CMED – TECHNICAL ARCHITECTURE DOCUMENT

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INTRODUCTION

This document provides a high level overview of the technical architecture for the CMED eco-system. It outlines the key technical aspects of the components, technologies and applications that UBC MedIT users will use for maintaining, delivering and consuming content.

OBJECTIVES

The CMED eco-system will comprise of multiple applications sourced from multiple vendors working with each other and providing a seamless experience to the end user. There will be myriad of use cases and requirements which will be executed by different type of users. This document concentrates on the most significant use cases which will have an architectural impact on the system. The objective is to provide a high-level architecture (or options thereof) for these significant use cases which affect the interactions and integrations between these applications within the CMED domain.

Other CMED requirements or use cases which are not architecturally significant are outside the scope of this document but will be addressed in respective detailed design documents.

The target audiences of this document is achitects, designers, developers or any other technical group who is involved in development, maintenance or operation of CMED systems; OR wants to integrate with CMED systems.

This document will form the basis of detailed design documents for the technical components and integrations between various CMED applications. These detailed design documents that will guide the actual implementation, deployment and maintenance of the technical components and integrations.

SCOPE

This document describes the implementation design of the following key software applications whi ch will form the core of CMED eco-system. These are:

- CM: Curriculum management application
- LMS: Learning Management System
- LOR: Learning Object Repository
- Portal: Client Portal System

The CMED applications may consume other components and applications developed and hosted by 3rd parties or groups within UBC like UBC IT. Technical details about those components or applications are outside the scope of this document.

The conceptual structure envisaged for CMED solution is as follows:

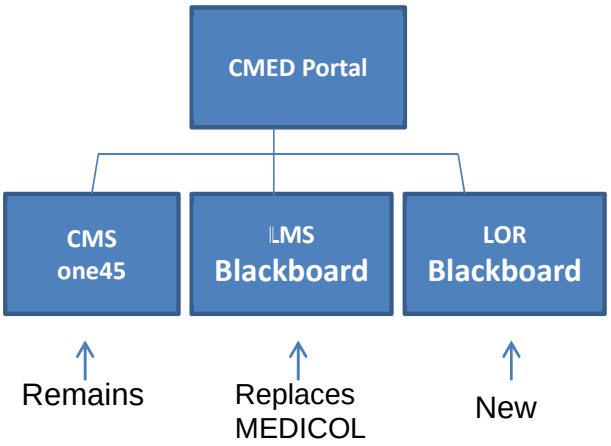


Figure 1 Conceptual CMED System Structure

REFERENCES

Title	Description
UBC Shibboleth Implementation Guide	Provides detailed technical information about integration with UBC IT Shibboleth Infrastructure
Basic LTI Implementation Guide	Provides detailed technical information about integration between LTI Tool Consumer and LTI Tool Provider through Basic LTI protocol

Table 1 List of References

DOCUMENT STRUCTURE

This document is structured in the following sections:

Section	Description
Use Cases	Lists and briefly describes architecturally significant use cases.
System Overview	Provides a high-level description and context of the whole system and its major components
Logical Architecture	Provides a detailed description of the architecture for each of the significant use cases
Physical Architecture	Provides an overview of deployment scheme and physical location of the system and its major components

Table 2 Document Structure

USE CASES

This section describes the use cases which are architecturally significant. These use cases will have a great influence on the overall system architecture and design.

SYSTEM USE CASES

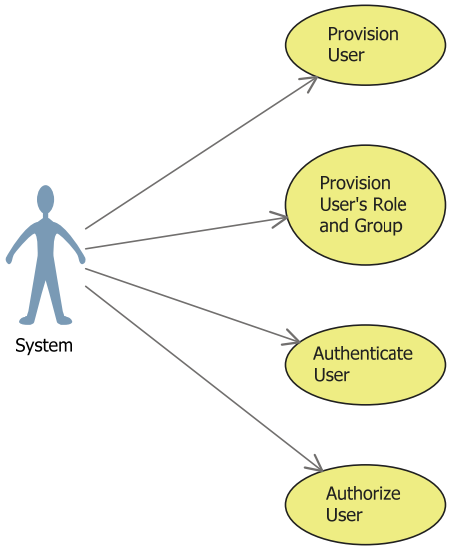


Figure 2 System Use Cases

PROVISION USER

The central IT system provisions users into CMED applications. The provisioning of users should account for all types of users including students, faculty, admin, staff etc.

Comment [RB1]: Can we elaborate based on our understanding of how provisioning happens at Central IT end. We can borrow information, diagram from their tech docs to provide brief explanation and refer to those documents if anyone wants more details.

PROVISION USER ROLE/GROUP

The provisioned users are assigned appropriate role or groups. These roles or groups could be used to assert the proper permissions on data or system objects.

Comment [RB2]: We should provide a glossary at the end describing various terms – role, group, system, authenticate, authorize, etc.

AUTHENTICATE USER

This use case allows the system to authenticate a user. The authentication process must invoke be based on SSO protocols so that the users can use a single set of credentials to login into CMED applications.

AUTHORIZE USER

This use case allows the authenticated user to authorize by asserting the right role or group permissions for any given use case that the user is trying to execute.

USER USE CASES

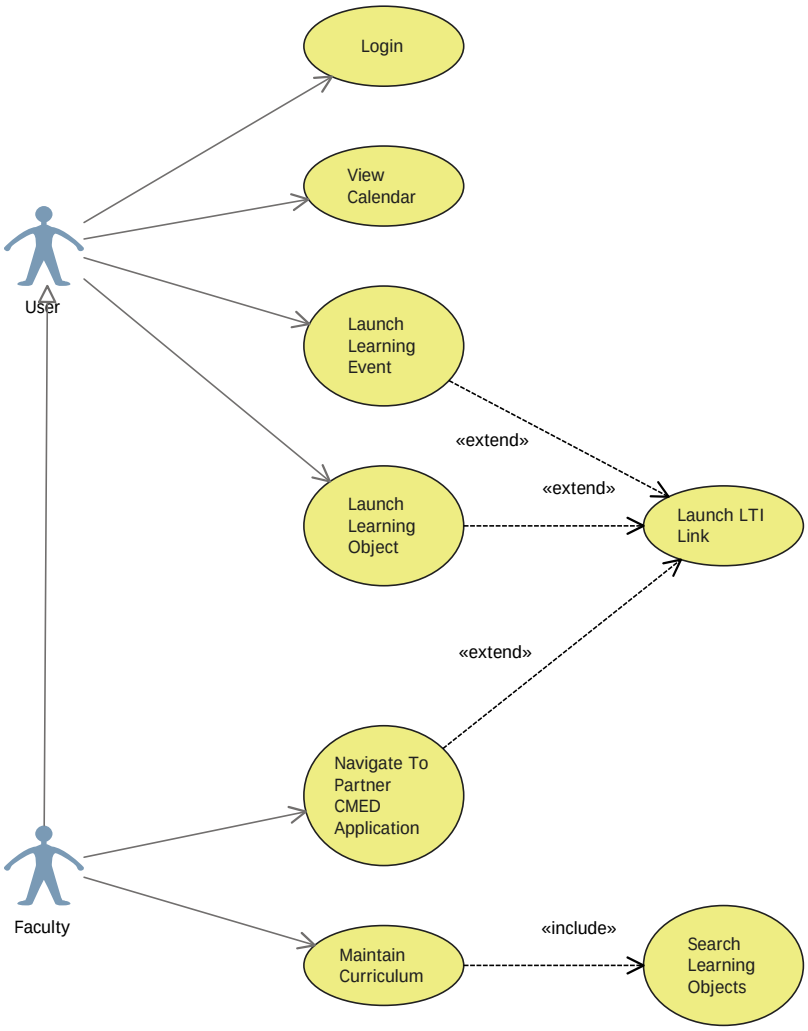


Figure 3 User Use Cases

LOGIN

The user logs in into the CMED applications using their SSO credentials.

VIEW CALENDAR

The user can view their aggregated calendar within CMED application. The calendar events should include the users' CMED scheduled learning events and their personal calendar events.

LAUNCH LTI LINK

This use case forms the basis of many other use cases involving the user crossing over from one CMED application to another. In order to facilitate the cross over and provide seamless experience to the user – LTI protocol will be used between the CMED applications.

The LTI interfaces will be protected by LTI security layer as implemented between the LTI Tool Provider and LTI Tool consumer. The user's identity and session information will protected via SSO and the user will be authenticated against UBC Shibboleth.

Comment [RB3]: Are we sure that all applications will support LTI? For instance One45, FMIS, etc.

LAUNCH LEARNING EVENT

The user launches a particular calendar event from their calendar view. The calendar event could be linked to a content item or learning object. This use case extends the Launch LTI Link use case.

LAUNCH/VIEW LEARNING OBJECT

The user can launch or view any learning object residing in the learning object repository subject to role and access restrictions.4. The launch could also happen as a result of user launching or viewing a content item, or learning event to which the learning object has been associated. The learning object may reside in a different location physically than the LOR (e.g. a recorded lecture video may reside on video server). This use case extends the Launch LTI Link use case.

Comment [RB4]: This means that there will be LTI integration with the video server? Will we ask vendor to build the LTI support in FMIS?

NAVIGATE TO ANOTHER CMED APPLICATION

There will be many different navigational links within CMED applications which will help the user navigate from one CMED application to another. The underlying links for such user navigation will be Basic LTI links and will help the user to navigate directly to the target LTI resource in the LTI Tool Provider application. Some examples of such cross over navigation are: user navigating from Portal to LMS, user navigating from Portal to CM etc. Underneath the covers all such use cases will extend the Launch LTI Link use case.

Comment [RB5]: We should have an assumptions section in the document that mentions the underlying assumptions for the use cases to work properly eg. All CMED applications support LTI.

MAINTAIN CURRICULUM

The user uses the CM component of the CMED system to maintain curriculum and propagate the calendar events.

SEARCH LEARNING OBJECTS

Many of the use cases use the search over the learning objects use case. The search can be executed within LOR user interface or via an API integration point.

SYSTEM OVERVIEW

This section describes the overall system and the internal components of the CMED application eco-system.

Comment [RB6]: We should update the diagram in light of our LOR decision.

COMPONENTS OF CMED

The CMED eco-system will comprise of multiple logical components working together and delivering a cohesive user experience for all Faculty Of Medicine users which include faculty members, students and staff.

The main components of CMED are:

FACULTY OF MEDICINE PORTAL

The portal acts as a single point of entry into all CMED applications. The users will be able to view and access data from all CMED application within this application.

CURRICULUM MANAGEMENT APPLICATION

This application will be used by staff and faculty members to maintain the education curriculum for Faculty of Medicine courses. The curriculum calendar will also be exposed to FoM users via standards based data feed e.g. iCal.

LEARNING OBJECT REPOSITORY

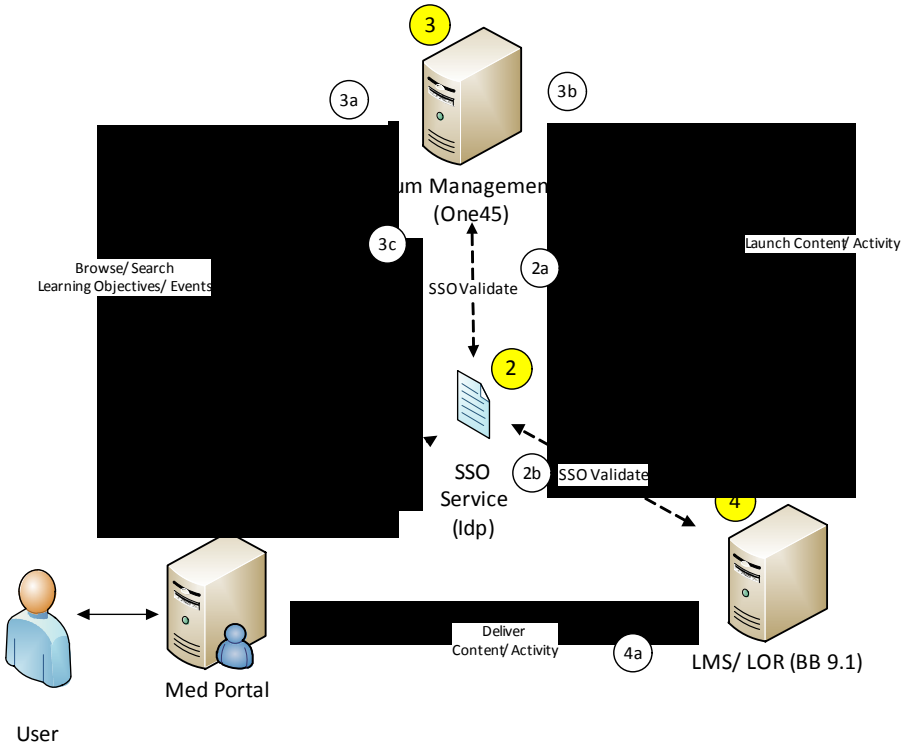
The Learning Object Repository (LOR) application will host and control the delivery, publishing workflow for learning objects or content which is to be delivered as part of FoM courses.

LEARNING MANAGEMENT SYSTEM

The Learning Management System (LMS) will be the system used by FoM users for the administration, documentation, tracking, and reporting of FoM curriculum. UBC IT has selected BlackBoard Learn as the system of choice for this component.

PHYSICAL COMPOSITION OF CMED COMPONENTS

It is important to understand that the logical components of CMED do not necessarily map to a separately deployed physical software component. One software component may be able to serve multiple functions and thus will assume the role of multiple CMED components. For instance, the LMS platform will serve the purpose of LMS and LOR.



1. User goes to MEdPortal, a consolidated portal site for accessing teaching and learning resources
2. The portal login provides Single Sign On to various applications in the ecosystem (Shibboleth / CWL)
2a. SSO validation with One45
2b. SSO with LMS/LOR
3. User views the consolidated calendar in the portal (populated via 3c) and views the associated event details in Curriculum Management System (One45)
3a. The curriculum map can be browsed/ searched to view learning objectives and associated events
3b. User selects a learning event and launches associated activity or content
4. The LMS delivers the learning activities and provides access to content within the LOR

Figure 4 System Overview

SYSTEM USE CASES

PROVISION USERS

Users will need to be provisioned (or enrolled) into all CMED systems before the user can interactive with CMED system in a comprehensive manner. This use case may be divided into 2 sub-use cases depending on how the users are provisioned into the CMED applications. These 2 sub-use cases are:

PROVISIONING OF USERS IN LMS

The registered users will be provisioned into LMS (BB Learn) via an application developed and maintained by UBC IT. This application is called CTC3. CTC3 will interface with central UBC SIS system and other source systems to collect information about registered users and provision them into BB Learn via a messaging system.

The users will be provisioned in real time i.e. as soon the users is registered within the source systems (e.g. UBC SIS System) – the message will flow via CTC3 and the user will be provisioned in BB Learn.

IMPLEMENTATION

The technical details and architecture of CTC3 are outside of the scope of this document – but UBC IT has provided a high-level system architecture of this system.

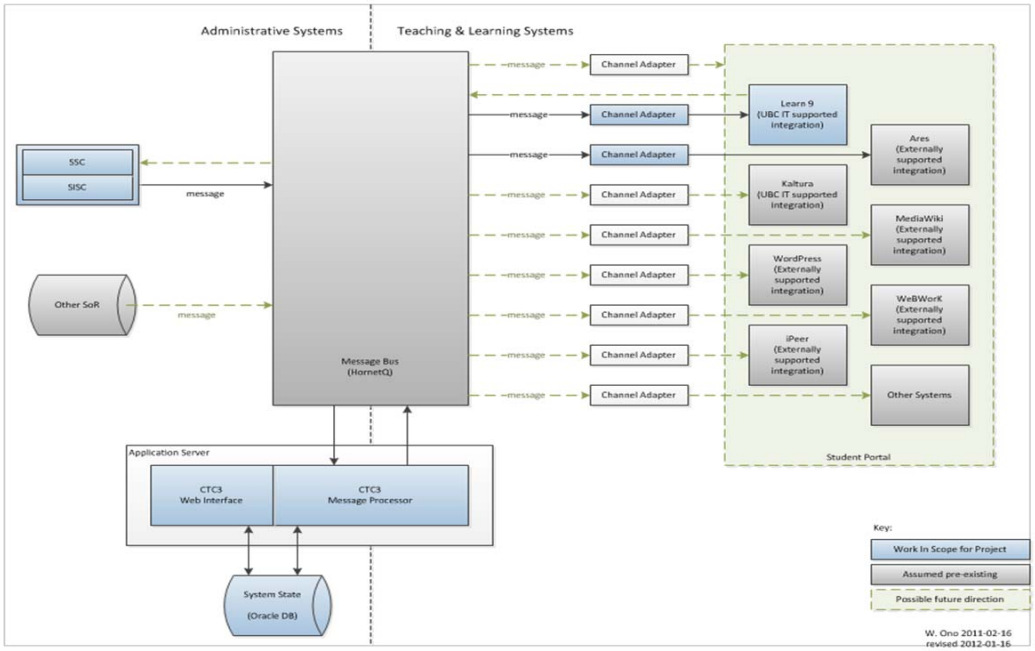


Figure 5 CTC3 System

PROVISIONING OF USERS IN OTHER CMED SYSTEMS

3 technical solutions were considered for provisioning the users into other CMED applications. These are:

- **Provision via CMED middleware**: In this option, a middleware component (like CTConnect3) will be required which receives user data from external sources and provisions the users into all CMED applications (except BB Learn)
- **Provision the users just-in-time (JIT)**: In this option, the CMED application will provision the users themselves just-in-time as they are logging in. The CMED application will intercept the login process and detect whether the current user is already provisioned or not. If not, it will initiate a workflow to provision the user JIT.
- **Provision manually**: In this option, the user will be provisioned manually or semi-automatically e.g. via file import

PHASED IMPLEMENTATION

After analyzing and weighing all the options – CMED technical team has decided to opt for a phased implementation of the user provisioning process. In the first phase – we will implement the manual provisioning of users (via import files).

In subsequent releases – these processes could be enhanced and automated solutions based on other options could be put in place.

PROVISION USERS MANUALLY

- In this option the users will be provisioned into CMED applications manually
- The users may be provisioned via a file import into the application to facilitate provisioning of large number of users quickly and to reduce the possibilities of human error

ASSUMPTIONS

For provisioning users manually the following is assumed:

- MedIT and/or UBC IT will implement business processes and personnel responsible for provisioning the users into disparate systems and keep the users status in synch across the systems. e.g. a faculty member may be responsible to provision users at start of each academic year.
- Proper error message conditions and messages will be defined by all CMED applications to inform users in case of any exceptional cases which may happen due to manual registration processes. This will help the users and administrators to troubleshoot any registration issues quickly
- CMED applications will have the capability to import basic user data along with any custom attributes which may be needed for proper integration with other CMED/UBC IT applications

ADVANTAGES

- Since it is assumed that all CMED applications may already have a manual provisioning capability – this option will be fastest and cheapest to implement

DISADVANTAGES

- Any manual workflow may lead to human errors and delays in registering all the users for all courses
- Depending on the integration scenarios – this manual registration may actually increase some work on the integration and customization of the components (e.g. say if a particular application does not support a required attribute which is essential for integration with other CMED applications)

OPEN ISSUES

- The necessary user attributes required for user registrations will need to be proposed, analyzed and validated with all stakeholders.
- The current capabilities of CMED application will need to be validated for proper implementation of this option

PROVISION USER ROLE/GROUP

In order to apply the necessary permissions and control the release of content to users – each user must be enrolled in their appropriate roles or groups. Users' enrollment will need to be provisioned into all CMED. This use case may be divided into 2 sub-use cases depending on how the users' roles and groups are provisioned into the CMED applications. These 2 sub-use cases are:

PROVISIONING OF USERS' ROLE IN LMS

The registered users will be provisioned into LMS (BB Learn) via CTC3. CTC3 will also take care of users' role enrollment into their respective courses.

PROVISIONING OF USERS' ROLE IN OTHER CMED SYSTEMS

2 technical solutions were considered for enrolling the users in their respective roles in other CMED applications. These are:

- **Provision via CMED middleware**: In this option, a middleware component (like CTConnect3) will be required to maintain and propagate the users' role and group enrollments to other CMED applications.
- **Provision manually**: In this option, the users' roles and groups will be provisioned manually or semi-automatically e.g. via file import

PHASED IMPLEMENTATION

After analyzing and weighing all the options – CMED technical team has decided to opt for a phased implementation of the user and role provisioning process. In the first phase – we will implement the manual provisioning of users and their role and group enrollments (via import files).

In subsequent releases – these processes could be enhanced and automated solutions based on other options could be put in place.

The actual mechanism of enrolling the users into their roles/groups will be same as provisioning the users. So the details of Provision Users use case also applly to this particular use case.

AUTHENTICATE USERS

The authentication process for users will leverage the Shibboleth infrastructure and use the SSO process.

ASSUMPTIONS

- All CMED applications will support UBC IT Shibboleth infrastructure
- Each CMED application will get all the necessary user attributes in the Shibboleth/SAML tokens which are required for proper functioning of the application
- UBC IT Shibboleth will support SSO configuration so that user does not have to login multiple times while navigating different CMED applications
- There will be no federation implemented for the current release of CMED

IMPLEMENTATION

Each CMED application will need to integrate with the Shibboleth Idp by supporting a Shibboleth Sp.

The technical details and architecture of Shibboleth are outside of the scope of this document – but UBC IT has provided a high-level system architecture of this system.

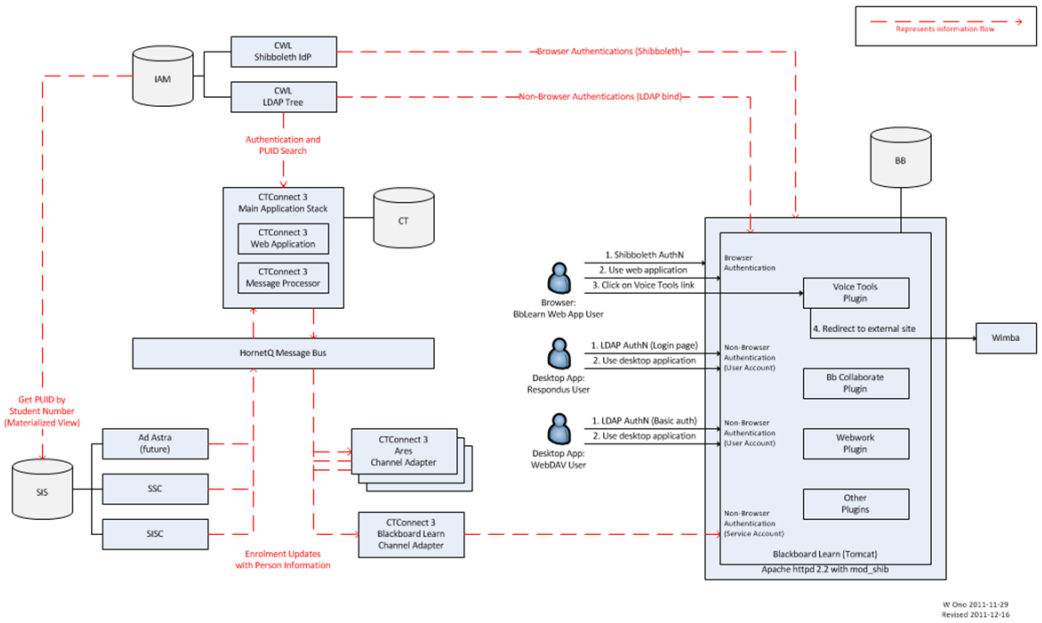


Figure 6 UBC IT Shibboleth Infrastructure

The complete implementation mechanism and technical details are provided at the following reference documentation pages provided by UBC IT:

http://it.ubc.ca/service_catalogue/accounts/shibboleth/guide.html

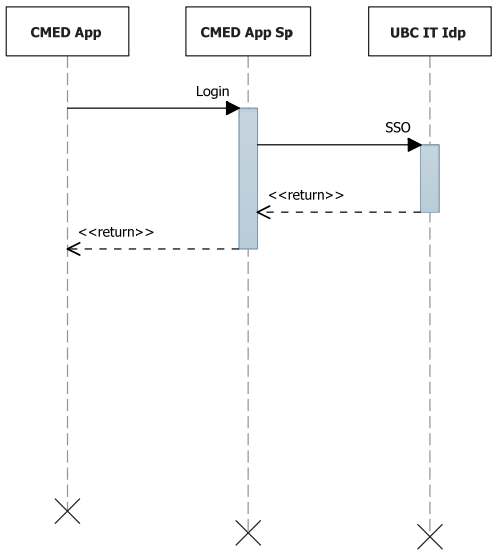


Figure 7 Sequence diagram for Authenticate Users

AUTHORIZE USERS

Given the fact that there is no central way to manage user's roles and permissions within UBC IT or CMED eco-system; the onus of authorizing the user for a given use case will lie with each CMED application. Each user record provisioned within the CMED application will be assigned a local role and/or group. After authentication – the user's session will be assigned an appropriate role or group and the relevant permissions will be asserted by the CMED application. The user sessions' role context will be updated as required while the user navigates to different parts of the application.

ASSUMPTIONS

- All CMED applications will have users and respective roles and groups provisioned by automatic or manual means
- All CMED applications will support the capability of assigning necessary roles/groups required to execute a particular use cases and assert them on granular or coarse level
- Each CMED application will get all the necessary user attributes in the Shibboleth/SAML tokens which are required for proper assertions to be applied (but the roles/groups role mapping will be internal to each CMED application)

IMPLEMENTATION

- CMED applications will provide a way for system administrators to setup the required users/groups for execution of particular use cases. These security requirements could be coarse grained or fine grained depending on the functionality and security requirements e.g.:
    - For LMS and LOR – security requirements could be setup to view/edit/delete particular learning objects
    - For CM – security requirements could be setup to publish the learning events
- Users and their respective roles and groups will be provisioned into CMED applications via automatic or manual workflows
- At the time of login – CMED application will establish a user context session which will include enough information for each application to assert necessary role/group membership
- CMED application will intercept access to a data entity or execution of a use case by a user and assert the necessary security rules

VIEW CALENDAR

The portal application will provide a calendar view portlet which will provide a consolidated view of the user's calendar events. The calendar events will include events from CMED schedule as well as any personal calendar events which the user has access to. Hence this use case also comprises of two sub-use cases:

PROVIDE CALENDAR DATA FEED

This use case involves exposing the calendar events in a standards compliant and secure manner. The data feed could be exposed an internal CMED application like CM or it could be exposed by a 3rd party calendar hosting application like Google Calendar.

ASSUMPTIONS

- The internal CMED applications will only publish the data feed to other CMED (or UBC) applications. In order to assert this security measure – it will support some method of authenticating the calling system as an authenticated and registered partner system.

IMPLEMENTATION

- CMED applications exposing calendar data feed will expose an interface endpoint which can be consumed by consumers to request for the relevant calendar entries
- The CMED applications' calendar data feed endpoint will authenticate
    - The system as recognized authenticated and registered system authorized to query the calendar integration interface
    - The user as a valid authenticated system user

- After proper authentication – the CMED calendar data feed provider will expose the calendar events relevant to the user context
- The event calendar feed will include all the details about the calendar event; most importantly it will also include an auto-generated deep link back into the provider application directly pointing to the module or page associated with the calendar item. The deep link will be in a standard format like LTI and will enable the user to directly navigate to the data item or event within the application.
- 3rd party calendar providers like Google calendar may provide alternate means to secure the access to users' personal calendars

Comment [k7]: We need to discuss this to determine if an externally hosted calendar is acceptable.

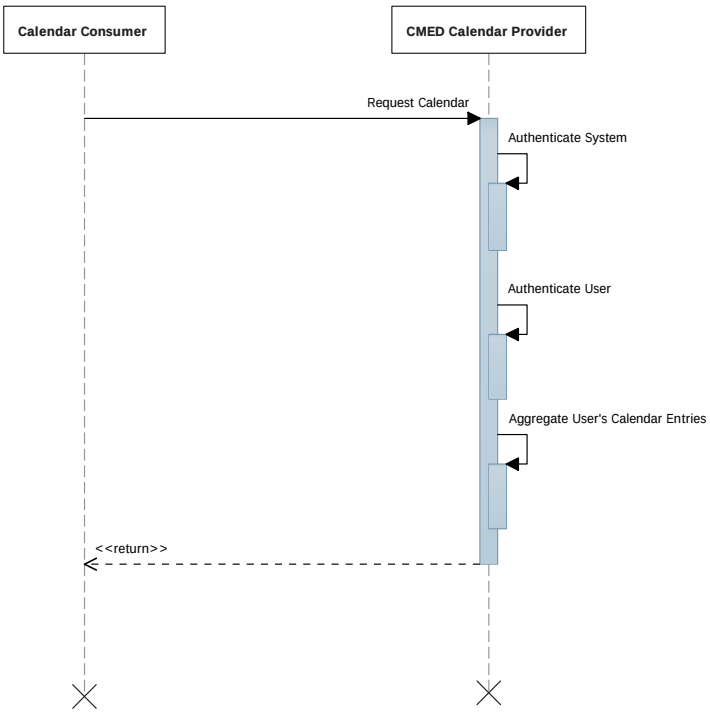


Figure 8 Sequence diagram for Calendar Provider

CONSUME CALENDAR DATA FEED

ASSUMPTIONS

- CMED portal application will be able to consume calendars from different calendar providers and aggregate and consolidate the calendar into a single view for the user

IMPLEMENTATION

- CMED portal application will have a default calendar view configured for each user which will query the CMED calendar providers' data feed interfaces
- Each interface query will include necessary context and security information for the calendar providers to authenticate the system and user and respond with the relevant data feed for each user
- The users will also be able to add new calendar feeds for their personal calendars by adding the URLs to their published calendars by various calendar providers
- The portal application will provider an aggregate and consolidated view of all the calendar items for the users

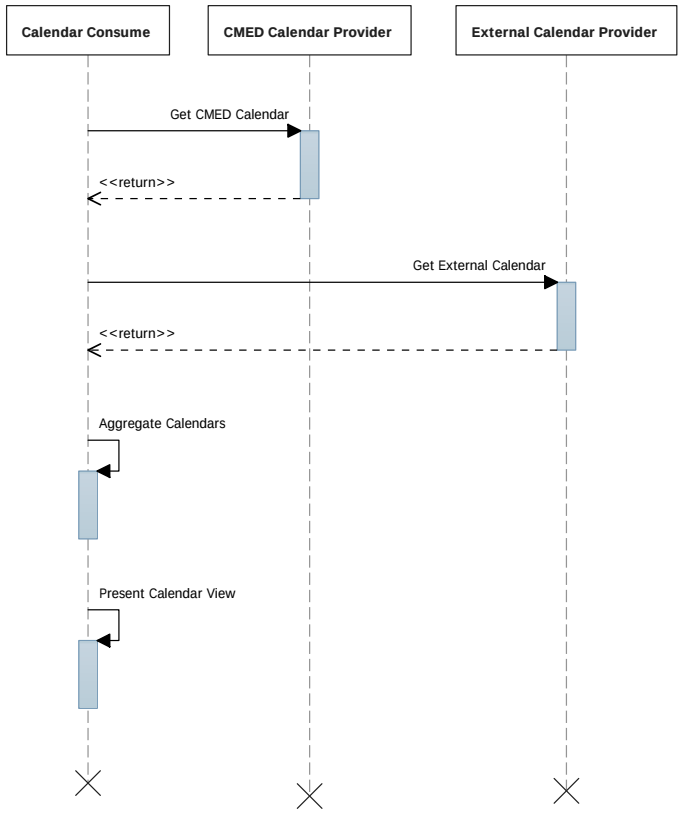


Figure 9 Sequence diagram for Calendar Consumer

LAUNCH LTI LINK

A user may launch or navigate to an LTI Resource exposed by a LTI Tool Provider by clicking on a deep LTI link associated with the target LTI Resource. The LTI link may be presented to the user as a part of calendar data feed or through any other integration interface with a CMED application which is LTI compliant. The LTI link will have all the necessary information to launch the target URL in the integrated application (LTI Tool Provider), establish the user context and session in the target application and ultimately navigate directly to the target module or page (LTI Resource) (as per the Basic LTI specifications and implementation guidelines).

The following sections apply to both sub-use cases listed below:

ASSUMPTIONS

- All CMED applications will support UBC IT Shibboleth infrastructure
- Each CMED application exposing LTI Resources to partner applications will be LTI compliant and will act as the LTI tool providers for learning events
- The LTI interfaces will be protected by LTI security layer as implemented between the LTI Tool Provider and LTI Tool consumer
- The user's identity and session information will protected via SSO and the user will be authenticated against UBC Shibboleth. The incoming LTI interfaces will be Shibboleth SSO enabled and will be able to establish the user context based on the Shibboleth authentication tokens
- The integration, deployment and configuration of each LTI integration between the applications will be completed as per the detailed design laid out by CMED's and application vendor's technical teams

IMPLEMENTATION

- The LTI Tool Provider will receive the incoming LTI request
- The LTI Tool Provider will authenticate the user via Shibboleth Idp and establish the user context
- The LTI Tool Provider will present the target LTI resource to the user

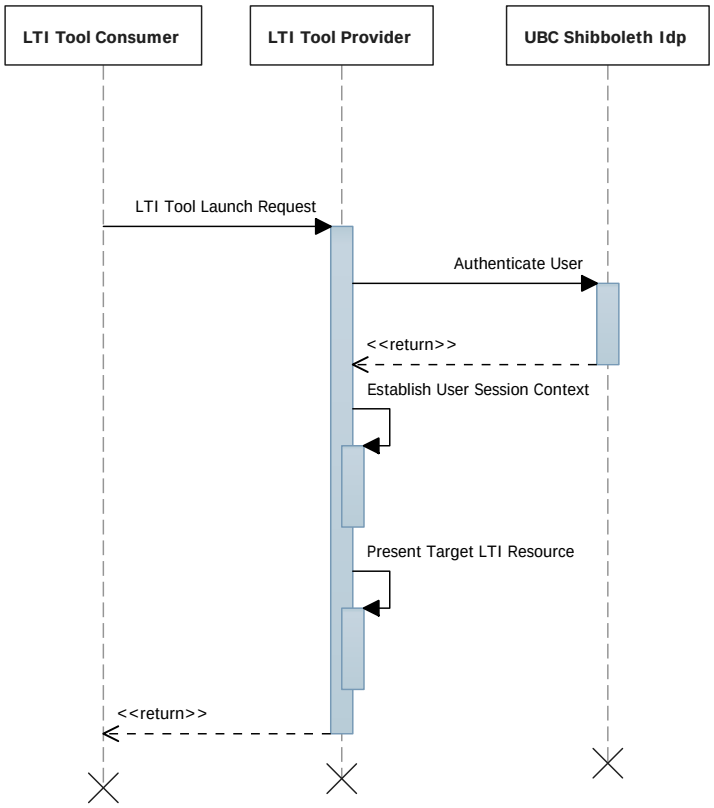


Figure 10 Sequence diagram for LTI Tool Launch

The complete implementation mechanism and technical details are provided at the following reference documentation pages provided by IMS:

http://www.imsglobal.org/lti/blti/bltiv1p0/ltiBLTIimgv1p0.html

LAUNCH LEARNING EVENT

A user may launch or navigate to a learning event by clicking on a deep link associated with the learning event. It is assumed that all deep linking across applications will be done via LTI protocol; hence the underlying mechanism to launch such links will depend on the Launch LTI Link use case.

LAUNCH LEARNING OBJECT

A user may launch or navigate to a learning object managed with the LOR by clicking on a deep link associated with the learning object. It is assumed that all deep linking across applications will be done via LTI protocol; hence the underlying mechanism to launch such links will depend on the Launch LTI Link use case.

NAVIGATE TO PARTNER CMED APPLICATION

CMED applications will expose numerous ways for the users to navigate from one partner application into another. These crossover links will be deep link associated with an entity or object residing in the partner application. It is assumed that all deep linking across applications will be done via LTI protocol; hence the underlying mechanism to launch such links will depend on the Launch LTI Link use case.

MAINTAIN CURRICULUM

The curriculum and schedule will be maintained in LMS and CM applications respectively. The access to these applications will be provided via deep links in the portal application. It is assumed that all deep linking across applications will be done via LTI protocol; hence the underlying mechanism to launch such links will depend on the Launch LTI Link use case.

This use case also makes use of Search Learning Objects use cases for searching for learning events, objects and entities across multiple applications.

SEARCH LEARNING OBJECTS

It is desirable that CMED users should be able to execute search over all the learning content across CMED applications and have the search results show up in a single UI screen (preferably within Portal). Depending on the technical capabilities and resources available to implement this functionality – there are 2 options available to implement the search. These options are:

INTEGRATED SEARCH ACROSS CMED APPLICATIONS

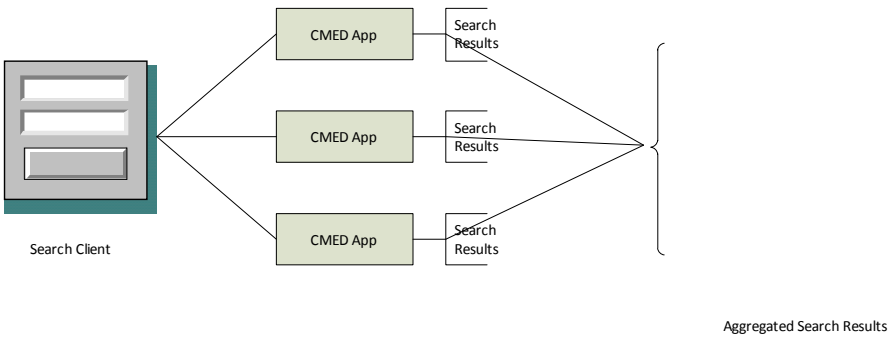


Figure 11 Integrated Search Across CMED Applications

- In this option the search will be an integrated search and will be executed across all the CMED applications.
- The search query will be performed via search APIs exposed by all CMED applications; the results will be aggregated and displayed in a uniform search result UI.
- The search query will be executed across all types of learning objects, events and entities.
- The individual search results will be aggregated and combined into a single result set before displaying it in the search UI.
- The search result UI will have the capability of caching the search results so that further filtering within the search results could be performed.
- All permissions, group, role privileges will be asserted while returning the search results to a particular user; only the entities which are accessible by the user will be returned in the search result.

ASSUMPTIONS

For this option to be viable – the following is assumed:

- The CMED applications will be able to expose search related APIs (preferably these APIs will have consistent signatures so that the consumer application does not need to develop and maintain multiple integration interfaces for each of the CMED applications)
- CMED Portal will be able to execute the search results in parallel across multiple applications and aggregate the results
- The search client component within the CMED Portal will be able to cache and aggregated search results and will provide further filtering capabilities within the aggregated search results to the users
- Initially the search consumer will be CMED Portal application – but since the search is executed via API – these APIs may be consumed by other applications in the future.
- The search client or aggregator component will be able to execute search across all repositories in a parallel fashion to increase the performance and responsiveness of the system

ADVANTAGES

- The most important advantage of this approach is that it will give a seamless search experience to the user. Instead of executing search within different applications – the user will be able to go to a single source for searching across all objects, events and entities within the CMED application system.

DISADVANTAGES

- The main disadvantage of this approach is that it will require development and maintenance of multiple integration interfaces and thus will be costly and time consuming
- Depending on the capabilities of vendors – many vendors may not be able to expose ideal search APIs required for the search client

OPEN ISSUES

- The protocols and signatures of the search APIs will need to be proposed, analyzed and finalized in consultation with CMED application vendors.

IMPLEMENTATION

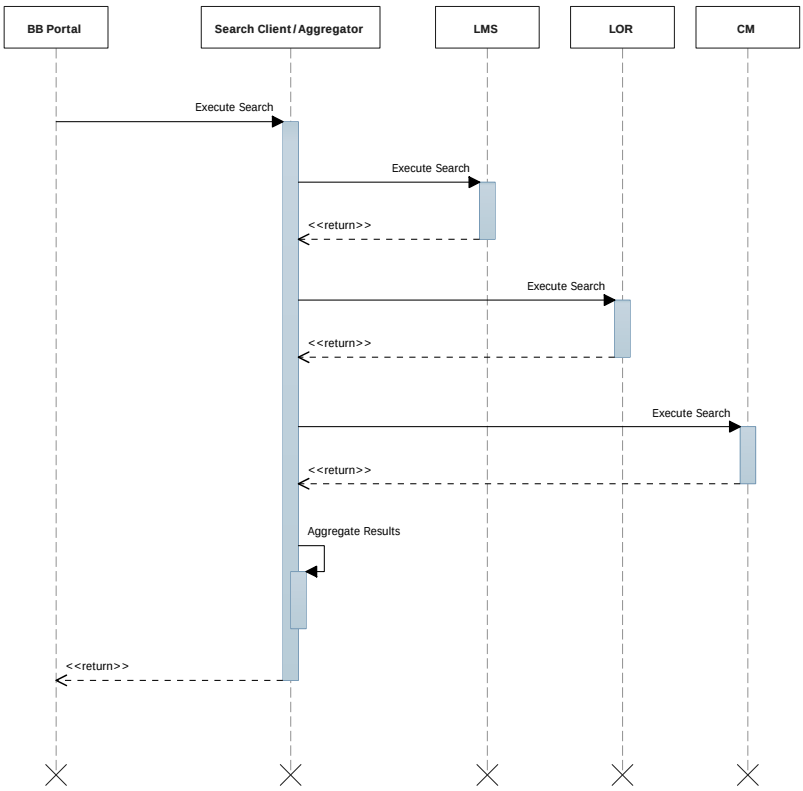


Figure 12 Sequence Diagram for Integrated Search

SEARCH LANDING PAGES

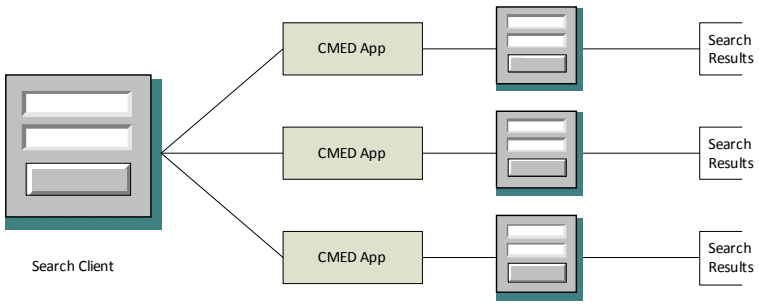


Figure 13 Search Landing Pages

- In this option CMED applications will expose a search landing page to the CMED portal (preferably via LTI protocol). When the user executes a query – the portal application will redirect the user to the target search landing page in the target CMED application along with the user's search query
- The query will be executed natively within the target CMED application and the search results will be presented to the user within the native application UI
- If the user wants to execute the same or another query within a different CMED application – she will need to navigate back to CMED Portal OR directly into the target application to execute the query

ASSUMPTIONS

For this option to be viable – the following is assumed:

- The CMED middleware will be able to expose a search landing page via LTI protocol to CMED Portal application which will be able to accept user's search query as input parameter
- CMED Portal application will be able to consume the search landing page LTI tool and will be able to redirect the user to the target CMED application along with the user's search query

ADVANTAGES

- This approach will require less effort because most of the vendors are expected to have search landing pages already in place
- Depending on the existing implementation – the effort required to integrate CMED with partner applications may also be insignificant

DISADVANTAGES

- The main disadvantage of this approach is that it will severely affect the user experience in a negative fashion because users will have to execute their searches across different applications manually and there will be no aggregate view of all the search results in a single UI screen

OPEN ISSUES

- The current implantation of CMED applications will need to be analyzed and integration interfaces defined for integrating the search landing pages.

IMPLEMENTATION

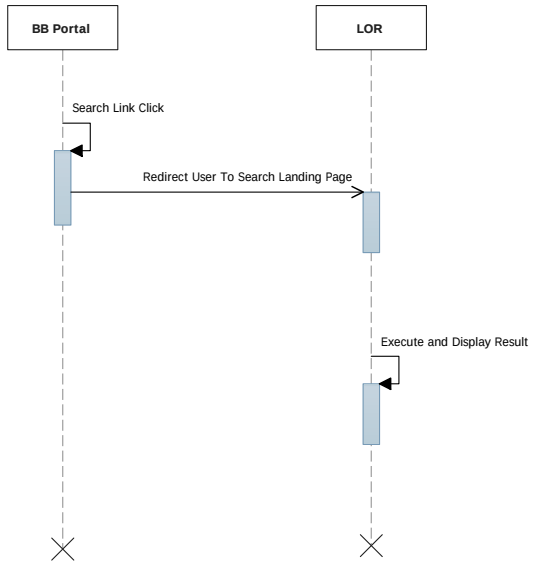


Figure 14 Sequence Diagram for Search Landing Pages

PHYSICAL ARCHITECTURE

The following diagram depicts the major components of the CMED system. It also depicts the physical system boundaries and respectives parties responsible for hosting and operating the components of CMED.

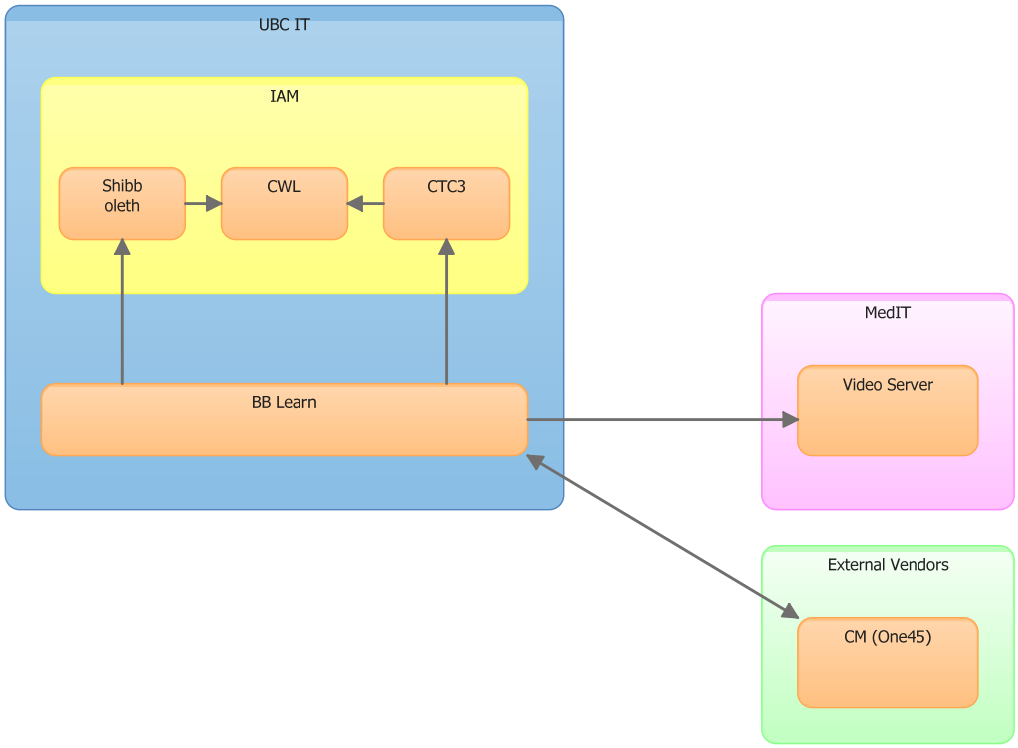


Figure 15 System Boundary Diagram

The following depicts the software interfaces providers and consumers of signification integration points between the CMED components systems:

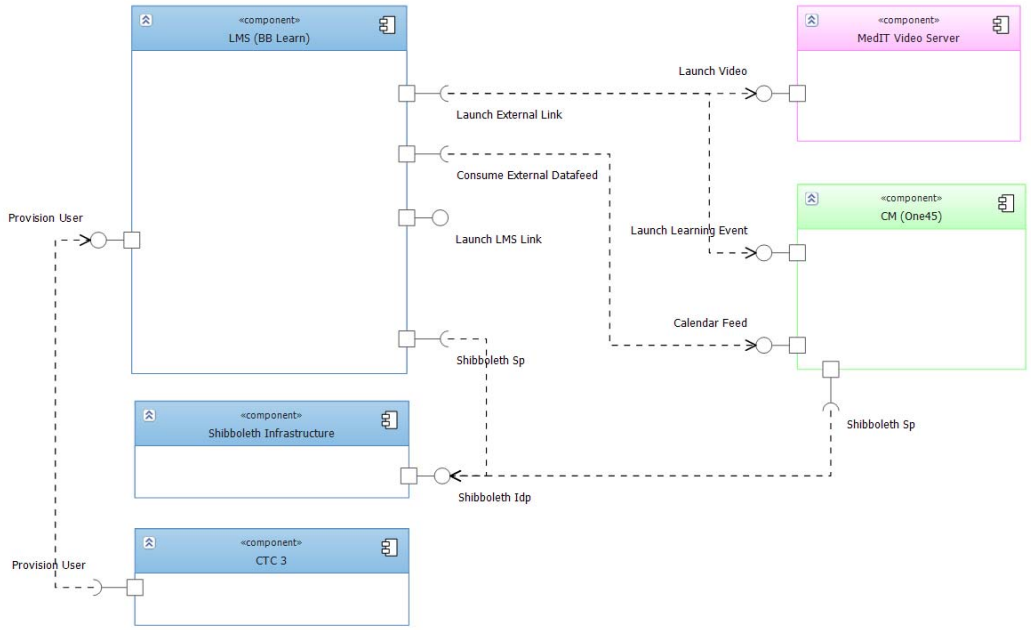


Figure 16 System Interface Diagram

GLOSSARY

Role	A group of users divided by their user profile or job function which can be assigned a standard group of permissions to interact with the system e.g. Faculty, Student etc.
Group	Groups are defined subsets of users for the purpose of collaboration and targeted communication
Authenticate	Process of indetifying the identity of the user based on user credentials
Authorize	Process of determining the user's authority to execute a certain functionality or interaction within the system
Shibboleth Idp	Shibboleth Identity Provider is the authority system responsible for authenticating the user
Shibboleth Sp	Shibboleth Service Provider is the system which user interacts with – this system relies on Idp for authenticating the user