Final Report of the Reference Model Projects Synthesis and Evaluation Project

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Executive Summary

The JISC reference model projects ran initially for 12 months from March 2005, with several of the projects being given a six month extension. The outputs from the reference model projects were both diverse and complex, In order to make the outputs of the reference model projects more accessible and to aid understanding of the reference mode projects, the JISC commissioned this project.

The reference model projects were:

- Course Validation Reference Model (COVARM)
- Framework Reference Model for Assessment (FREMA)
- Learning Activity Design in Education (LADiE)
- e-Portfolio for Lifelong Learning (eP4LL)
- Personal Learning Environments (PLE)
- Exchanging Course Related Information (XCRI)

Only four of the six projects included in this work were originally funded under the reference model banner. PLE and XCRI were funded through other mechanisms and then added to the reference model programme as they included some effort aimed in the direction of reference models. The result is that the artefacts that those two projects produced have the least in common with the other reference model projects.

Given the level of funding available to the synthesis project it has had to focus closely on the deliverables defined in the invitation to tender (ITT):

1. Collation of the approaches and outputs from the six Reference Model Projects into a preserved collection that can be browsed with high degree of openness and ease of access. This appears on the JISC website at http://misc.jisc.ac.uk/refmodels The web site is organised into two main sections: Analysis material specifically requested in the ITT with links to drill down into the body of the collated projects, and synthesis material organised around the lifecycle method (see 3 below) that compares and contrast reference model projects in the framework of a single method, and again supplies drill-down links to original reference model material.
2. Feedback recommendations on approaches used by Reference Models to current set of Domain Maps projects.

   We have been in discussions with the P-SPEX and ADOM domain model projects, and this has helped to lead to greater commonality of approach between the projects. We will also be sending them copies of the final report.

   We have also been working with the FREMA team in the development of the e-Framework upper levels (eFUL), which builds on the approach taken by the FREMA project and the HILDA project to develop a coherent, community based model of the higher education domain that can provide a method of exploring, locating and understanding the information in the e-Framework
3. Advice and guidance aimed at institutions and stakeholders on how to use domain maps to support the design, development and implementation of ICT systems to support the delivery of learning and teaching. There are three levels at which our advice and guidance apply:

   Firstly, in model driven development, a domain model for the problem domain has to be generated as the underpinning activity for any production of code. In such development, particularly where it follows the OMG standard for Model Driven Architecture, the model has the potential to become the operational system.

   The second level of application of these guidelines is in the use of an existing model-based knowledgebase that addresses the problem-domain and its context. For the UK HE sector such a knowledgebase may be provided by a rich population of the High Level Domain Architecture (HILDA) model.

   Thirdly, the development process will yield deliverables for the project itself and for the HILDA knowledgebase, for which guidelines are provided to place them correctly within the knowledgebase.

4. Synthesis of reference model work undertaken into a coherent accessible whole for wider dissemination. The outputs from the reference model projects were analysed and two kinds of syntheses produced.

   The first synthesis was a methodological synthesis. As a result of analysis, we derived a single lifecycle method from the four most methodologically similar reference model projects. We then used this lifecycle method to compare and contrast the methods and design artefacts used in the four projects.

   The lifecycle method provides a general method that may be adopted by future reference model projects.

   The second synthesis approach was at the domain level where High Level Domain Map (HILDA) was used to supply a framework that positioned the individual projects in a higher-level domain map of Higher Education.

5. Evaluation of the outcome of the reference model programme against its aims, objectives and assumptions.

   The six reference projects exhibit considerably diversity in origin, methodology and nature of deliverables. This makes it is difficult to provide a fully levelled evaluation of results across all projects yet also reflect the true value of their outcomes within the e-learning framework.

   In order to introduce a degree of conformity across the project profiles a small online survey was performed designed to capture views of a key stakeholder from each project. Questions were structured in line with the requirements for a reference project as detailed in "JISC Circular 10/04 Circular for the Specification of e-learning Framework Reference Models". The goal was to gain insight to the projects against these common criteria.

   Results are analysed by question across projects, and the respondents original answers are supplied in an appendix to this report. In summary we conclude that the core question to answer is “to what extent have the projects collectively advanced the e-Learning Framework (ELF)?” This is best answered in two parts:

   - Furthering Domain Knowledge - Each project developed a body of work that delves deeply into its chosen domains and provided improved understanding in its area of the HE environment.
   - Adding further substance to the ELF – Through the development of knowledge within each domain the ELF gained greater depth.

   Our judgement is that the sum of the effort across the projects was to further advance the ELF.

6. Extraction of further SUMs from the reference model projects. The state of this activity both inside and outside the synthesis project is:

   - In the time available the synthesis extracted two draft SUMs from the COVARM project and submitted them to the UK e-Framework editor
   - The UK e-Framework editor has already extracted a SUM from the eP4LL project.
   - The UK e-Framework editor has undertaken, as a result of negotiation with the synthesis project, to document the XCRI Interoperability standard in the e-Framework.

7. Recommendations to JISC on the

   - Value of a domain model approach
   - On further development activity
   - General topics associated with the reference model projects

   Overall we are supportive of a domain model approach to underpin development in the e-learning and allied domains. We considered alternative ways to represent domain models in our work, and decided that adopting the approach espoused by the High Level Domain Map (HILDA) represented the best available approach to representing the work of the projects at domain level.

The recommendations for future work are divided into three parts:

- Work that might be undertaken to ensure that reference model (and related work in SUMs, domain mapping etc) might be made more useful.
- Work in general areas where it might be appropriate to undertake more reference model creation that would help to move forward the e-Framework as a whole.
- Existing work in the individual projects that could be extended to provide greater value and build on the existing work.

We note that much of the information about future work information was derived, as agreed with the JISC, by consulting staff who worked on the reference model projects. Time limits on the synthesis project precluded deeper investigation of these topics, and we strongly suggest that that the suggestions need to be further validated before any of them are selected for future funding.

The synthesis project produced 42 recommendations to the JISC. These recommendations a broad spread of aspects of the reference model projects and the reference model programme. In order to simplify scanning of these recommendations we have reduced them to four overarching summary recommendations, and centralised all recommendations at the beginning of the full report together with page references to the recommendations' original context.

The three summary recommendations are:

- **Recommendation**: Synthesis projects should be funded alongside, rather than after, programmes in order to maximise the benefit. This would mean providing time for individual projects to work with the synthesis project and ensuring that the synthesis project was providing benefit to the individual projects.
- **Recommendation**: Reference modelling, domain modelling, and the production of SUMs and other project outputs is far more effective where these are provided by or elicited from community of practice, and JISC should therefore ensure that such work is closely tied to existing CoPs.
- **Recommendation**: More guidance should be given to projects working towards part of e-Framework (including reference models and domain models) so that the outcomes of projects can be combined and re-used more effectively. This includes guidance as to effective design, development and deployment lifecycle methods, and guidance as to project outputs.

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Recommendations

Recommendations can be found throughout the document to provide their proper context, however they are all brought together here for ease of reference. The recommendations can be summarised in the following three recommendations:

Recommendation: Synthesis projects should be funded alongside, rather than after, programmes in order to maximise the benefit. This would mean providing time for individual projects to work with the synthesis project and ensuring that the synthesis project was providing benefit to the individual projects.

Recommendation: Reference modelling, domain modelling, and the production of SUMs and other project outputs is far more effective where these are provided by or elicited from community of practice, and JISC should therefore ensure that such work is closely tied to existing CoPs.

Recommendation: More guidance should be given to projects working towards part of e-Framework (including reference models and domain models) so that the outcomes of projects can be combined and re-used more effectively. This includes guidance as to effective design, development and deployment lifecycle methods, and guidance as to project outputs.

1 Introduction

This is the final report for the JIISC-funded project to synthesise and evaluate the reference model projects.

In this introduction the reference model projects are briefly listed; reference models, domain maps and SUMs are briefly introduced; and the introduction concludes with a discussion of the deliverables for the synthesis project and how these were met within the synthesis project.

1.1 The reference model projects

The reference model projects are:

- Course Validation Reference Model (COVARM)
- Framework Reference Model for Assessment (FREMA)
- Learning Activity Design in Education (LADiE)
- e-Portfolio for Lifelong Learning (eP4LL)
- Personal Learning Environments (PLE)
- Exchanging Course Related Information (XCRI)

The reference model projects ran initially for 12 months from March 2005, with several of the projects being given a six month extension. Only four of the six projects included in this work were originally funded under the reference model banner. PLE and XCRI were funded through other mechanisms and then added to the reference model programme as they included some effort aimed in the direction of reference models. The result is that the artefacts that those two projects produced have the least in common with other reference model projects; this will be referred to again as appropriate.

1.2 Reference models, domain models, SUMs

There has been considerable change since the projects covered by this synthesis were funded. The JISC's thinking has moved on from reference models and towards other ways of describing domains, including domain models and service usage models (SUM). It is therefore worthwhile looking at what each of these terms mean, and their relationship to the work of the reference model projects.

As a starting point we will use the definition of reference model in the original JISC circular that called for the projects[1].

1.2.1 Reference models

The closest that the circular comes to definition of a reference model is in paragraph 3, which states:

> Each project is expected to:
>
> - Produce an e-learning framework (ELF) reference model in line with the domain areas described in this circular:
>
> i. define the scope of the application domain to be addressed;
>
> ii. gather a portfolio describing current practices, processes and systems that address this application domain of use cases and scenarios of the domain;
>
> iii. identify the shortcomings to be addressed and produce a gap analysis of the domain area;
>
> iv. map the application domain to the services defined in the ELF;
>
> v. define a common solution pattern for the application domain;

[1] http://www.jisc.ac.uk/fundingopportunities/funding_calls/2005/01/funding_circular10_04.aspx

vi. develop use cases describing the use of systems within this pattern;

vii. define which ELF service definitions are best to be used to support the pattern, if necessary defining application profiles of existing specifications, or new service definitions.

This suggests that a reference model should have the following characteristics:

- A *reference model* is based on an *application domain* rather than, for instance, a functional domain. Thus It would suggest that a reference model might encompass a student record system rather than admissions, enrolment or some other functional area. However, most of the reference model projects were based around functional domains rather than application domains.
- A *reference model* would be based on current practices and processes, but include shortcomings and gaps in those practices and processes. There is a strong suggestion here that a reference model is primarily descriptive of current practices, with the intention to incrementally improve them through the identification of the gaps and shortcomings.
- A *reference model* will encompass a set of use cases that address the application's functions and scope.
- A *reference model* will go beyond mapping and define a common (normative) solution pattern for the application domain that will, in some sense, define the functionality of applications that address the domain.
- Using the common solution patterns (sometimes referred to as canonical), a *reference model* is a way to map an application domain to services, and especially services as defined in the e-learning framework (ELF). The intention being to reuse appropriate existing services from the ELF and implement other services which could populate the ELF. With the move to the e-Framework this mapping is done by SUMs.

In short, a *reference model* is a method for describing an existing application domain in a normative way and mapping the application domain to services within the e-learning framework through the use of scenarios and use cases. This in turn could be generalised to mapping the application domain to services in a framework (such as the e-Framework), and removing the particularity of the ELF.

However, since the funding of these projects the *e-learning* framework has merged into the *e*-Framework, an international effort supported by JISC (UK), DEST (Australia), SURF (Netherlands) and Ministry of Education (New Zealand). The reference model concept has been replaced by SUMs including service genres and service expressions to describe lower level components (equivalent to the services in the ELF). There is also recognition of the need for a higher level model or map which can be used to help people to understand the domain and to locate SUMs etc and where particular ones may apply. To date there has been the development of the high level domain map (HILDA) which addresses the more abstract domain levels, and there is other work being undertaken on the "e-Framework upper levels", with work currently based on HILDA and the semantic wiki that was used in the FREMA project. HILDA and the e-Framework are discussed in Appendix A: HILDA and the e-Framework and the FREMA Wiki is discussed in the main body of the report (as part of one of the FREMA reference model project).

1.3 Project deliverables

Given the level of funding available to the synthesis project it has had to focus closely on the deliverables defined in the invitation to tender (ITT). Accordingly, it is worth briefly considering each of the project deliverables as defined in the ITT for the synthesis project:

3. Collation of the approaches and outputs from the six DeL Reference Model Projects into a preserved collection that can be browsed with high degree of openness and ease of access. This could be through a section of the JISC website.

4. Feedback recommendations on approaches used by Reference Models to current set of Domain Maps projects.

5. Advice and Guidance document aimed at institutions and stakeholders on how to use Domain Maps to support the design, development and implementation of an ICT system to support the delivery of Learning & Teaching.

6. Synthesis of reference model work undertaken into a coherent accessible whole for wider dissemination, including an integrated contribution, drawn from the projects, to a higher level domain map for learning, and which can also be used as a navigation tool to the projects in the preservation web site.

7. Evaluation of the outcome of the programme against its aims, objectives and assumptions.

8. Recommendations to JISC
    - Value of domain model approach
    - On further development activity

It should be noted that deliverables 1 and 4 form the synthesis project's web site. While an overview of that site is included in this report, the web site should also be accessed by interested readers.

The following sub-sections discuss how the synthesis project deliverables were met.

1.3.1 Collation of projects into a single web site

The projects web sites have been brought together in a single web site, at http://misc.jisc.ac.uk/refmodels (or http://tinyurl.com/39u7fj).

We provided a number of different ways in which the reference models can be explored and used including the information on the following topics:

Overview: General description of project.

User level: Description of how user and use information was gained by the project, and how any design was performed to decide on issues which affect the users and the use of systems. This includes how the project decided on and designed system scope, contents, functionality and user interfaces.

Technical level: Description of design processes for technical aspects of the system, including any decomposition into services.

User to technical transition: Description of how the transition was made from user-level concerns and design processes to technical-level concerns and design processes.

Services: Services identified and prototyped or implemented in the projects. These potentially contribute to e-Framework SUMs.

Development tools: This lists any specialists tools used in the project, and excludes standard tools (e.g. drawing programs, word processors).

Reuse tools: Tools produced by the project for reuse by other projects.

Not all projects produced information or products in all of the areas above.

Projects' final reports were gathered from diverse locations and incorporated into the web site.

Further, as part of one of two synthesis activities, the four most similar reference model projects (COVARM, FREMA, eP4LL, and LADiE) were examined in a single model based design framework. This material, also on the synthesis project website, allows other ways of drilling down into the original reference model project material, allowing examination and comparison of design methods and notations adopted by the four projects.

1.3.2 Feedback recommendations to current domain map projects

We have been in discussions with the P-SPEX and ADOM domain model projects, and this has helped to lead to greater commonality of approach between the projects. We will also be sending them copies of the final report.

We have also been working with the FREMA team in the development of the e-Framework upper levels (eFUL), which builds on the approach taken by the FREMA project and the HILDA project to develop a coherent, community based model of the higher education domain that can provide a method of exploring, locating and understanding the information in the e-Framework.

1.3.3 Advice and guidance document aimed at institutions and stakeholders on how to use domain maps

This is attached at Appendix B: Advice and guidance document aimed at institutions and stakeholders on how to use domain maps.

1.3.4 Synthesis of reference model project outputs

The outputs from the reference model projects were analysed and two kinds of syntheses produced.

The first synthesis was a methodological synthesis. Each reference model used a particular approach or method in its analysis and design work. The four methodologically most similar projects were chosen, and their methods analysed. Each project used a model based approach to design, and the projects' methods were placed in a generic model based approach. From the general approach and individual project descriptions a lifecycle method was derived for future projects working in similar domains.

The second synthesis approach was at the domain level where High Level Domain Map (HILDA) was used to supply a framework that positioned the individual projects in a higher-level domain map of Higher Education.

The methodological synthesis appears in section 3. The domain mapping appears in HILDA.

1.3.5 Evaluation of the outcome of the programme against its aims, objectives and assumptions

The evaluation was undertaken by a combination of review of the project documentation and a survey of the projects. The evaluation can be found in Section 4 and the survey results in Appendix E.

1.3.6 Recommendations to the JISC

Recommendations to the JISC appear in context in the body of and appendices to this report. They are extracted from their context (together with originating page numbers) and presented in a table in the front material to this report.

2 The projects

The six reference model projects are described very briefly below. Further detail is contained on the synthesis project web site at http://misc.jisc.ac.uk/refmodels.

2.1 COVARM

2.1.1 Overview

The COVARM project was concerned with **course validation** which can include the specification of new courses at various levels. Specifications address areas such as rationale, appropriateness, justification, marketing analysis, resources required, economic viability of the courses, and detailed descriptions of the courses in terms of programme outcomes, aims and objectives and so on. Much of the scope of course validation is determined by local institutional constraints (e.g. relationship to other courses and university regulations) but there are wider requirements that impose a significant overhead on the developmental process for validating new courses. These wider requirements are determined by the national bodies such as the QCA. These bodies collectively ensure that courses are designed and validated to the required level of quality standards. Course validation could also include the re-validation of courses, and as suggested in the definition relates to number of other domains including teaching and learning and marketing.

The COVARM project gathered course validation process and domain data from four institutions. These were modelled in UML, and canonical domain and process models were then synthesised from the for sets of individual institutional models

A component architecture was then designed to implement the generic process. A detailed description was written in Business Process Execution Language (BPEL). To deal with different institutional cases and their variations in terminology, process activity and business rules a second implementation phase was performed, where the BPEL was augmented with a business rule language.

The project was very clear about using a model based approach:

> "One way to provide services in close alignment with business processes is to adopt a formal model driven development process that can link the business processes to the sets of services required to support them, managing the whole service provision lifecycle. The starting point for this model driven development is a business process model that can become a reference model used to direct the provision of services.[2]"

This is discussed further in the user level[3] and technical level pages[4] on the synthesis project web site. However, while the approach, of building a superset process model and superset domain model works here, we can not venture if it is a generally applicable approach.

There were three elements to COVARM's on a model-driven approach, they are mentioned here as an exemplar of the approach:

> "The general approach taken by the project will be based on three principal foundations. Firstly, an adapted version of Rational Unified Process (RUP) will be used to support the design / implementation of the services and the proof of concept application for the reference model. RUP will be adapted to support component based /service based principles of software architecture.

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2 http://misc.jisc.ac.uk/refmodels/COVARM/covarm.tvu.ac.uk/covarm/papers/COVARM_ICEIS_v1.pdf

3 http://misc.jisc.ac.uk/refmodels/guide_to_projects/COVARM/user_level_design.html

4 http://misc.jisc.ac.uk/refmodels/guide_to_projects/COVARM/technical_design.html

A second foundation will be the use of a model driven architecture using UML 2.0 as the primary mechanism for defining and delivering models. The ELF and the general JISC strategy would appear to be predicated on the use of models. This project will enforce that approach and we will be using a model driven approach in a systematic manner to:

- represent the results of the analysis of various institutions;
- construct the canonical information requirements and business processes for the domain;
- define technology independent specifications of services;
- define XML data representations of the information consumed and produced by services;
- generate appropriate implementation models of the service specifications.

The third element will be an iterative approach to enable early outputs of deliverables for dissemination and review. This is particularly relevant to the technical deliverables. Iteration and early testing will allow the changes to specifications. A use case driven approach will enable us to scope requirements and the content for the iterations based on prioritised use cases."[5]

The COVARM method is described in the COVARM "methodology" paper presented at ICEIS[6].

The COVARM synthesis method is highly interesting as an approach to building canonical models from individual institutional models but we (the synthesis project) have some further questions about the approach: If there are widely divergent process models and domain models in some domain (as are evident in the FREMA assessment reference model project) then can we build a common process and domain model that is a superset of the domain? From a UML modelling process, yes, but will there be usable coherency?

Recommendation 1: The JISC should consider investigating the extent to which the COVARM model synthesis approach is broadly applicable, and the domains in which it is likely to be applicable. If any of those domains are central to HEI or FEI operation the JISC should then consider funding projects to characterise those domains, and to further study the application of the synthesis method.

Two SUMs were derived from COVARM descriptions as part of the synthesis project, and have been submitted to the e-Framework.

2.2 eP4LL

The eP4LL reference model project uses the BECTA e-Portfolio categorisation as a means to further subdivide the otherwise broad area of e- Portfolios. BECTA divide e-Portfolios into four divisions:

- Transition
- Assessment
- Presentation
- Learning

eP4LL addresses the Transition e-Portfolio. Transition focuses on the progress a learner makes through the stages of lifelong learning beginning with primary education through further education into higher education, and incorporation of professional life. e4PLL considers transition to also take into account administrative and learning processes.

Within the possible transitions a learner might make, eP4LL focuses on two transition phases:

- Key Stage 4 to further education
- Further education to higher education via UCAS

The project aim is to:

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[5] from the web site methodology page http://misc.jisc.ac.uk/refmodels/COVARM/covarm.tvu.ac.uk/covarm/methodology.html

[6] http:// misc.jisc.ac.uk/refmodels/guide_to_projects/COVARM/extraMaterial/covarm- methodology-paperV1.pdf

- Within its focus, conceptualise e-Portfolio in terms of the e-Framework.
- Review the role of interoperability standards.
- Seek a simpler more pragmatic model of interoperability than IMS LIP (UK LeaP).

The project documentation lists a number of outputs, the key ones for this summary being:

- The overarching domain map comprising service flows (possible SUMs) and Web Services covering the process of transition of FE into HE via UCAS.
- Evaluation of the e-Framework as an e-Portfolio enabling technology.
- Development of the concept of the "Thin e-Portfolio" as a practical approach to a complex problem and application of this concept to the transition stages noted above.
- Consideration of "integrative e-Portfolio" driven by "e-Portfolio engine"

The project outputs included an HTML demonstrator of how e-Portfolio might contribute to the HE application process, and this is now being worked out further by the Wolverhampton PortisHEad project which is working on e-Portfolio-based admissions to HE. eP4LL also commissioned two prototype demonstrations that are, in one case, no longer live, and, in the other case is, made hard to discern by later prototype developments.

Some other project outputs are drawn from a JISC website eP4LL page[7]:

- An overarching domain map, comprising service flows and web services covering the whole process of transition into HE through UCAS, predicated on an e-Portfolio-based learner application.
- Technical specifications.
- Design of a service genre, the Personal Profiling service.
- Provision of use cases and Service Definitions scoping further service genres.
- Prototypes of two web services: Get Entry Profile service and Get e-Portfolio Items service.
- An exemplification of the "thin" model of e-Portfolio designed for the more open information environments JISC is developing and covering implementations within a single institution and for Lifelong Learning and Lifewide Learning.

2.3 FREMA

The Framework Reference Model for Assessment (FREMA) Project was to build a reference model for the assessment domain on top of the e-Framework in order to ease development and promote reuse. Particularly:

> "Assessment is a large and complex portion of the e-Learning Framework, interacting with VLE's, Portals and Marking Tools at the User Agent layer, multiple Learning Domain Services including Sequencing tools, Grading, Marking, Reporting, Competency and Tracking and relying on most of the ELF common services."

FREMA set out to:

- Define the scope of the Assessment domain terms of existing practice
- Define common Assessment solution patterns in terms of use case studies and scenarios
- Relate them explicitly to the ELF in the form of a service profile and service descriptions
- Provide prototype services that fulfil the profile of the Assessment domain, act as proof of the Assessment Reference Model and allow the reference model to be evaluated."

FREMA took an interesting approach that was not replicated in any of the other reference model projects, where (after analysis with users) the FREMA team built a knowledge base around a semantic wiki and supplied knowledge maps to ease the activities of people using the FREMA reference model.

The FREMA project produced the following main deliverables:

- A reference model in the form of a semantic wiki
- An ontology of the e-assessment domain
- A set of e-assessment concepts, depicted in two concept maps

[7] http://www.jisc.ac.uk/publications/publications/eportfolioforlifelonglearning.aspx

- A glossary of e-assessment terms
- A collection of e-assessment use cases (including "End to End Summative" and Peer Assessment)
- SRC Cards - a notation to describe the responsibilities and collaborations of abstract services
- Publications
- The FREMA project produced one SUM, for Summative Assessment. This FREMA SUM is not an e-Framework SUM, but there is a similarity between the two kinds of SUMs, and the FREMA SUM is a potential e-Framework SUM.
- FREMA also provides two scenarios (for peer assessment and for the involvement of external examiners in the assessment process). These scenarios are not yet near the stage of being a FREMA SUM or an e-Framework SUM, but they indicate areas for potential development. Peer assessment is a particularly important area and this warrants further development.

Recommendation 2: The FREMA peer assessment scenario should be developed further. The developed scenario and the FREMA end-to-end assessment SUM should be represented as e-Framework SUMs and placed in the e-Framework.

2.4 LADiE

The Learning Activity Design in Education (LADiE) Project designed a reference model called the Learning Activity Reference Model (LARM). LARM consists of two components which are a learning activity editor, and a learning activity player. The aim of the learning activity editor is to allow learning technologists to specify units of learning which can then be interpreted using the learning activity player, a learner activity runtime system. Neither has been implemented by the project. LADiE also provides guidelines to use the reference model

Recommendation 3: The two potential SUMs identified in the LADiE project (the learning activity editor and the learning activity runtime player) should be refined to the extent that they can be extracted and included in the e-Framework. This is not a small project and will involve considerable work and possible reconstitution of the editor and player in the light of ongoing work elsewhere.

The design of LARM was informed by a series of activities with teachers (practitioners) where, with the eventual intervention by learning technologists, use cases were developed that described particular teaching activities.

These use cases were then used to inform the design of the facilities in LARM, mediated by knowledge of available and/or likely services. Thus LADiE combines top-down and bottom-up approaches.

LADiE claims in one of its presentations[8] that it is:

- Rooted in Practice
- Informed by effective approaches to teaching and learning
- Expressed in a well defined and understood vocabulary
- Independent of proprietary software

LARM addresses three groups via three guides that together define the LARM:

- The Learning Activity Reference Model - Pedagogy Guide[9] addresses the needs of teachers / practitioners. It "offers guidance on how to create a learning activity, on effective use of tools and resources in implementing activities, and a language and structure by which teaching practitioners and learning technologists might discuss the development and implementation of learning activities" "The full set of use cases is described in the LARM Pedagogy Guide. "

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8 http://misc.jisc.ac.uk/refmodels/LADiE/www.elframework.org/refmodels/ladie/outputs/workshop/LADiE_presentation.ppt

9 http://misc.jisc.ac.uk/refmodels/LADiE/www.elframework.org/refmodels/ladie/guides/LARM_Pedagogy30-03-06.doc

- Learning Activity Reference Model - Services Guide[10] addresses the needs of developers and vendors. It discusses technologies for core services (IMS LD, IMS SS, BPEL,..); Service definitions for the Learning Activity Editor, Player, and peripheral services. "This version of the LARM is primarily based on the use cases ... While these use cases are not exhaustive they do provide sufficient examples of the general principles involved in learning activities. The detailed requirements for each service in the following section have been derived from the requirements of the use cases."
- Learning Activity Reference Model - Implementation[11] addresses the needs of technologists / implementers. It "defines the reference model so that those creating new educational technology applications can ensure they can be used through the LARM". It includes a description of a set of services, with the note that: "New use cases will emerge over time and these will require new services to be added."

In as much as LARM exists, readers may be interested in how to use it[12].

2.5 PLE

"The Personal Learning Environment (PLE) project … sought to investigate the impact of emerging technologies on e-learning provision from a variety of perspectives ranging from institutional organisation to pedagogical practice."[13] The work involved considering the emerging representations of PLEs in the current discourse, with its particular emphasis on some of the ideas that have been emerging through the growth and development of Web 2.0 type technologies. The PLE Project then made use of the patterns, pioneered by Christopher Alexander, and identified patterns that must be reproducible within a PLE. The PLE Project then used the patterns to specify parts of the PLE as a reference model.

The PLE Project also produced a desktop Personal learning Environment (PLEX) that is based on the Eclipse rich client framework Some PLEX features include:

- Manage Activities, People and Resources
- Opportunities Explorer
- RSS subscription
- Atom, FOAF, Blogger support
- IMS Enterprise support
- Monkey JavaScript support
- Resource manager view to organise your favourite files and web links

10 http://misc.jisc.ac.uk/refmodels/LADiE/www.elframework.org/refmodels/ladie/guides/LARM_Services.doc

11 http://misc.jisc.ac.uk/refmodels/LADiE/www.elframework.org/refmodels/ladie/guides/LARM_Implementation.doc

12 http://misc.jisc.ac.uk/refmodels/guide_to_projects/LADiE/using_LARM.html

13 http://misc.jisc.ac.uk/refmodels/guide_to_projects/PLE/reports/plejiscrep_hw_1.pdf

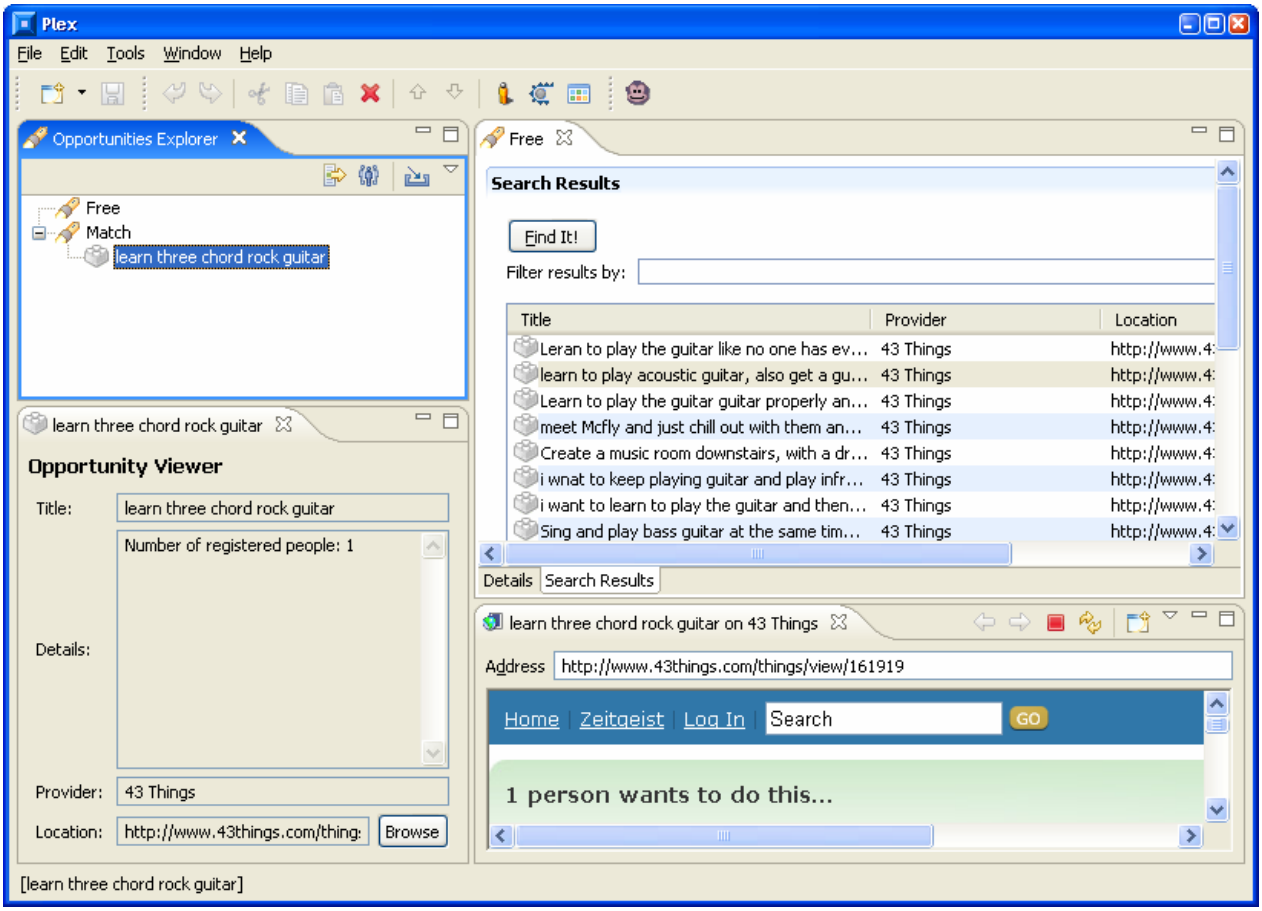

Figure 1: Screen shot of the Plex personal learning environment

2.6 XCRI

The main aim of the XCRI project was to produce an XML based standard for course description purposes, with an emphasis on its use for advertising courses. The XCRI standard has gone through two iterations and is very successful, having been used in a variety of different circumstances that are presented in the final report and detailed on the following map (drawn from the final report):

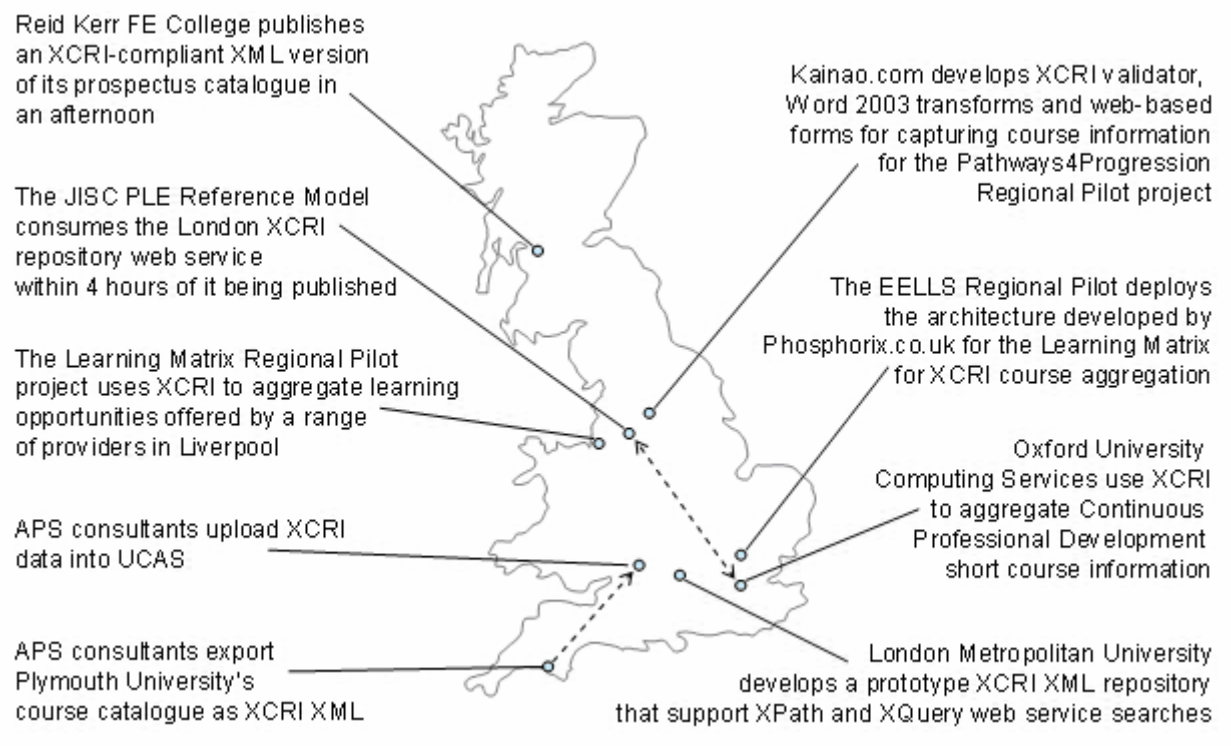

Figure 2: Use of XCRI by other projects across the UK

While the XCRI Project is highly successful, because the project produced an interoperability standard rather than a reference model, there is relatively little of relevance to the synthesis project in the XCRI reference model work. What is of interest to the synthesis project is:

- A service, the London Metropolitan University XCRI Repository, was developed for the e-Framework that used a RESTful HTTP protocol that included XPath and XQuery searches in the URLs.
- The PLE Reference model project consumed data from the London Metropolitan University XCRI repository.
- More recently a demonstrator search utility that mashed-up XCRI data with geographic information illustrates service use in a Web 2.0 mashup style.

Some XCRI-Based Projects are:

- XP development by Phosphorix[14]
- UCAS and the University of Plymouth, database-to-database transfer
- Scottish Further Education College Reid Kerr extended the Microsoft Active Server Page solution used to populate their online course prospectus to include XCRI-compliant XML in only an afternoon.
- Oxford University Computing Services used the XCRI schema to publish details of their short course offerings for aggregation in a Continuous Professional Development (CPD) system
- Manchester Metropolitan University is currently reviewing the template used for its Programme and Module specification documents. Wrote XSLT to transfer XCRI to XHMTL.
- The XCRI XML repository and query web service developed by London Metropolitan University. Useful REST-BASED service with XPath queries inline in HTTP requests. All code developed for the XCRI web service is available for download from the XCRI web site. A zipped distribution is available with links to a TiddlyWiki[15] with Javadoc and UML documentation.

[14] http://www.elframework.org/projects/xcri/20060130Manschester#phosphorixi
[15] http://misc.jisc.ac.uk/refmodels/guide_to_projects/XCRI/TiddlyWiki/xcriTiddlyWiki.html

3 Methodological synthesis of the reference model projects

3.1 Introduction

As discussed above, one of the approaches taken to synthesis of the reference model projects was to examine how individual projects went about the business of design – from the projects initial investigation of a domain (including contact with users) through to the design of a service oriented architecture and the prototyping or implementation of that architecture.

In what follows we carefully use two terms consistently:

- A *method* is a sequence of steps that a project follows in order to perform activities. A method can cover the entire lifecycle of a project, from initial investigations, through design, implementation, rollout and investigation of the system in real use. A method can cover iterative application of lifecycle activities. [16]

- *Methodology* is the study of, and, possibly, the invention of methods. Methodological is the adjective that is derived from the noun methodology.

Thus, in the context of this synthesis project, *methodological synthesis* is concerned with the creation of a single method that describes the individual methods used by the reference model projects.

In fact, not all projects were studied for the purpose of synthesis. There was no requirement that reference model projects documented their methods, and we were lucky to be able to extract methods used from four of the projects (COVARM, eP4LL, FREMA and LADiE) from their documentation. All of these projects used the same kind of method, called model based design (discussed below).

The PLE project also used model based design when they designed and implemented their prototype, PLEX. However, because of other project concerns in the limited time of the project, the PLE Project did not document their model based design activities.

XCRI was concerned with the extraction of information to design a standard, and therefore was not concerned with a method that corresponded to the other projects' methods.

No criticism of either the PLE or the XCRI project is implied by exclusion from the synthesis activities described here.

3.2 Usefulness

We found that a methodological approach was very useful in detecting similarities across and differences between COVARM, eP4LL, FREMA and LADiE.

Most importantly, this approach has given rise to a method which we tentatively call *the lifecycle method*. With some additional methodological work the lifecycle method may be adopted in future reference model programmes and projects. The lifecycle method has some similarities to the JISC's Users and Innovation Programme's Users and Innovation Design Model (UIDM). We discuss similarities and difference between the lifecycle method and the UIDM on the synthesis project web site [17].

[16] A method is composed of various design techniques, e.g. scenario generation, use case generation, domain mapping, service identification etc. A design technique takes some aspect of the design problem (either observing or interacting with the domain and/or an existing design artefact produced from the enactment of another design technique) and transforms that representation to produce a design artefact that contributes to the developing design, prototype or implementation.

[17] http://misc.jiac.ac.uk/refmodels/analysis_and_synthesis/methods_UIDM.html

The creation of the lifecycle method comes at a significant time in respect of other strands of the JISC's activities, and the method may, with more work, be linked into those strands. The related strands are:

- The e-Framework. The lifecycle method is an important adjunct to the e-Framework, which is method agnostic and provides no methodological guidance to project teams.
- JISC guides – several guides have been commissioned by the JISC, on:
  - Requirements analysis
  - Scenarios
  - Domain mapping
  - Process modelling
- The lifecycle method is capable of placing these guides in context.
- The high-level e-Framework, under development. This will provide indications of areas where the lifecycle method might be applied.

The UIDM, as discussed above. At the very least the lifecycle method and the UIDM share common components and approaches. The two methods may possibly be integrated, with the proviso that they address different aims (the UIDM is aimed at prototype developments that are more likely to be in a state of continual beta and that may not be based on service oriented architectures).

Recommendation 4: The lifecycle method be integrated with other JISC artefacts and activities; particularly with the requirements gathering, scenario, domain mapping and process modelling guides commissioned by the JISC. This activity must include any necessary alignment across the guides and construction of a highly usable resource for future projects and their programme managers.

Recommendation 5: Commonalities and differences between the lifecycle method the UIDM should be identified, particularly for each method to take advantage of work performed on the other, and for potential unification in some method areas. This activity should be undertaken by experienced lifecycle methodologists who are not responsible for the UIDM to ensure that the lifecycle method focuses on its users' needs.

3.3 Model based design

The lifecycle method is a model based design method. An introduction to model based design is provided Appendix D, both as a preamble to the lifecycle method and to see how four of reference models can be viewed in the context of the method.

The four stages (i) user domain and process characterisation, ii) abstraction and model building iii) system design and iv) prototyping, implementation , testing and rollout) form a general description[18] and we can now situate activities in the four projects against this scheme. We do not consider detailed ordering of activities, both because this information was understandably generally missing from project documentation, and because we assume use of an iterative process.

We compiled all notable project activities against stages and their activities indicated by four boxes that are discussed and that appear across the top of the following diagram. We populated the stage boxes for each project with:

- Particular design techniques (constituent parts of methods). These appear in an upright (non-italic) font.
- Design artefacts produced by the projects. These appear in an italic font.

[18] There is a fine line to some activities belonging in first stage or the second stage. What if domain modelling introduces a new concept? For example, a learning design that can be created, edited, and enacted. Treating this strictly, modelling the new concept as an object in the domain model is design modelling. That activity occurs in second stage, rather than in the first stage, even though that idea might arise during the general flow of user and domain characterisation and description on the left of the diagram. At the level of detail in this report we will gloss over distinctions like this.

For each of the four projects the synthesis project's web site provides a methodological analysis that consists of:

- An introduction to the project area and scope
- A discussion of the project method
- A commentary.

These pages contain 'drill down' links into the project material. The pages are reachable in multiple ways[19].

[19] The pages are at
http://misc.jisc.ac.uk/refmodels/analysis_and_synthesis/method_covarm.html
http://misc.jisc.ac.uk/refmodels/analysis_and_synthesis/method_eP4LL.html
http://misc.jisc.ac.uk/refmodels/analysis_and_synthesis/method_frema.html
http://misc.jisc.ac.uk/refmodels/analysis_and_synthesis/method_ladie.html
They may be reached via
http://misc.jisc.ac.uk/refmodels/analysis_and_synthesis/methodological_overview_four_projects.html
or via http://misc.jisc.ac.uk/refmodels/analysis_and_synthesis/methodology.html

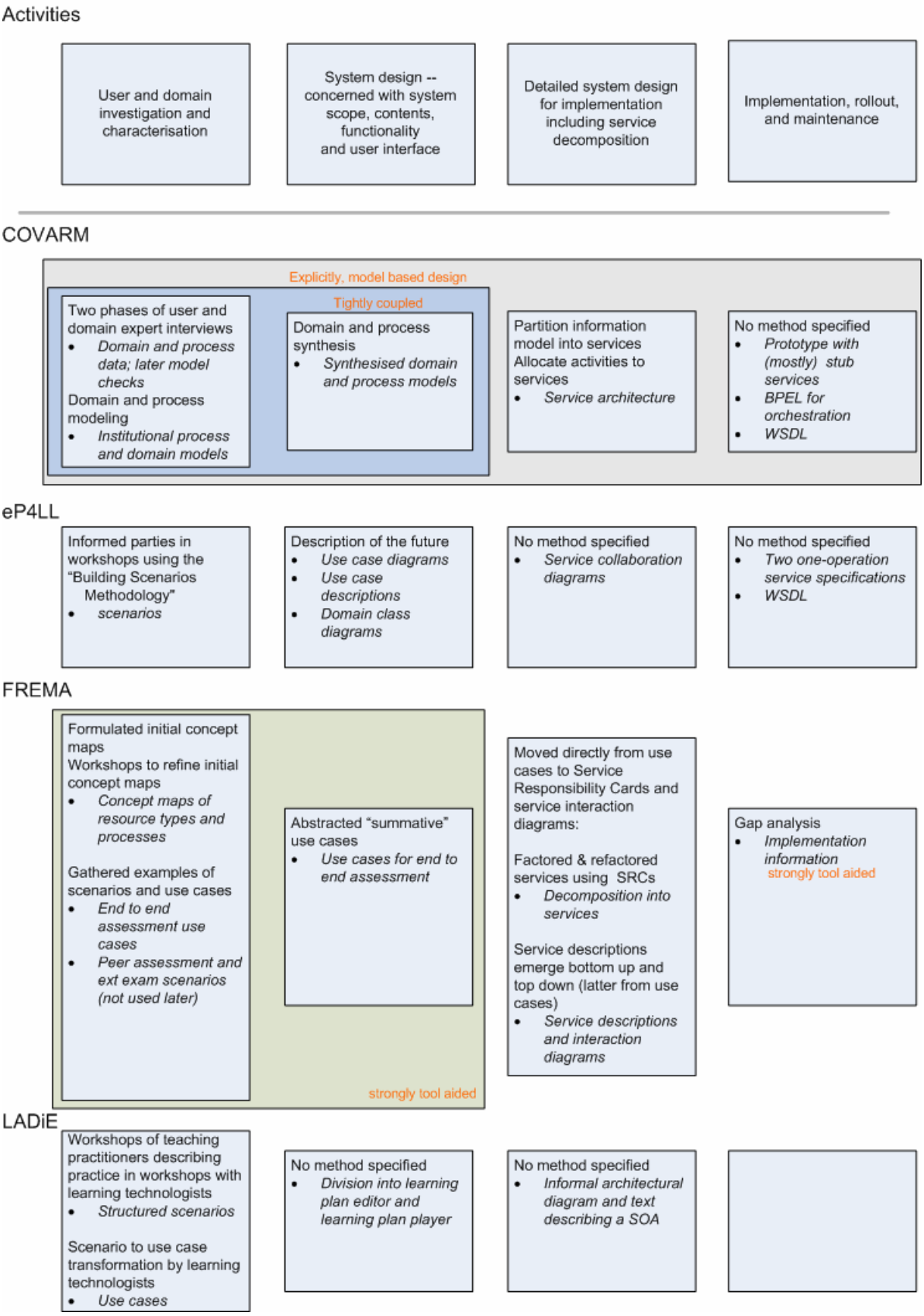

Figure 3: Design techniques (upright / non-italic font) and artefacts (italics) by stage across projects

3.4 The general lifecycle method

The outlines of a synthesised method are presented. The general method could be used by future projects that utilise a service oriented architecture approach. More information on the method's applicability is on the applicability page on the synthesis project website[20].

The method is based on:

- A synthesis of the four reference models' methodological practice.
- And the tripartite foundation of user involvement in design, model based design, and iterative design that involves formative evaluation by users.

The model is presented diagrammatically in two parts, first as an iterative pattern of four 'stages', then, secondly, showing the activities in the stages.

3.4.1 The iterative cycle

A set of design, prototyping/implementation and test loops is as shown previously:

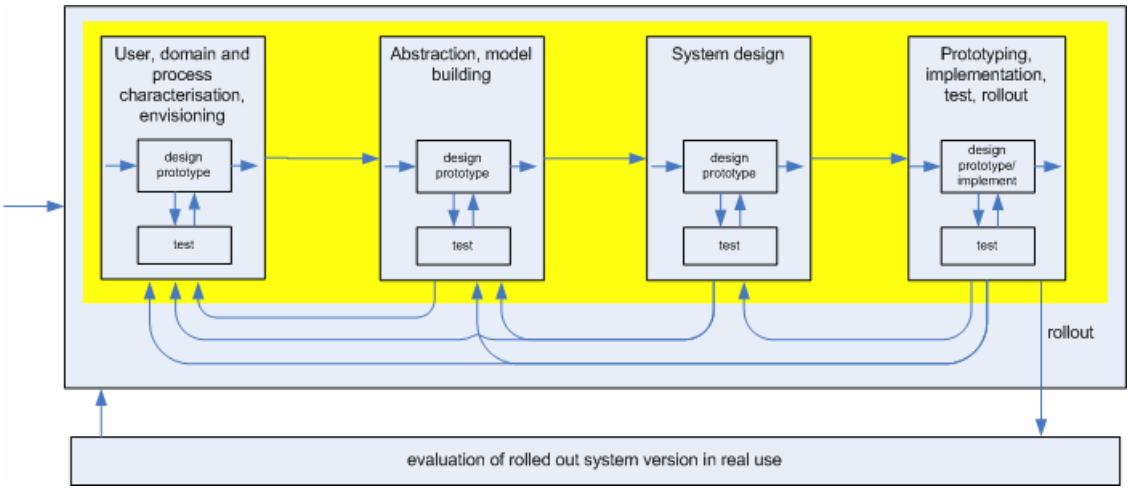

Figure 4: Full model based design cycle(s)

3.4.2 Activities in each stage

The iteration applies to the lifecycle method whose 'stages' are shown below:

[20] http://misc.jisc.ac.uk/refmodels/analysis_and_synthesis/method_applicability.html

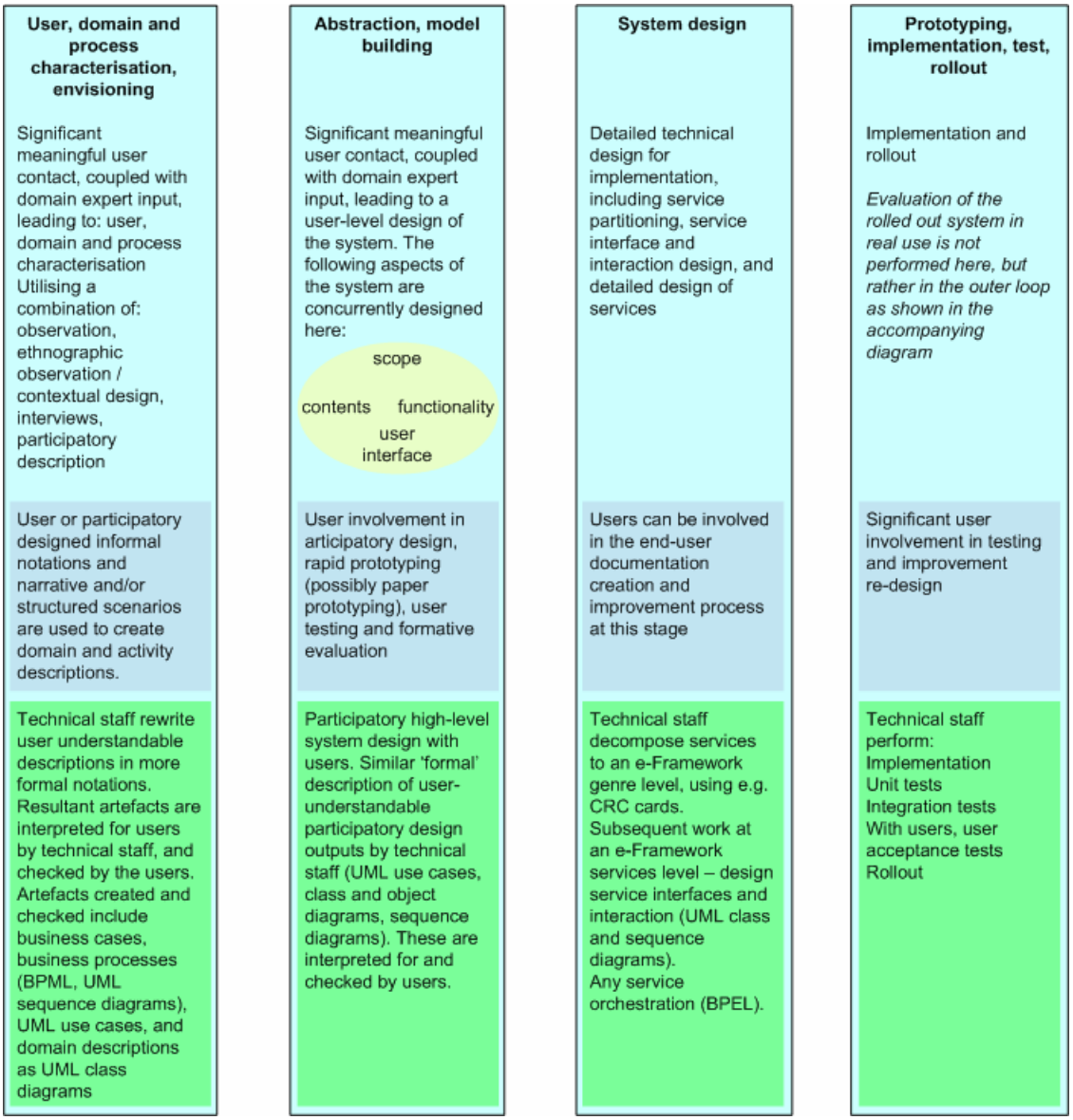

Figure 5: Lifecycle method showing stages

Meaningful contact with users is mandatory. For best results widespread user participation and participatory design is strongly recommended. Also recommended is widespread use of paper prototyping, with user tests involving formative evaluation.

3.5 Summary of design techniques used by stage

It is true that different projects will need to follow somewhat different forms of the lifecycle method depending on various factors including:

- Domain
- Organisational culture
- Team skills
- The availability of users for participatory design, formative evaluation and redesign
- Funding profile and available resource

In some respects projects need a well motivated pick-and-mix approach to design techniques, intermediate notations and project artefacts to support design in the particular circumstances within which the project finds itself. There needs to be a chain of design techniques that use intermediate (and

sometimes “mediating”, in LADiE’s terms) representations where the artefact that is the output of one design technique becomes the input to the next design technique.

Sometimes projects will, as LADiE did, need to change aspects of their chosen method during project execution in the light of experience gained in the use of the method.

In order to assist in a motivated approach to method construction, the notations and artefacts used by all six reference model projects are tabulated on the synthesis project web site according to the four phases of model based design.

The tables on the resulting four pages[21] contain links to reference model project exemplars for different artefacts. Just one example is shown here, for scenarios. In this and similar entries there are links to:

- A general description of what a scenario is
- To the projects using scenarios
- To particular examples of scenarios as used by the projects.

Mousing over links provides hints as to what the links represent. This is particularly useful for the examples where clicking on an example can be relatively heavyweight, e.g. downloading and opening a word document produced in the course of a reference model project.

Use of user-understandable notations

ARTEFACT / NOTATION	PROJECT USE
scenarios	eP4LL scenarios scenario.usecase.development COVARM scenarios LADiE scenarios

Example of a drill down table for artefacts and notations used by the projects

3.6 Recommendations from the methodological synthesis

Recommendations are made to future projects, and to the JISC.

3.6.1 Recommendations to JISC for the projects

Recommendation 6: Projects should maximise user input at all stages.

Recommendation 7: Projects should pay attention to the first and second 'stages' of the lifecycle method (i) user domain and process characterisation, ii) abstraction and model building iii) system design and iv) prototyping, implementation , testing and rollout) and to larger iterations through the outer loop as the key to usability.

[21] http://misc.jiac.ac.uk/refmodels/notations_artefacts_stage_1.html
http://misc.jiac.ac.uk/refmodels/notations_artefacts_stage_2.html
http://misc.jiac.ac.uk/refmodels/notations_artefacts_stage_3.html
http://misc.jiac.ac.uk/refmodels/notations_artefacts_stage_4.html

Recommendation 8: Projects should employ a multiplicity of design representations: Each representation's notation determines particular ways of looking at the problem; having multiple perspectives via multiple representations help enable design.

Recommendation 9: The JISC should require that projects use a method like the lifecycle method, and that each project include a start-up activity to provide a method plan that specifies the initial choice of design techniques needed to populate the method.. Projects should document any method changes that are required during the project, and document experience with the chosen methods.

Recommendation 10: The JISC should require as project outputs a description of the method used, including in-project changes and reasons therefore. These should be input to an ongoing methodological synthesis project.

3.6.2 Recommendations to JISC

Recommendation 11: The JISC needs to continue the work started here to build a lifecycle method for SOA based products.

Recommendation 12: The JISC should commission a regular distillation and incorporation of successful design practice into the lifecycle method until the method is stable, particularly with respect to experience of use of different method constituents (design techniques) and the ability to offer methodological guidance as to the assembly of custom methods to suit particular project circumstance.

Recommendation 13: The JISC should continue commissioning tool development with an emphasis on both tool usability and tool integration with other tools, e.g. as produced in the high level domain map work. COVARM and FREMA both produced tools that provide the basis for further work (and indeed some has already been commissioned).

4 Evaluation of the outcome of the reference model programme against its aims, objectives and assumptions

4.1 Evaluation of the reference model programme and its outputs

This section of the report contains a review of the six reference projects in the context of the expectations of the original call for projects and the overall programme.

When reviewing the projects from this perspective it is most important to consider:

- While there are six projects listed as Reference Model projects, two (XCRI and PLE) both started outside of the original funding call and consequently may not exhibit the same degree of rigour against the reference model expectations.
- Projects may have delivered benefits outside of these core objectives and will have contributed to advancement in thinking and practice in their domain area.

The objective is less to asses each project within its chosen domain (invariably this has been accomplished elsewhere) and more to understand how the resultant reference models support the e-Learning Framework and/or how the projects were completed.

3 Each project is expected to:

- Produce an e-learning framework (ELF) reference model in line with the domain areas described in this circular:
  - i. define the scope of the application domain to be addressed;
  - ii. gather a portfolio describing current practices, processes and systems that address this application domain of use cases and scenarios of the domain;
  - iii. identify the shortcomings to be addressed and produce a gap analysis of the domain area;
  - iv. map the application domain to the services defined in the ELF;
  - v. define a common solution pattern for the application domain;
  - vi. develop use cases describing the use of systems within this pattern;
  - vii. define which ELF service definitions are best to be used to support the pattern, if necessary defining application profiles of existing specifications, or new service definitions.
- Produce a reference model implementation(s) that support(s) the development of the reference model and/or provides proof of concept.
- Provide supporting information and advice to related Distributed e-Learning Programme Regional Pilot Projects http://www.jisc.ac.uk/programme_edistributed.html.
- Work closely with the relevant CETIS Special Interest Group(s) (SIG).

Figure 6: Requirements for reference model projects from the original JISC Circular

4.2 Evaluation Approach

The six reference projects exhibit considerably diversity in origin, methodology and nature of deliverables. This makes it is difficult to provide a fully levelled evaluation of results across all projects yet also reflect the true value of their outcomes within the e-learning framework.

In order to introduce a degree of conformity across the project profiles a small online survey was performed designed to capture views of a key stakeholder from each project. Questions were structured in

line with the requirements for a reference project as detailed in "JISC Circular 10/04 Circular for the Specification of e-learning Framework Reference Models" (Figure 6: Requirements for reference model projects from the original JISC Circular). The goal was to gain insight to the projects against these common criteria.

4.3 Defining the Application Domain

All projects were tasked with the responsibility to establish a full definition of the application domain in which the reference model would provide a solution. This task was focused on defining the scope (in terms of areas to be addressed) and delivering a portfolio that considered current practices, processes and systems. This work would contribute to subsequent activities for use case and scenario analysis. Part of this exercise called for assessment of any identified shortcomings and a gap analysis to aid this activity.

The projects completed and documented the as-is analysis of their domains (except PLE, for which the domain does not exist yet, so the project identified the scope of the domain) – the results are synthesised here. Of particular interest in the assessment of the projects success is to what extent the as-is analysis supported development of a to-be model that underpinned further project development.

Reference Model	Business Areas Analysed	Primary Gap Analysis/Shortcomings found
COVARM	Course Validation	Institutional lack of “closure” on process activities.
XCRI	Course Information for: • Quality • Marketing • Enrolment • Reporting	Lack of any suitable specifications or standards for data exchange.
eP4LL	UCAS Applications	• Learners' use of social networking to seek informal advice and guidance • Web services allowing HE admissions staff to assess applications • Services needed for aggregation of feedback for institutions • Need to integrate learning results from assessment and learning • Lack of generally agreed lightweight standards
LADiE	Learning Activities	Gap analysis undertaken comparing the range of potential pedagogies and the use of particular tools.
FREMA	e-assessment	Implemented a dynamic gap analysis tool that reveals current “gaps” in this domain between available software artefacts and desired to-be implementation. In this instance “analysis” is part of the reference model implementation.
PLE	Personal Learning Environments	Absence of easily used services for distributed coordination and workflow in the domain.

Table 1: Gap analysis by project

Considering each project in isolation, as the table above shows, all performed a level of domain analysis necessary for development of their to-be model.

When looking at the projects as part of the reference model programme it is harder to find common ground in methodology and representation of results. As noted elsewhere in this assessment this is at least in part a product of the diversity in the project origins and expectations. However it does detract from the ease of access across all project outputs.

Recommendation 14: future reference model projects should be have more clearly defined set of deliverables in terms of methodology (e.g. process analysis, gap analysis etc) and structure for resultant documentation.

4.4 Adoption of Use Cases

In considering use cases it is useful to start by drawing a distinction between a scenario and a use case:

- A scenario is a concrete example of practice or system use. Thus a scenario expresses what a one or more users or practitioners do in a given situation. Thus we might have a scenario that explores how a particular learning technologist, Fred, acts in a particular situation, and includes just one path of actions (the path of actions) that Fred takes in order to construct a learning object.

- A use case is an abstract description of system use where:

    - The people taking part in the use case are no longer specific individuals. Instead the use case is enacted by actors, where an actor is an abstraction of a group of similar users. Thus, we might have a use case where someone, a learning technologist, constructs a learning object.

    - The actor actions described by the use case are an abstraction across all possible scenarios. Thus if the use case is about constructing a learning object then the use case should describe all possible actions that might be involved in the construction of that kind of learning object, including any exceptional or conditional actions that the actor may undertake in special circumstances. A special case might be where the learning technologist detects an inconsistency in the learning object content and refers to another actor, a subject expert, to help remove that inconsistency.

A use case should describe a process that produces just one discernable and significant result for the actor(s). What is a discernable result is subject to concerns of level: Thus a higher-level use case may result in the production of a learning object. This use case may be composed of other use cases, of which one might be to produce the learning design for the learning object; being the sequencing of activities that constitute the activities involved in using the learning object.

A use case may be described in structured natural language text, or in a graphical form. If the use case is described in a graphical form, the one alternative is to use the use case notation of a the Unified Modeling Language (UML, where “modeling” is written in the North American single-l form). UML is great for a quick overview of the use cases which may together form the sum of the use of a system. However, when it comes to describing the minutiae of detail of a use case some of the UML use case notation (exceptions and includes) is rather hard to use and understand. None the less, UML is increasingly being used and should be used at overview level.

Use cases can be accompanied by text, be that text itself a use case, or a narrative scenario. It is strongly arguable that UML uses cases need to be accompanied by textual use cases, and by carefully chosen narrative scenarios that bring the use case to light. Use of Cooper’s personas[22] (cf. their use in LADiE) also help define how any potential system might be used by careful definition of interested stakeholders that are then used in scenarios and use cases.

A sensible alternative to UML use cases is Constantine and Lockwood's Essential Use Cases[23].

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[22] Cooper, A., Reimann, R., and Cronin, D. *About Face 3: The Essentials of Interaction Design*. 3rd Ed., John Wiley & Sons, 2007.

[23] Constantine, L and Lookwood, L. “Structure and Style in Use Cases for User Interface Design” In van Harmelen, M. *Object Modeling and User Interface Design: Designing Interactive Systems*. Addison Wesley, 2001. Also at http://www.foruse.com/articles/structurestyle2.pdf

We conclude that Use Cases need not be expressed via UML and arguably the notation provided by UML for use cases provides only a starting point for comprehension of the full use case.. Notwithstanding this, where UML is used it does need to be used effectively, and the low level of skills across the sector is an inhibition to both the creation of useful UML and its comprehension by others.

On the basis that the Reference Models were intended to capture requirements in a standardised manner, it is expected that the primary reference point for Use Case description is UML for any diagrammatic representation.

While an objective for a reference model, not all projects opted to produce use cases. The basis for this decision varied from project to project. The reasons include:

- The project may not have been started as a reference model so consequently may not have been planned or structured to include activities that support use case analysis and development
- The project team may have decided that Use Cases were not an appropriate tool for analysis of their domain and have opted for alternative techniques.

Reference Model	Diagrams[1]	Narratives[1]	Alternative/Additional Techniques[2]
COVARM	Not at all	Not at all	We used event scenarios - as a way of decomposing a large business process. These were documented as scenarios and sequence diagrams
XCRI	Not at all	Not at all	blogged everything we found and received community critique via email, workshops and special "summits"
eP4LL	Where ever possible	Mostly	TQM notation for expression of feedback cycles
LADiE	In some instances	Where ever possible	Initial review documented the range of different forms of representation that are possible for describing a learning activity.
FREMA	Exclusively	Mostly	
PLE	Not at all	Not at all	We did not use a Use-Case approach as this project was concerned with future scenarios and pattern analysis; processes did not exist to model with use-cases.

1. Note that the phrasing here is from a multi choice option in the survey.

2. These descriptions are mostly taken directly from the survey to ensure the detail is preserved.

Table 2: Type of use cases produced by projects

Some form of use case record is in place across half of the projects. Where use cases are not available a body of work in varying degrees of formality (UML sequence diagrams through to blog entries) is in place.

The objective of adopting use cases was to provide a common set of artefacts within all reference models. Recognising that this is not the case it remains fair to note that all projects have recorded the data required and if necessary a subsequent effort could standardise this material with some additional effort to update it.

Recommendation 15: for similar efforts in the future a more formal definition of the project requirements for the use and implementation of use cases should be adopted. This might also be retrospectively applied to the existing reference model projects.

4.5 Identification of (new or existing) E-Learning Framework Service Definitions to Support Reference Models

Project outcomes in this area were understandably uneven. Factors affecting the extent of service identification included:

- Breadth of scope verses specificity of a given reference model project – a broader breadth allowed a wider "catchment area" for candidate services from the ELF.
- Relative maturity of the subject matter under investigation – a more developed or broadly accepted domain area provided a greater potential for both finding existing service definitions and identifying commonalities that might yield re-use opportunities.

Reference Model	Identified Services Candidates for cross domain re-use	
COVARM	No	
eP4LL	Yes	
FREMA	Yes	*For all projects services etc are fully detailed in their various documentary outputs.*
LADiE	Yes	
PLE	Yes	
XCRI	No	

Table 3: Identification of services for cross domain use

The above table focuses on services in the broader respects of the ELF and multiple domain re-use. Within each project various software artefacts and ELF constructs were created in support of the reference model.

While COVARM did not identify service re-use opportunities outside of the reference model COVARM did define a number of services for use within the Reference Model.

Equally XCRI, originally not initiated as a reference model project, was focused on delivery of an XML specification rather than a set of services, though a useable course service expression was designed, implemented and used..

Consequently these findings from the projects indicate success in achieving the programme objectives.

4.6 Reference Model Implementation

All the projects succeeded in the task of implementing their reference model, primarily as a proof of concept. The FREMA project delivered a production implementation along with a proof of concept demonstrating how to benefit from FREMA.

It could be argued that the various reference model implementations are a success only in terms of the individual projects objectives and not necessarily as a "standardised" reference model. In some respects it was up to the project in isolation to determine the nature of any implementation based on the results of their analysis. Optimally future reference model projects would provide clear definition of the features required from a reference model implementation in terms of, for example, how ELF services are used and/or created and these implementation are made available for reference.

Recommendation 16: Any further reference model programme (or similar) should provide clear definition of how the outputs will meet the needs of the e-Framework.

Interestingly the value experienced from implementing the reference model varied across the projects. This would seem to be a result of differences in the type of implementation which in turn is a consequence of the overall objectives of the project along with the stage in the lifecycle of the project. This underlines the diversity found in the reference models themselves.

The fact that some of the projects found that it was too soon in the project life cycle to gain benefit from developing some form of implementation is a reflection of:

- The relative depth of available knowledge in a given domain – less results in more time dedicated to discovery and exploration before it is viable to consider possible tangible solutions
- The overall complexity of the domain

Clearly a greater amount of time and resource allocated to a project would allow the responsibility of implementing the model to occur at an optimal time rather than distract from the core model development effort. A further consideration is that possibilities for tighter scope when defining domain boundaries could assist the project structure though run the risk of undermining overall model value.

Perhaps the single biggest influence of the varying levels of value experienced by the projects in this area lies in the differences in which the reference implementation took form. Consider that COVARM, XCRI eP4LL and PLE – all of whom found the implementation effort to offer varying levels of benefit – were able to implement artefacts that were predominantly built through adoption of existing technologies and standards – eg Web Services, XML Schema and Internet technologies. Even in this sub set of projects it should be recognised that there is diversity in the deliveries. For example COVARM's delivery of sample BPEL available for download is markedly different to PLEs Plex.

Reference Model	**Model Implementation**	**Project Conclusion about value of Proof of concept Model[1]**
COVARM	A number of artefacts (e.g. BPEL, Web Services) available for download.	Essential for successful development of the model
eP4LL	HTML Demonstrator with two service prototypes	Greatly eased development of the model
FREMA	Along with the FREMA solution the project delivered a number of patterns for process design complete with working implementations of interoperating services – source code was made available for these examples.	Implementation detracted from necessary model development (i.e. too soon in cycle)
LADiE	Primarily as documentation describing three layer reference model	Implementation detracted from necessary model development (i.e. too soon in cycle)
PLE	Plex (Desktop rich internet application) PLEWeb (Web LifeRay Portal version)	Greatly eased development of the model
XCRI	Demonstration implementation of curriculum catalogue	Was beneficial but not essential

1. Note that the phrase used here is from a multi-choice option in the survey rather than direct from the project team so it is an approximation of the project experience.

Table 4: models implemented by projects, and their value

In terms of achieving the core objective of a reference model implementation all projects have achieved this against the individual projects objectives. However, in terms of the programme providing a set of

common reference model artefacts it is fair to say that the lack of evenness in implementation may challenge someone who has worked with the output of one reference model (for example the XCRI schemas) expecting to find a similarly developed type of artefact in another model (for example LADiE).

4.7 Support Distributed e-Learning Programme Regional Pilot Projects

All the Reference Model projects bar PLE were able to provide some level of support to various distributed e-Learning Regional Pilot Projects.

The PLE Project was not tasked with this responsibility as a result of it not operating as a reference model project, and is not included in the following table.

Reference Model	Project(s) Supported	Nature of Support
COVARM	SUNIWE	The primary assistance provided was provision of a "Synthesised Domain Information Model" for Course Validation that supported the efforts of these projects.
eP4LL	RIPPLL (Regional Interoperability Project on Progression for Lifelong Learning) EELS (Embedded E-Learning Solutions)	Shared some project team members. This resulted in the eP4LL 'thin ePortfolio' concept gaining form in the RIPPLL Shibboleth implementation. This was a two-way process between the projects where RIPPLL UK LeaP experienced contributed to eP4LL standards development. The eP4LL project partner Phosphorix in turn worked with the EELS project resulting in further "cross pollination" between these related initiatives.
FREMA	r2q2 asdel peerpigeon cats minibix	This list represents a selection of projects known to have benefited from the FREMA project. FREMA assisted these projects in identifying reusable software and services as well as spotting gaps where such development would be needed. Additionally FREMA has provided a number of artefacts (e.g. Use Cases, SUMS) to assist the community.
LADiE	None specific	While there was no specific DEL liaison during the LADiE project the project team are confident that the body of work produced in their domain will be highly relevant to the DEL programme.
XCRI	Hertfordshire, Liverpool and Manchester LLNs	The development of these Lifelong Learning Networks were provided considerable support though a series of project visits and presentations culminating in use of XCRI in the "Learning Matrix".

Table 5: Distributed e-learning projects supported by the reference model projects

4.8 Working With CETIS SIGs

With the exception of PLE all projects participated in relevant CETIS SIGs. There was no appropriate SIG for the PLE Project to work with.

It is worth restating here the XCRI in fact started as a CETIS Enterprise SIG project prior to being classified as a Reference Model project.

Reference Model	SIGs Participation	Activities
COVARM	Enterprise	SIG Discussion forum
eP4LL	Portfolio	SIG provided feedback that contributed to the reference model.
FREMA	Pedagogy	CETIS facilitated workshop and SIG meeting greatly assisted project and helped develop new ideas. This also provided a means to make connections with relevant people working in related domains.
LADiE	Assessment	Benefited from SIG expertise in e-Assessment and Processes. Assistance in development of the reference model domain map. Ongoing evaluation of project outputs.
XCRI	Enterprise Portfolio Metadata	Essential process for specification, prototyping and critique of XCRI. These collaborations underpin the success of the XCRI project.

Table 6: Participation in CETIS SIGs by reference model projects

It is clear from the positive comments in the survey that working closely with CETIS SIGs provided extra impetus to discovery and validation in a given domain area.

4.9 Inter-project Collaboration

The following Venn diagram illustrates the amount of formal inter-project collaboration reported across the six ELF projects.

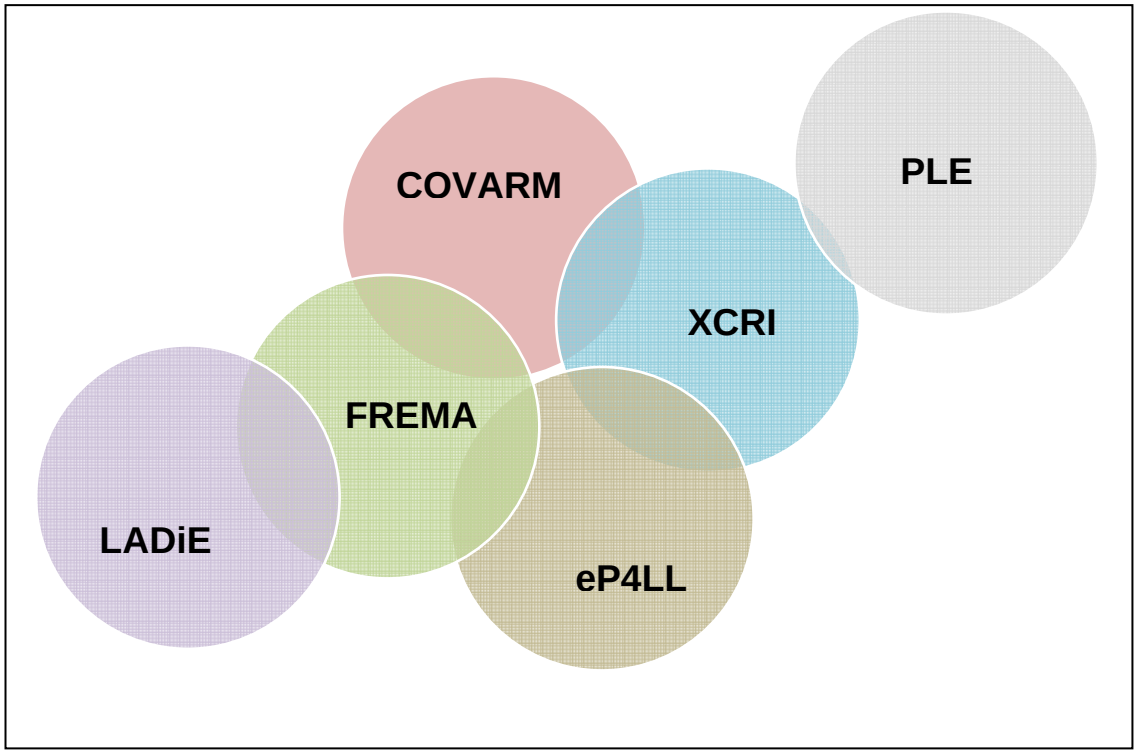

Figure 7: Inter-project collaboration

The exception of PLE is not unexpected – remember the PLE did not originate as a reference model project but instead was re-classified as such after initiation, and was considering a future not an existing domain, but it still managed some collaboration with XCRI, consuming XCRI data within the PLEX implementation.

The nature of the collaborations was commonly focused, as one would expect, on areas of:

- Domain analysis
    - exploration of modelling approaches
    - establishing domain boundaries
    - mapping common entities and/or using one domains experience to assist discovery in an another (e.g. LADiE learning activities to FREMA assessment)
- Mutual support though electronic methods (email), meetings, workshops etc.

4.10 Assessment Conclusion

The recurring themes throughout this assessment have been:

- Not all projects started out as reference model projects, and so are not all as tightly bound to the stated objectives of a reference model
- All projects exhibited considerable diversity in terms of approach and outcome

The core question to answer here is to what extent have the projects collectively advanced the ELF? This is best answered in two parts:

Furthering Domain Knowledge - All projects have clearly developed a body of work that delves deeply into their chosen domains and offers the opportunity for improved understanding across the HE environment.

Adding further substance to the ELF – Through the development of knowledge within each domain the ELF has gained greater depth.

Consequently the sum of the effort across the projects is to further advance the ELF.

Against this we should note that the lack of commonality across the projects did detract from their ease of incorporation to the body of the ELF and does act as a barrier to wider adoption of their outputs. In many respects that is the purpose of this synthesis project, though similar efforts in the future would be greatly improved through adoption of common methods and working practices along with outcomes defined directly against very specific aspects of the ELF.

Recommendation 17: Further reference model or similar projects should, as far as possible, adopt common methods and working practices so that their results can be combined and re-used more effectively.

5 Take up and use of reference model project results

One of the key indicators of the effectiveness of a programme such as the reference model one is the continued use of the results of the projects that have been produced. In this respect the programme has been very successful in a number of different ways that are outlined below against each project.

Before looking at how the results of each project have been taken forward it is worth making a few general points.

As has already been said, the projects were breaking new ground in determining what a reference model is, and what it is for and therefore took different approaches in working with their communities and developed significantly different types of artefact, there is therefore no common pattern to the ways in which the results from the projects have been taken forward.

All the projects have led to published papers, which have been used by others, as can be adduced from citations of the original papers. These are not included here as there have not been resources to analyse the ways in which the reference model publications have been used, and, because of high latency in publication, it is too early to attempt any form of quantitative analysis.

The following tables outline the key outputs from the projects:

Reference Model	Developer	Application
eP4LL	Phosphorix PortisHead	eP4LL implementation Implementation of the integration of the PebblePad ePortfolio system throughout the admissions process
FREMA	University of Southampton	PeerPigeon
PLE	CETIS	Personal competence manager

Figure 8: Applications developed as a result of the reference model projects[24]

While the number of applications that we have identified is small, this is an underestimate. For instance, XCRI has led to the development of a large number of applications that will make use of the specification (see below for the projects implementing it). Equally, there will be projects that are making use of the ideas in the reference models that we do not know about.

Reference Model	Project	URL
COVARM	Programme Specification Domain Map (P-SPEX) Thames Valley University Course validation project	http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/pspex.aspx

[24] Note this does not include those developed as part of the projects themselves (such as PLEX).

Reference Model	Project	URL
eP4LL	e-Portfolios in successful HE admissions (PortisHEad)	http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/admissions/portishead.aspx
	Admissions domain map (ADOM)	http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/admissions/adom.aspx
	Delivering Enhanced Learner Information for Admissions (DELIA)	http://www.jisc.org.uk/whatwedo/programmes/programme_elearning_capital/admissions/delia.aspx
FREMA	PeerPigeon	http://www.peerpigeon.ecs.soton.ac.uk/
PLE	TenCompetence	http://www.tencompetence.org/
	FeedForward	http://www.jisc.ac.uk/whatwedo/programmes/programme_rep_pres/tools/feedforward.aspx
XCRI	Programme Specification Domain Map (P-SPEX)	http://www.jisc.org.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/pspex.aspx
	XCRI support project	http://www.xcri.org/
	Bolton XCRI Project (BoXCRIP)	http://www.jisc.org.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/boxcrip.aspx
	Course Validation Arranger (COVa)	http://www.jisc.org.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/cova.aspx
	MOVE-XCRI	http://www.move.ac.uk/index.php?option=com_content&task=view&id=76&Itemid=106
	Open Course Collection and Aggregation Model (OCCAM)	http://www.jisc.org.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/occam.aspx
	OXCRI - integrated use of XCRI at Oxford University	http://www.jisc.org.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/oxcri.aspx
	staffsXCRI	http://www.staffs.ac.uk/xcri/
	XCRI@MMU	http://www.jisc.org.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/xcrimmu.aspx

Figure 9: Follow on projects

As can be seen there have been a large number of follow on projects from most of the original reference model projects, with not all of them being JISC funded. This follow on work is a strong sign of the success of the original projects. It may also under report the amount of work that has arisen out of the projects, as it is not possible to determine where other teams have built on the work of the reference model projects.

Recommendation 18: JISC should consider enabling projects to record where their results are being used beyond the end of the project (ie some form of citation process) so that it is easier to understand the long term uptake of projects. This could in part be done by new projects explicitly recording projects that underlie their work, in a searchable manner.

It is now worth looking at what the projects have achieved in a little more detail.

5.1 COVARM

Perhaps the most important outcome of the COVARM project was as a demonstration of the use of process modelling, a method that has been taken up by JISC and used widely across other projects, with the project team running a series of workshops on process modelling and the importance of a focus on the business aspects of the model. Beyond that the outcomes of the project have been used as follows:

- Thames Valley University is currently developing a course validation system, in part as a result of the project. They are explicitly consulting with the project team to assist with building the requirements for the system.
- Early use of BPEL (Business Process Execution Language) within the sector has led to considerable interest in the use of BPEL from modelling purposes.
- The results are being further developed in the JISC funded P-SPEX (Programme Specification Domain Map) project which is developing a domain map that will be published in a semantic media wiki, development of a set of requirements specification for the programme management system. The aim is to engage the community and vendors. The project will also specify and develop a set of software services for the configuration management of programme specifications and will include an illustrative process example of consuming the services. This will be elaborated as Business Process Model descriptions captured using BPMN notation.[25]

5.2 eP4LL

The eP4LL reference model has been taken forward in a variety of ways through JISC funded projects.

- PortisHEad is implementing the integration of the PebblePad ePortfolio system throughout the admissions process as an example of the thin ePortfolio model recommended by the eP4LL Project. This collaborative project includes PebblePad and UCAS, as well as the universities of Nottingham and Wolverhampton[26].
- The ADOM project (Admissions domain map) builds on the work undertaken in the eP4LL project to build a domain map of the admissions process. This will tie in with the e-Framework, the High Level Domain Map and other work in the area[27].
- eP4LL has led to the creation of a demonstrator based on thin client technology by Phosphorix. It exemplifies a thin client model, where a personal development process hooks into web services on other systems or through other information providers. It also provides a glimpse of some of the tools which might be required to provide evidence of and present skills and expertise to others, together with a demonstration of a way to gather information from distributed web services and organise that information. Finally, it shows how a user can tailor and select the information to share with peers and mentors or prospective institutions or employers[28].

5.3 FREMA

The FREMA project developed a semantic wiki with the aim of involving the community in the continued support and development of the content of the wiki. However, funding did not allow for the necessary work to help to develop the community that would take the work forwards, so that work on adding content to the wiki has been slow. This is exacerbated by the complex nature of the wiki (for instance, in terms of understanding the relationships and underlying structures) which leads to a steep learning curve. Concerns have also been expressed over authority and competence in editing or contributing. Even without funding there have been some notable successes for the project. Several projects have built on the work of FREMA including:

- The PeerPigeon Project produced services for the e-Framework that support peer review based on the service usage models produced by FREMA. This is one of the examples of the production of actual services derived from the work of the reference model projects[29].

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[25] http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/pspex.aspx
[26] http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/admissions/portishead.aspx
[27] http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/admissions/adom.aspx
[28] eP4LL.ionetwork.ac.uk/eP4LL/
[29] http://www.peerpigeon.ecs.soton.ac.uk/

- The Scottish Qualifications Authority (SQA) is apparently asking new projects to record information from those projects in FREMA.
- The semantic wiki forms the part of the "e-Framework Upper Layers (eFuL), together with the High Level Domain Architecture (HILDA). This may be important both in helping people to access and make use of the e-Framework, and as a tool in its own right to support greater understanding of the higher education domain.

While they have not achieved it yet, the group is still attempting to make FREMA into a community owned space that the assessment community will use to support their work, and they have therefore been continuing to actively promote the use of FREMA to support the community, for instance by presenting it at relevant workshops.

5.4 LADiE

LADiE produced a number of results including use cases and crib sheets as well as defining the characteristics of learning activities.

The modern idea of "learning activity" as a formal design concept is relatively recent and poorly understood by teachers with the result that little of the activity of this project has been as widely taken up as might have been expected. Notwithstanding that there has been some use of the materials produced by the project including:

- Limited use by Higher Education Academy subject centres of the characteristics of learning activity.
- Use of the learning context templates, for instance by lecturers teaching through second life.
- The pedagogy work has been further developed by members of the team.

5.5 PLE

Because the PLE Project was not originally part of the reference model programme and was rather tasked with forging new ground, the results which have had the greatest impact are not those that relate to reference model, so much as some of the concepts behind PLEs and its reference implementation.

It is arguable that this project was one of the very first projects anywhere in the world to look at what a personal learning environment might mean in a web 2.0 environment. While there has been some discussion of PLEs before this (and while it could be argued that previous work by the team was close to being a personal learning environment this was based on technology that is more than ten years old).

The result is that the team thought through many of the ideas that have entered the main stream and define what a PLE is. As there is considerable interest in PLEs this has been a very important result for the project. However, it is important to note that the team state that "You cannot make a PLE - an individual has to construct their own". By this, they mean that a PLE is a collection of tools that a learner uses in their learning, and the user will need to assemble that set of tools for themselves in much the same way that they might select the set of applications that they use on their computer. What the PLE offers is a framework into which the tools can be "plugged" in order to achieve a coherent toolset. There are implications for reference models in the approach taken by the PLE project. In particular, it means that one cannot produce a specification; as that leads to the development of a system. Instead the project produced patterns, which it describes as generative. This construction perspective is in fact only one of two dominant perspectives in the world of PLEs.

The other main deliverable from the project was the prototype PLE called PLEX which was developed to demonstrate some of the patterns created during the project, and included demonstration of the use of feeds or conduits and aggregators to create an environment. Some of the ideas from this have been taken up in the Flock browser[30] . PLEX also forms the basis of two large projects that CETIS is currently working on:

[30] http://www.flock.com/

- TenCompetence is a €14 million EU funded project that will support individuals, groups and organisations in Europe in lifelong competence development by establishing the most appropriate technical and organisational infrastructure, using open source standards-based, sustainable and innovative technology. PLEX is being used as the basis for the personal competence manager[31].
- FeedForward is a JISC project that is developing a desktop productivity application for handling information workflow, to increase the visibility and use of other services through closer end-use integration with informal sources[32].

5.6 XCRI

XCRI has undoubtedly had the greatest success in supporting the uptake of the work developed during the project; though this is of a standard (or more specifically a specification that is a candidate standard) not of a reference model as such.

A variety of organisations have picked up XCRI as a method for exchanging course related information. These include:

- A significant number of universities including Manchester Metropolitan University, University of Bolton, University of Oxford, The Open University, Thames Valley University and University of Manchester have already adopted XCRI as a method for handling course related information. (http://xcri.org/)
- JISC which has just launched a programme for five projects to implement and test the XCRI course information specification and is particularly interested in projects which aim to use XCRI to submit information to bodies which provide information on courses, such as UCAS and LearnDirect.
- UCAS (the university and colleges admissions service) is working on a project to accept course information from institutions using XCRI.
- P-SPEX is a follow-on, JISC funded, project which will produce a programme specification Domain Map for higher education[33].
- The Learning and Skills Council has made XCRI-CAP the "preferred standard" for UK-wide 14-19 prospectus, writing "To enable data to transfer between providers, the local area prospectus (where there are different software products) and a national prospectus, solution standards must be agreed if the systems are to be interoperable. The current preferred option being pursued is a standard being developed in higher education called Exchanging Course Related Information (XCRI). This is an XML standard that is about to be presented to the DCSF Information Standards Board (ISB) for ratification. The data definitions stated in the XCRI standard should match those maintained in the MIAP CDD. Initial contact has been made to explore how the XCRI standard can be extended into FE.[34]"
- CEN, the European Committee for Standardisation has begun the process of developing a European standard for course descriptions in conjunction with CDM (Norway), EMIL (Sweden) and CDM-FR (France); although latest information suggests that "The start-up companies Digitary, unisoution and Kion will develop a draft specification based on Norway's CDM (Course Description Metadata) and France's CDM-FR. This draft will become the de facto standard—except in the U.K., U.S. and Canada—and subsequently will be adopted as the CEN (European Committee for Standardization) approved standard. Insight from the XCRI product will be incorporated into the DUK (Digitary, unisolution and Kion) specifications; XCRI will remain a UK only specification.[35]

[31] http://www.tencompetence.org/
[32] http://www.jisc.ac.uk/whatwedo/programmes/programme_rep_pres/tools/feedforward.aspx
[33] http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/pspex.aspx
[34] Managing Information Across Partners (MIAP) Programme, LSC, June 2007, http://www.erlp.co.uk/ccm/cms- service/download/asset/?asset_id=168727
[35] http://www.immagic.com/eLibrary/ARCHIVES/GENERAL/IMM/I071112F.pdf

6 Future work

The recommendations for future work are divided into three parts:

- Work that might be undertaken to ensure that reference model (and related work in SUMs, domain mapping etc) might be made more useful.
- Work in general areas where it might be appropriate to undertake more reference model creation that would help to move forward the e-Framework as a whole.
- Existing work in the individual projects that could be extended to provide greater value and build on the existing work.

We note that much of the following information was derived, as agreed with the JISC, by consulting staff who worked on the reference model projects. We strongly suggest that that the suggestions need to be further validated before they are selected, as it has not been possible in this synthesis to:

- Determine which areas are most important for the e-Framework,
- Determine which areas (including the many not considered here) are most important to the higher education sector,
- Ensure that this would not duplicate work that is being undertaken elsewhere,
- Determine whether there is in existence a community of practice (or similar) that would support and sustain the work listed.

6.1 General

There are a number of areas that the synthesis work has uncovered that might be appropriate for additional work that would bring some of the existing projects into a more coherent whole. The evaluation of the programme against its objectives has shown that there is overlap between some of the projects' domains, and this would be a fruitful area for additional work. While it is important to map out the various domains, they do not stand in isolation. As a single instance, consider e-portfolios. These have interactions with a wide variety of other domains including teaching and learning (which would include PLEs), admissions, assessment, course validation and probably even course information.

The scope of the synthesis project has not allowed for the production of all the SUMs that could relatively easily be developed from the work of the reference model projects.

Recommendation 19: JISC should commission the writing up of the other SUMs which can easily be extracted from the reference model projects.

Most generally, there is still much confusion within the sector, and elsewhere, as to what reference models, domain models, the e-Framework, SUMS, Service Genres and Service Expressions are. This is not helped by JISC sometimes using terms differently to the wider community. Examples include reference model, middleware[36].

Recommendation 20: Wherever possible JISC should make use of existing terms (even where they are not a perfect fit) as this supports greater use of developments outside the community than inventing new ones, or redefining them for use within the JISC community.

Recommendation 21: JISC needs to do more to promote a common understanding of the scope and purposes of its work around SOA, including the e-Framework, SUMs, reference models etc.

A useful piece of work would be to take each of the six projects here and investigate what the process, information and control flows between them are. This would be a large piece of new work, but would help to identify a number of the critical areas where common services would be appropriate.

[36] See for instance Wikipedia (http://en.wikipedia.org/wiki/Main_Page) or whatis.com (www.whatis.com)

Recommendation 22: JISC should consider funding additional work to investigate the process, information flows, and controls between the existing reference models through further analysis of the domains and thereby show the relationships between the domains.

This would go considerably beyond what has been possible within the synthesis project by identifying what the flows and overlaps are and incorporating them into the appropriate reference models, SUMs and domain maps.

We believe that it is advisable to start this week now. There is considerable overlap between the existing domain models (see Figure 7: Inter-project collaboration which shows where relationships exist). The problem is effectively NP-Hard; that is it grows at least exponentially with the number of domains. The only way to manage the work is to start now and add links to existing domains as new domains are added. This is likely to reduce the problem to manageable proportions, and make use of the expertise involved in modelling additional domains.

6.2 Possible domains for further work

One can not use the synthesis work undertaken to date to determine the most appropriate areas to explore and create reference models for, as there are large areas that have not been touched on (human resources, finances, research to name just three). However we are able to identify some areas that could be considered as candidates for further work. These include the following recommendations:

Recommendation 23: In order to support change JISC should consider which areas are currently of particular interest to higher education, and where processes or systems are being actively changed, In conjunction with relevant communities of practice JISC should develop domain models that can support change activity.

Recommendation 24: JISC should consider funding a project to produce a domain map of the admissions life-cycle (which includes marketing, assessing and selecting candidates, enrolment and induction). This is an extension of the eP4LL work.

Recommendation 25: JISC should consider funding a project to produce a domain map of the course life-cycle (which includes marketing, course development, admissions, course delivery including assessment, course review). This is an extension of the areas addressed by COVARM and XCRI to cover the whole of the relevant life-cycle. Note that it includes the admissions life-cycle and assessment, or at least parts of them. As this suggests, it is will be essential to break it down into a number of discrete areas, but equally important to consider the relationships between those parts.

Recommendation 26: JISC should consider funding a project to produce a domain map of the learning and teaching. Mapping Learning and teaching has proved to be highly problematic, while being one of the two major roles of universities (the other being research), but it will be essential to have a meaningful reference model for learning and teaching as part of any framework that is to meet the needs of HE,

6.3 Individual projects

Beyond that, the projects themselves identified a number of areas where continued or additional work could be beneficial, including:

6.3.1 eP4LL

eP4LL undertook an analysis of a limited part of the e-portfolio domain, and as such it would be possible to extend the work to other parts of the e-portfolio domain beyond the use of e-portfolios for progression to, for instance, the use of e-portfolios for assessment or personal reflection.

6.3.1.1 Partnerships

- Re-enforcing Strategic Partnerships: Continuing work in ensuring major stakeholders within the UK (and internationally) maintain a consensual view of the e-portfolio data definitions and services is important.
- Continuation of Implementation Partnerships: Continuation of partnerships with key implementers of the standards, data definitions and services (such as UCAS and the Nottingham LEA) within the domain of this Reference Model in order to maintain credibility for this work is vital
- Lead the development of a community of key players and stakeholders within the e-Portfolio domain who can develop a consensually agreed pragmatic successor to the UK LeaP approach for the achievement of interoperability.

Recommendation 27: JISC should continue to support the development of a successor to UK LeaP, and this should include working with strategic partners within the UK (such as UCAS), and where appropriate internationally as well, given the importance of Bologna Process.

6.3.1.2 Standards

- Contribute to Standards Development: Work with BSI, CETIS and others to develop a standards framework that will both enable interoperability across sectors and the facilitation of a wide range of services must be continued. Few others can contribute with the authority of having been involved with 'real life' implementations.
- Development of a pragmatic XML based standard for data transfer within the e-Portfolio domain. This is an urgent requirement to provide both interoperability across JISC projects and a basis for the wider educational community to obtain efficiencies from the application of standards.
- Provision of pro-active support for national bodies in the satisfaction of their objective of producing computer based systems that handle both effectively and economically the transfer and processing of data within the e-Portfolio domain.

6.3.1.3 E-Framework

- Further contribution to/ validation of the e-Framework: From links with other Reference Models, additional work must ensure that the web services approach enables re-usability of tools with/ from other domain areas. Future work will need to identify levels of services below the macro application areas currently employed within this model. Future work should also contribute to the development and monitoring of a dynamic e-framework ('updating the bricks').
- Modelling of Use Case: The development of further 'thin e-Portfolio' models in terms of data flows that identify links to the e-Framework need to be developed in order to demonstrate the flexibility offered by the standards and web services based approach.
- Provision of two discrete and easily accessible indexed information sources. The first for developers who want to employ / tailor appropriate web services and application profiles and the second for research and research related papers. These 'repositories' should be complemented by 'spaces' for comment (such as wikis) underpinned by a pro-actively supported community.

Recommendation 28: JISC should consider the provision of spaces where communities of practice (CoP) can record their work on reference models, domain models etc. This relates closely to the e-Framework upper levels, and in particular the use of the FREMA wiki to support CoPs.

6.3.1.4 Extension to other areas

- Enhance the credibility of the work underpinning the model by its application to other areas (such as achievement recording) within the e-Portfolio domain.

6.3.2 FREMA

There are several areas of work that could usefully be taken forward from the FREMA project.

- The use of semantic wikis (or a similar approach) to support other communities in undertaking the development of reference models of their domain (including domain maps, SUMs etc). This

would require further development and refinement of the semantic wiki system to make it easier for domain experts to use together with some form of "editorial" support for communities that are working with it.
- The inclusion of more information within the FREMA site to make it a richer and more useful resource. This would involve supporting those groups and projects working in the domain to record appropriate information in the FREMA wiki.
- Relating semantic wikis more closely with other work in the domain including domain maps and the e-Framework. This work has already been proposed in the e-Framework Upper Levels report.

Recommendation 29: JISC should consider supporting Communities of Practice to populate the e-Framework upper layer.

6.3.3 LADiE

The LADiE final report suggested a small number of activities that could usefully be undertaken to support the use of reference models:

- Other technologies, besides IMS Learning Design, could be used to model one or two of the use cases developed in LADiE. This would help identify functional gaps in the various technologies. In addition to IMS Learning Design, technologies worth investigating would be BPEL, LAMS, a BPEL IMS LD hybrid (building on the work of Scott Wilson), simple sequencing and Moodle.
- A technical implementation of the reference model could be undertaken to better inform the reference model itself and to review the guides.

6.3.4 COVARM

The COVARM team suggested a number of places where additional work could be beneficial, and some of these may tie in with areas covered by some of the other projects. The areas are:

Work placement and work placement assessment is a key part of many vocational programmes (social work, nursing etc). Generally, there is likely to be considerable similarity in the processes by which these placements are conducted, the data/information requirements and the (academic) business rules under which placements are conducted. This may also relate to e-Portfolios as these become increasingly important in assessment. Given this, it might be useful to review a disparate set of vocational programmes and construct a generalised reference model that captures in reference form (processes, information model, services to manage) the work placement assessment model. This also relates to another project the team is involved in at Southampton University and Royal Holloway. they have documented the work placement process and are using that to help structure and refine co-design activities which will lead to the design and implementation of a mobile application to support student social workers in a work placement setting[37]..

Recommendation 30: JISC should consider supporting the development of a reference model in the work placement domain, building on work already undertaken at Southampton University and Royal Holloway College.

6.3.5 PLE

The PLE team identified a large number of issues that could usefully be addressed to follow on from the work undertaken within their project. Given that the project was not originally funded under the reference model banner it is unsurprising that many of the suggestions do not fit under that banner, but include the following:

[37] http://samsa.tvu.ac.uk/remora

6.3.5.1 Development of Toolkits.

- The extension/development of complete 'bottom-up' toolkits (whether rich-client or web-based) in the manner of PLEX.
- The extension of existing web oriented platforms to effect PLE-like coordination within an existing context. Tools within this group include the Mozilla Firefox-based tools (particularly Flock), where a plug-in architecture allows for significant customisation of functionality, or widget-based toolkits that also allow for some coordination (although this may be more restricted).
- Investigation of alternative access platforms (ranging from mobile devices to USB drives). A flexible persistence model would allow for interoperability between PLE-like systems on many different sorts of devices from mobile phones and PDAs to web-based operating systems. Even if access is primarily by PC, mobile phones and other devices may be used to record or playback content, whilst USB drives may hold personal resources as a repository.
- Research into issues of interoperability between toolkits, data persistence and off-line working.

6.3.5.2 Development of Services

Some of the services described in the reference mode have already been implemented, others exist only as service descriptions. Implementing these services would test the validity of the Reference Model

- Workflow and Activity Management services to support educational engagement.
- Services to support monitoring of student competency achievement to assist in aligning of the functionality of the PLE with e-Portfolio and PDP tools and to permit coordination of progression.
- Trial services to support recommending of learning opportunities facilitating investigation of new ways in which learners can discover learning opportunities.

Recommendation 31: Should JISC consider it appropriate to test the validity of the reference models by the development of services, then consideration could be given to the funding of services described by the PLE project.

6.3.5.3 Investigation of Pedagogic Issues

- Projects exploring the nature of the role of 'learning activities' in the maintenance of social relationships within a learning context, and the extent to which those learning activities are efficacious in the engendering new skills in the learner.
- Projects exploring the boundaries between informal and formal learning and uncovering of mechanisms which link formal learning with the praxis of daily life.
- The extent to which expanded social connectivity may be of benefit to overall personal organization, and the emergence of new skills to maintain personal commitments.

6.3.5.4 Projects that link the PLE concept with other e-learning domains

- E-Portfolio
- Personal Repositories
- Learning Design.
- Learner Profiles and Identity Management.

This is an important area, already addressed in Recommendation 22

6.3.5.5 Investigation of Organisational Issues

- The changing role of the student
- The role of PLE for student retention
- Issues around learner control of technology and the enhancement of the student experience
- Issues around teacher use of PLEs
- The impact that pressure from employers, schools, etc will have on the emergence of the PLE

6.3.6 XCRI

There is considerable additional work extending that carried out under the XCRI project.. It will be appropriate for those activities to make their own recommendations and JISC should press this.

7 Reference models and the reference model programme

There are a number of important observations and further recommendations that relate to reference models *per se* and that relate to the way in which the reference model programme was undertaken.

7.1 Reference models

It is worth noting that JISC has effectively dropped the use of the term *reference model* in favour of domains models and domain maps and service usage models (SUM) with the attendant service genres and service expressions which was the result, at least in part, of a lack of common understanding of the term across the community.

There has been considerable discussion of the term. For instance:

> "There are many types of **Reference Model** and no two seem to be the same
> But they seem to have a common role:
> They provide a standardised way of
> a) Achieving a given goal, or
> b) Solving a given type of problem
> c) Using the means specified in the model
> d) … in order to provide a common approach"
>
> Service Framework Reference Models Olivier, 2005[38]

> "A Framework provides a “broad vocabulary” consisting of all the possible 'services' for a domain such as e-learning.
> A Reference Model selects some of these services for a common learning or teaching requirement and shows how these services can be used to meet this need"
>
> Reference models - the next important step, Holyfield, 2005

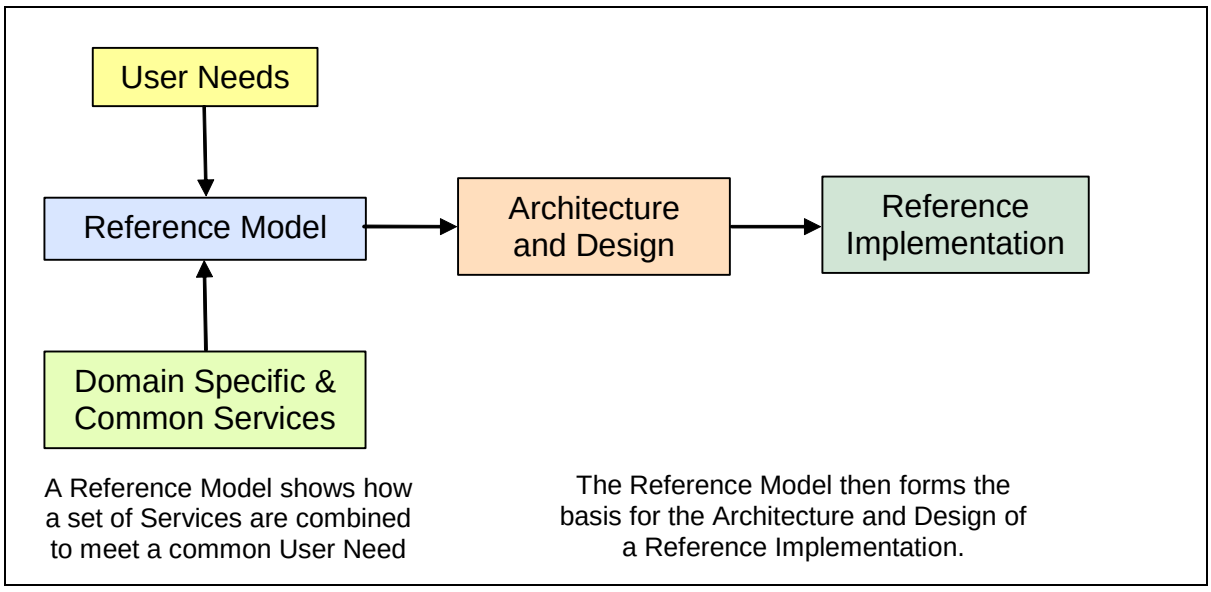

Figure 10: Reference models in context[39]

[38] Olivier, The Framework : an Overview, 2005 http://www.jisc.ac.uk/uploaded_documents/e-Framework%20Editor%20Framework%20Briefing%20May%2005.doc

"it is unclear what “reference models” actually means."

JISC Pedagogical Vocabularies Project: Report 1, Currier, Campbell, Beetham, 2005[40]

It is also clear from the programme that there was little common understanding across the projects of what a reference model might be.

We therefore support the decision to move away from the use of the term reference model, and towards terms that have been through the process required to reach a shared understanding across the community.

7.2 The reference model programme

At the time that the reference model projects were funded there was little shared understanding across the higher education community as to what a reference model might be. This has been made clear by a number of things over the life of the programme, and beyond. The document provided with the ITT as a guideline was not unambiguous with respect to the nature and content of a reference model for the e-Learning Framework, and the examples provided were taken from very different areas and demonstrated widely differing approaches (ref The Specification for Developing ELF Reference Models).

The problem for the teams was not so much in the term 'reference model' but in the fact that no template or meta-reference model was provided or co-developed at the start of the project. JISC intentions at the commencement of the project were investigatory: To learn what the nature of reference models for the e-Framework might be, and to discover successful approaches. At a fairly early stage in the projects the teams came together and, discovering their divergence, jointly created such a meta-model, agreeing levels of abstraction that would provide a useable framework for all five of the projects (PLE was not part of the programme at that time). However, no effort was made by the programme managers to steer the projects towards making use of this common view and the five projects continued along their individual paths, each with its own terminology, abstraction levels and views of the ways in which a reference model may be used.

The variety of approaches is, in part, exemplified by the following diagram: This variety of approaches can be partly mitigated by mapping the reference model elements in the individual projects to a set of meta-elements from the HE Domain map, that were selected for this synthesis to represent a 'reference model view' of the domain. However, the table masks the differences in granularity or abstraction used by different projects. There was also inconsistency in the content of the elements named here. To some extent elements have been "shoehorned" into this table, and some of the elements in the table would need considerable effort to normalise.

Reference model aspect relationship	**COVARM**	**eP4LL**	**FREMA**	**LADiE**	**PLE**	**XCRI**
Addresses role	Roles in Swimlanes	Actor	Player	Actor	-	-
How describes sub-domain	From text	From text	From text	From Text	From Text	From Text
Artefacts	Class	Class	Entities	From taxonomy	Pattern as mechanism artefact	Class

[39] http://www.jisc.ac.uk/uploaded_documents/e-Framework%20Editor%20Framework%20Briefing%20May%2005.doc

[40] http://www.jisc.ac.uk/uploaded_documents/PedVocab_VocabsReport_v0p11.doc

Reference model aspect relationship	COVARM	eP4LL	FREMA	LADiE	PLE	XCRI
Functions	From text	From text	Process	From text in pedagogy guide	-	-
Processes	Process	From text	-	-	-	-
Service Expressions	Service Expression	Service Expression	Service Expression	-	-	-
Service Genres	Service Genre	Service Genre	Service Genre	-	-	-
Sub- processes	Sub- process and BPEL	Scenario	-	-	-	-
SUMs	Can be implied from scenarios	Can be implied from scenarios	SUM, but not in same format as e-framework	Can be named from architecture description	Can be implied from scenarios	-
Use Cases	-	Use Case	Use Case	Use Case	-	-
Specifies Services	Service	Service	Service Description	-	Service	Service demonstrator

Key:

Can be abstracted from text in project outputs
Explicitly modelled by project

Table 7: Mapping HILDA Reference Model Aspect to Individual reference Model Elements

Further, even where projects produced similar types of output (e.g. use cases) these were often in varying forms and levels of abstraction that makes combining them into an overall system such as a combined reference model somewhat problematic.

It is important to note that JISC has dropped the whole concept of reference model since the inception of the programme. With the development of the e-Framework (as opposed to the e-Learning Framework) there has been a movement towards service usage models (SUMs) at service genre and service expression levels which has left some of the higher level work undertaken by the reference model projects with no appropriate repository for rendering it useful to the sector. There is strong feeling amongst the reference model teams that there is a need to model the context of services more abstractly than is possible with the SUMs.

There have been important implications in all of this for the synthesis of the outcomes of the project.

If we consider the areas that the projects were addressing we can see some relationships between them:

Project	Domain	Relationships with other projects
COVARM	Course validation	XCRI for handling course information FREMA for assessment

		LADiE for learning activity Possibly eP4LL for progression into or out of the course
eP4LL	Progression	PLE which would include e-Portfolio activity within its remit Possibly XCRI for identifying opportunities
FREMA	Assessment	COVARM assessment information Possibly eP4LL for progression
LADiE	Learning activity	COVARM for definition of the activity FREMA for assessment
PLE	e-learning toolkit	eP4LL as part of the functionality addressed XCRI to identify opportunities Potentially the others
XCRI	Course information	COVARM as a source of information on courses eP4LL as a way of matching opportunities to the user PLE as a consumer of the information

Table 8: relationships between projects

These relationships were not significantly addressed during the project, as the projects were essentially developing models of their part of the domain and the programme did not provide the resources to develop the relationships between the projects. While the projects did point out some of the relationships between them, these were not explicitly modelled, and we have had to further work out the relationships as part of this synthesis project.

This is made more complex by the different way the projects have presented their results. The lack of common notations for presenting results not only makes it harder to synthesise the results in this project, it also makes it considerably harder for other people working in institutions to make use of results of more than one project in their work.

7.3 Synthesis of the projects

There are a number of important lessons that we have learnt in undertaking this project which will be applicable to other programmes where a significant part of the programme is the extraction of information to support something like reference models, the e-Framework or the Information Environment Testbed.

As already mentioned, there was insufficient clarity as to the exact nature of reference models, with the result that each project took a different approach, at different levels of abstraction and covering different parts of the higher education domain. This has made the synthesis project extremely difficult as it has hard to create a framework in which the work of each project can be placed, and that there is sufficient population of the framework to enable meaningful synthesis.

Recommendation 32: Before a programme of this nature is funded there needs to be clarity as to the nature of the results that are required. For example it would mean having a clear and well understood definition of reference models that was shared across all the projects.

Even if a clear definition was understood and accepted by the projects there would still be the potential for significant problems that arise from performing the synthesis after the projects. This should be addressed in the definition of future programmes.

Recommendation 33: Future programmes should have the synthesis built into the initial programme definition, and should be carried out alongside, rather than after, the programme. This would require the reference model projects to include time for the synthesis and coordination with the synthesis project.

Recommendation 34: Projects should be obliged, or at least encouraged, to provide their outputs in compatible formats which would simplify the process of synthesis. This would enable other users to more easily understand and compare outputs from different projects and ensure a coherence that enables project work to be further built on.

It should also be noted that as we have conducted this work we have found that several of the projects had not made all their outputs available in a single location. On several occasions we have had comments about resources that are not referred to on the synthesis web site because they were not on the project web sites, but in alternative locations including institutional website, other wikis and project staff's personal computers. This has wasted a certain amount of time and caused frustration to both sides.

Recommendation 35: Projects should be obliged to place all materials relating to the project on a single site. Where this is not possible (for IPR or technical or other reasons) there should be an index on the project site that clearly points to all material not on the project site.

8 Conclusions

The reference model programme was an investigatory step at time when reference models were being investigated by the JISC and the wider community. As such the definition of reference models was only loosely conceptualized when the programme was announced in the ITT, and consequently the reference model projects came up with different kinds of results for the reference models they delivered.

Common themes that ran through five of the six projects was user involvement in the earlier stages of requirements elicitation, and then, in a different five of the six projects, a process of model based design based on earlier requirements analysis. There were good reasons for individual divergences from these patterns.

What is apparent from the work of the synthesis project is that there is insufficient guidance, even now, to projects working in the SOA field. Recommendations in this report include the provision of methodological guidance, guidance about outputs, and the assistance of synthesis projects that run alongside SOA projects.

The projects had some overlap, but tended to form somewhat isolated islands of focus in a higher level domain map. Current JISC-funded work is mapping out a higher level domain map and the reference model projects have been situated in that map by this synthesis project. Some e-Framework SUMs have been extracted from the reference model projects both independently, and in the course of this project.

Our general conclusions are that the reference model projects and the reference model programme formed a well-needed body of work that provided requisite advances:

- The projects furthered domain knowledge: Each project developed a body of work that delves deeply into its chosen domain and provided improved understanding in its area of the HE environment.
- The programme added substance to the ELF: Through the development of knowledge within each domain the ELF gained greater depth.

In the course of this project these results were amplified by two kinds of synthesis:

- A methodological synthesis leading to an iterative lifecycle design, development and deployment method
- A high level domain map synthesis, leading to increased population of the developing high level domain map implemented within HILDA, and a greater understanding of the high level e-Framework (eFuL).

As with many aspects of this synthesis project, these activities were perforce limited by the available resource in project work packages, and more work is needed in these areas.

We have supplied 42 recommendations to the JISC, and these have been carefully distilled into three summary recommendations with which we conclude this report:

Recommendation: Synthesis projects should be funded alongside, rather than after, programmes in order to maximise the benefit. This would mean providing time for individual projects to work with the synthesis project and ensuring that the synthesis project was providing benefit to the individual projects.

Recommendation: Reference modelling, domain modelling, and the production of SUMs and other project outputs is far more effective where these are provided by or elicited from communities of practice, and JISC should therefore ensure that such work is closely tied to existing CoPs.

Recommendation: More guidance should be given to projects working towards part of e-Framework (including reference models and domain models) so that the outcomes of projects can be combined and re-used more effectively. This includes guidance as to effective design, development and deployment lifecycle methods, and guidance as to project outputs.

A Appendix A: HILDA and the e-Framework

A.1 High Level Domain Map

The High Level Domain Map (HILDA) was created, in part, to enable a view of the e-Framework from the users' perspective. The e-Framework primarily addresses the technical level with SUMs, service genres and service expressions etc, but has little to say about how these might support processes in institutions, or be assembled into applications. HILDA was created to provide a tool to support understanding, discussion and planning and to help users to understand the domain that they are interested in.

In brief, a map is a tool which can be used to support navigation. Thus, a domain map is a tool which supports navigation through a model of the domain, which in this case is a model of higher education. The model comprises the various functions which are undertaken in a university, and these functions can then be broken down into processes. A domain map can be either generic, that is represent a canonical university, or it can be customised to the precise workings of a particular university.

It is worth noting at this stage that the vast majority of functions are generic across institutions, being things like "enrol student", "develop learning and teaching strategy". Further, many of the functions will be implemented in remarkably similar ways despite superficial differences. In part this is because many functions are strongly influenced by external requirements. For instance, student applications are strongly influenced by the need to interface with UCAS in the way that UCAS defines and requires.

HILDA provides a variety of views of the higher education domain, including:

- **Domain (or work area).** Domains (or sub-domains if higher education as a whole is taken as the domain) are an apparently simple starting point - because we *think* we understand what they are and what they mean. They are, in some ways, particularly difficult starting points for providing effective understanding since they do not easily decompose further into meaningful sub-domains that people will agree on. This is because they are ill-defined, with very strong interdependencies between different work areas, that tend to be ignored in informal discussions, but which must be shown in a more formal map. For instance, there are particular problems with *Information Technology* as a domain, as it could be argued that it applies to (almost) everything, or that it only applies to those things that are specifically IT, such as network provision. The first is unhelpful as it covers the entire map without providing useful additional information, the second is problematic and one would end up with domains that essentially map to departments (organisational units) such as estates, library, human resources. In other words, domains and their decomposition into sub-domains can be somewhat simplistic, and has the danger of encouraging "silo thinking". This is because decomposition does not allow us to easily capture the complexity and dependencies that exist between domains.
- **Lifecycles** can be a helpful way of thinking about the functions in any organisation, including universities. While functions are self-contained, they do not stand in isolation, but are related to other functions within the university. The use of lifecycles allows the user to quickly see the relationships, while not being overwhelmed with the complexity, in part this is because lifecycles can be naturally decomposed into a small number of lifecycle stages or states. Lifecycles come from the biosciences, and even quite complex ones like the malaria can quickly be understood with a little care.
- **External agents.** An alternative way of understanding a model is to consider its context. In the case of higher education this can be done by considering the external agents that universities work with, and the interactions with them. There are probably around 40 types of external partner, ranging from research collaborators to schools to funding councils to banks.
- **Applications** can be a natural way for many people, especially in IT, to think about the university. There are a relatively small number of major applications in the university, and one of the functions of the e-Framework is to support their development and implementation, in significant part, through offering re-use opportunities. We believe that applications can be a useful view or navigation route in a generic model, though it will need testing to establish whether there is sufficient commonality in the scope of applications between universities. Applications would include:
    - Student record system

    - Finance system
    - Human resources management system
    - Virtual learning environment
    - Library management system
    - Timetabling / resource allocation system
    - Research management system
    - Content management system
    - E-portfolio
- **Roles** provide a method of understanding the domain from the point of view of the players. Roles (as distinct from jobs which may comprise one or more roles and be constructed very differently in different institutions) are more common across institutions, and relate to particular functions or groups of functions.
- **Reference Model** provides a view of the domain that is geared towards planning service development. The domain map metamodel includes the elements needed to link functions and processes in HE to their supporting services whose use may be defined in service usage models (SUMs). This provides a bridge to the e-Framework from the domain map. The SUMs and the service specifications (Genres and Expressions) are held in the e-Framework itself.

As can be seen from the above there is a strong relationship between HILDA and parts of the reference model, in particular defining the scope of an application, as a tool to support the identification of shortcomings and gaps in current processes and applications and for mapping application domains (functions in HILDA) to services (or rather SUMs in the e-Framework).

A.2 The e-Framework

The e-Framework allows the educational community to document its requirements and processes in a coherent way, and to use these to derive a set of interoperable services with the intention that the services conform to appropriate open standards. The e-Framework enables documenting requirements, processes, services, protocol bindings and standards in the form of service usage models, service genres, service expressions and descriptions of standards. This enables members of the community to collaborate on the development of service components that meet their needs (both within the community and with commercial and other international partners). By documenting these things in a common space it also encourages the re-use of the artefacts it contains and the development of a community of practice.

The e-Framework web site describes the e-Framework as:

> "an initiative by the UK's Joint Information Systems Committee (JISC) and Australia's Department of Education, Science and Training (DEST) to produce an evolving and sustainable, open standards based, service oriented technical framework to support the education and research communities. New Zealand's Ministry of Education and the Netherlands' SURF Foundation joined the partnership later.
>
> The e-Framework supports a service oriented approach to developing and delivering education, research and management information systems. Such an approach maximises the flexibility and cost effectiveness with which systems can be deployed, both in an institutional context, nationally and internationally.
>
> The e-Framework allows the community to document its requirements and processes in a coherent way, and to use these to derive a set of interoperable network services that conform to appropriate open standards. ...
>
> The initiative builds on the e-Learning Framework and the JISC Information Environment as well as other service oriented initiatives in the areas of scholarly information, research support and educational administration. ...
>
> The e-Framework Partnership intends to operate in accordance with the following guiding principles:
>
> - The adoption of a service oriented approach to system and process integration
> - The development, promotion and adoption of Open Standards
> - Community involvement in the development of the e-Framework

- Open collaborative development activities
- Flexible and incremental deployment of the e-Framework "[41]

[41] http://www.e-framework.org/Home/eFramework/tabid/601/Default.aspx

B Appendix B: Advice and guidance document aimed at institutions and stakeholders on how to use domain maps

B.1 Domain maps and reference models: Some definitions

Two useful definitions may be found in Wikipedia:

A **domain model** can be thought of as a conceptual model of a system which describes the various entities involved in that system and their relationships. The domain model is created to document the key concepts and the vocabulary of the system. The model displays the relationships among all major entities within the system and usually identifies their important methods and attributes.

A **reference model** is an abstract representation of the entities and relationships involved in a problem space, forming the conceptual basis for the development of more concrete models of the space, and ultimately implementations, in a computing context. It thereby serves as an abstract template for the development of more specific models in a given domain, and allows for comparison between complying models.

In the context of the JISC/DEST e-Framework, reference models have been renamed Domain Maps: "The term "Reference Model" is currently used in the e-Framework as a place holder for the concept of developing models based on learning, teaching, research or business requirements to show how one or more Services can be used to meet the described need. However, it has subsequently been agreed that "Reference Models" was not a good term to describe the range of outputs resulting from the set of projects commissioned, nor what the e-Framework was asking the community to contribute to the initiative. As a result, the concept of "domain maps" has emerged, which consist of a set of models (functional, practice, process, information and service usage models). Domain Maps play a key role in bridging the world of users with the underlying invisible world of services. They thus also provide a route for institutional planners and users to finding appropriate tools and services that meet their needs."[42]

Reference Models /Domain Maps for service frameworks (referred to as DM in the rest of this document) thus provide a view of the domain that is geared towards planning service development.

B.2 The issues addressed by these guidelines

These guidelines are for use by any of the roles participating in the planning or execution of software system development to support activities in Learning and Teaching.

There are three levels at which they apply. Firstly, in model driven development a DM for the problem domain has to be generated as the underpinning activity for any production of code. In such development, particularly where it follows the OMG standard for Model Driven Architecture[43], the model has the potential to become the operational system. The second level of application of these guidelines is in the use of an existing model-based knowledgebase that addresses the problem-domain and its context. For the UK HE sector such a knowledgebase may be provided by a rich population of the High Level Domain Architecture (HILDA) model[44]. Thirdly, the development process will yield deliverables for the project itself and for the HILDA knowledgebase, for which guidelines are provided to place them correctly within the knowledgebase.

The guidelines therefore address the creation of models during system development, reference to the existing HILDA knowledgebase during that process and the contribution of the development activity outputs to the HILDA knowledgebase for future developers to utilise.

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[42] http://www.jisc.ac.uk/whatwedo/programmes/elearning_framework/refmodelssept05.aspx

[43] MDA (Model Driven Architecture) www.omg.org/mda

[44] HILDA (High Level Domain Architectures) http://130.88.2.245:8088/hilda/

B.3 The HILDA model and its potential uses

The HILDA project addressed the following questions:

- What is a domain map?
- Who would use a domain map?
- What would they use it for?
- Is it feasible to build one?

The HILDA domain map developed to attempt to answer these questions is a model of things in the world of HE provision. It comprises a metamodel and a knowledgebase. The domain map meta-model is the set of elements needed to model both those things in the world of Higher Education and the navigation routes for the domain map users. The knowledgebase is the set of concrete instances of those elements, taken from studies and development projects in the HE sector.

The following diagram shows the manner in which a domain model and knowledgebase could be used to bridge to the e-Framework

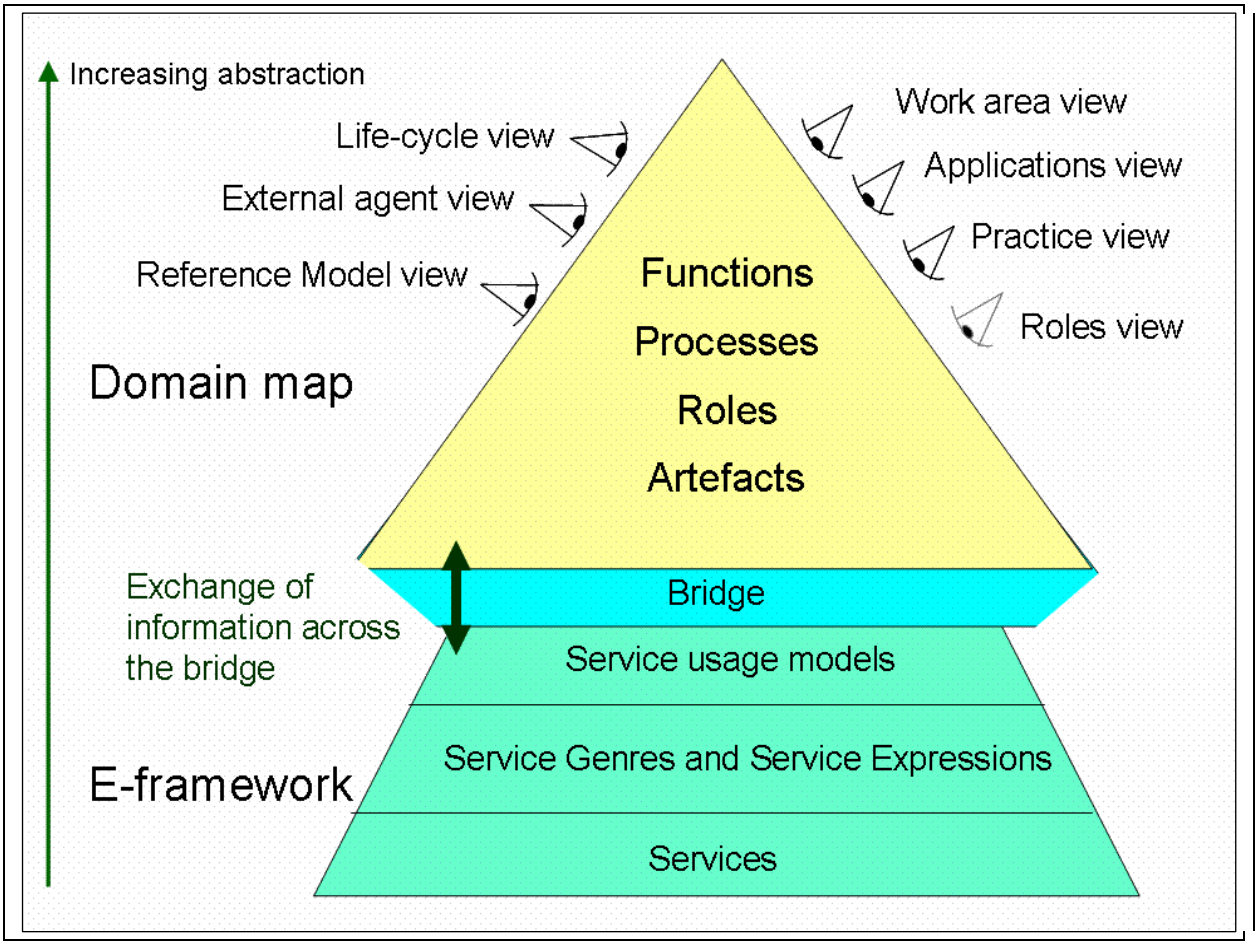

Figure 11: HILDA Diagram of the relationship between the domain map and the e-framework

The HILDA model linked to the e-Framework has the potential to address the following issues:

1. The vision, goals, plans and strategy of the HEI.
2. Interaction of the HEI with its environment of external organizations.

3. Functions and processes of the HEI (A 'function' here is taken to mean what is done and a 'process' is taken as meaning how the function is performed[45]).
4. Information and other artefacts used and produced by the processes of the HEI functions
5. Roles and responsibilities.
6. Organisational structuring of HEIs.
7. Enterprise architecture mapping the links between processes and practices to the underlying infrastructure and standards.
8. Reference models (DMs) for showing how services may be used to meet functional requirements in particular areas.
9. Services and their specification.
10. Packaging of the artefacts created in service specification (for example, requirements documents, models, exemplars, genres, expressions)
11. Location, asset lifecycle management and use of the e-Framework elements.
12. Asset packaging and description (metadata).

These areas are framed or contained in a single coherent model, allowing incremental development of each area, while maintaining the relationships between the areas.

The HILDA knowledgebase contains examples of all the different element types that are in the metamodel and each element type may be documented, described and modelled in multiple ways as appropriate. For example, UML Use Case documents to describe functions and Work Breakdown Schemas or UML Activity Diagrams to describe processes. The knowledgebase does not prescribe particular modelling or documentation tools, notations or methods.

B.4 The reference model viewpoint within HILDA

The reference model (DM) viewpoint in HILDA enables end-to-end navigation from a high level view of an issue, process or practice in HE, to the services that have been specifies to support that area of concern. It will allow the user to access any of the artefacts created in the workflow outlined in sections Glossary of terms used in the HILDA reference model and A generic workflow for software development in an SOA. The UML Class Diagram of this viewpoint (Figure 12) shows the associations between the elements that permit this navigation within the HILDA knowledgebase.

[45] JISC funding 2007: http://www.jisc.ac.uk/media/documents/funding/2007/04/jisc%20itt%20%20high%20level%20domain%20map%20final.doc

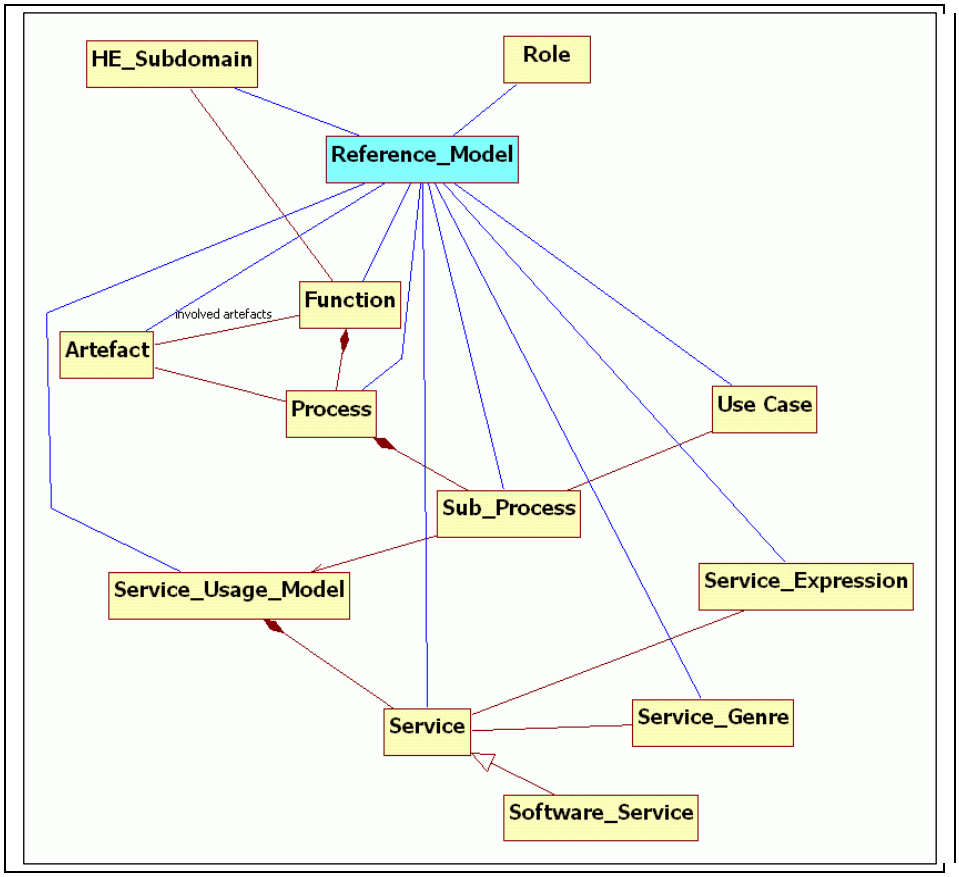

Figure 12: The Reference Model (DM) Viewpoint Metamodel in HILDA

B.5 Glossary of terms used in the HILDA reference model viewpoint

Table 9 provides the definitions used in the HILDA project for the terms that participate in the reference model (DM) viewpoint.

HILDA element	Definition
Artefact	Activities in a process have input and output artefacts. An artefact is a work product of the process: roles use artefacts to perform activities, and produce artefacts in the course of performing activities. The collection of artefacts contributes to the domain information model. The detailed domain information model should evolve alongside the functions and processes as they are detailed.
Function	The function describes what actors (people or systems) do to achieve their goals (aims and objectives). The function will contain flows of events (process) that show how value is obtained from that function for the actor(s).
HE-Sub-domain	Also called work area. An area of control or a sphere of knowledge, identified by a name, within the HE domain sphere of knowledge.
Process	A process is a set of linked activities that creates value by transforming an input into a more valuable output. Both input and output can be artefacts and/or information and the transformation can be performed by human actors, machines, or both.
Reference Model	An abstract representation of the entities and relationships involved in a

HILDA element	Definition
	problem space, forming the conceptual basis for the development of more concrete models of the space, and ultimately implementations, in a computing context. It thereby serves as an abstract template for the development of more specific models in a given domain, and allows for comparison between complying models (wikipedia). In the JISC/DEST e-Framework context the reference model is referred to as a “domain map”.
Role	A role defines the behaviour and responsibilities of an individual, or a set of individuals working together as a team, within the context of an organisation.
Service (software- or people-)	A single component or assembly of components that aligns to a 'unit of work' in a business process. It is packaged as an autonomous unit with a defined interface. May be deployed as a Web Service
Service Expression	Service Expressions represent specific cases of the related but abstract and generalized Service Genre. The detailed description of the Service Expression can be used to design an actual implementation of the behaviours associated with the Service Genre. (Ultimately, Service Expressions are ‘derivatives’ of a Service Genre, but the process by which Service Expressions are created is not always ‘derivation’ – Service Expressions could be developed before or simultaneously with establishing their related Service Genre.)[46]
Service Genre	A collection of related behaviours describing an abstract capability that supports a business process. It represents an interoperability point or interface to a set of individual activities or capabilities - actions that would be needed to carry out the process[47].
Service Usage Model (SUM)	The relationship between a process and the set of services required for its execution It provides a description of the needs, requirements, workflows, management policies and processes within a domain and the mapping of these to a design of a structured collection of Service Genres and Service Expressions, resources, associated standards specifications, data formats, protocols, bindings, etc., that can be used to implement software applications within the domain. SUMs model how services meet business needs.[48]
Software Service	A software (executable code) implementation of a service specification.
Sub-Process	A business process can be decomposed into several sub-processes, which have their own attributes, but also contribute to achieving the goal of the super-process.
Use Case	A specific way of using a system by performing some part of the functionality. Each use case constitutes a complete course of action initiated by an actor, and it specifies the interaction that takes place between an actor and the system. The collected use cases specify all the existing ways of using the system.

[46] International e-Framework – Service Expressions http://www.e-framework.org/Services/ServiceExpressions/tabid/615/Default.aspx

[47] International e-framework – Service Genres http://www.e-framework.org/Services/ServiceGenres/tabid/614/Default.aspx

[48] International e-Framework – SUMs http://www.e-framework.org/SUMs/tabid/607/Default.aspx

HILDA element	Definition
	A Use Case describes a Function.

Table 9: Glossary of Terms from HILDA for the Reference Model (DM) Viewpoint

B.6 A generic workflow for software development in an SOA

The following development process diagram shows a sequence of activities for quality driven, incremental and iterative development of a set of services. This is a high level view of the process in which the underlying detailed tasks form iterations. Each iteration results in some form of deliverable that may be evaluated, and the service provisioning plan allows for staggered development of services. On completion of an iteration, subsequent development activities are planned on the basis of evaluation of all the key deliverables and risk assessment.

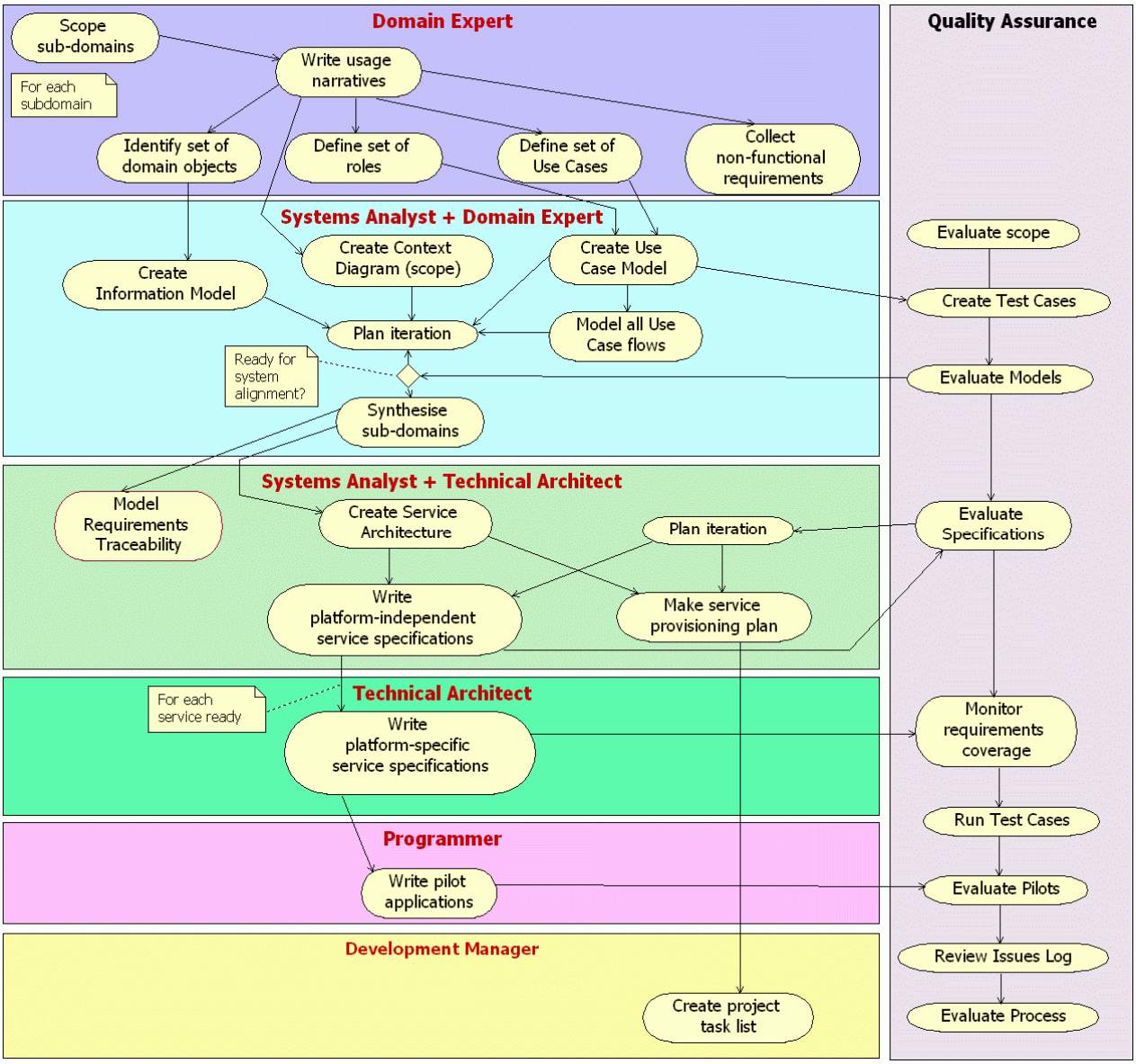

Figure 13: A generic SOA system development process

B.7 Dividing the system development workflow by roles

It is useful to view the development process from the roles and responsibilities of the development team. As in PRINCE2 roles are defined, jobs are not. This means roles may be (in many cases) combined and split between project team members[49]. This approach is also taken in the Rational Unified Process where there are examples of the Roles, Tasks and Guidance for developing applications in an SOA[50].

Successful development is highly dependent on successfully bridging between the domain experts knowledge and the technical architect and programmers. To enable all participants to work within their areas of expertise and use their own vocabularies to describe and produce a system, collaborations are set up allowing the "systems analyst" role to act as a mediator, translator and communications facilitator. The evaluation and testing role operates on all the other activities, driving refinement activities, risk management and iteration scope planning.

There are seven combinations of roles defined for the process, made up from: Domain Expert, System Analyst, Technical Architect, Programmer and Quality Assurance. These are high level roles and may be fulfilled by combinations of teams and individuals with the appropriate skills and competencies.

B.8 An example of system development according to this workflow: the HeLM project

The Horus e-Learning Management (HeLM) project[51] is being conducted by the team that developed Horus, an e-technology to help doctors-in-training learn in workplaces. It started out with the realisation that medical students were unaware what they should learn from their various workplace experiences, despite teachers' best efforts. Horus presents learners with their objectives and gives both general advice and objective-specific support to help learners achieve those objectives. It serves as a portfolio for learners to keep a reflective log of their learning and their attainment of targets prescribed by the curriculum. The same process of reflective evaluation provides teachers with feedback on the quality of the learning experiences they have provided. Horus can also record workplace assessments and help teacher and learner manage the appraisal cycle. It provides sophisticated tools to derive quality management data from learners' entries.

HeLM is an implementation project, which aims to increase the range of Horus services available to undergraduate medical students across a wider range of hospitals and other clinical workplaces. It will strengthen Horus support to in-depth reflective learning, extend the support to teachers as well as students, scope the application of Horus services to other higher education courses, and draw together learning and assessment within a single virtual learning environment.

The project is being conducted in the University of Manchester, largely within the School of Medicine, but extending to Pharmacy, Dentistry, and other courses within the University. The goal is to build capacity to conduct further research and development and to make the Horus toolset more widely available to the Higher and Further Education Sector. Figure 14 shows the areas of concern (the value drivers) within the HeLM project scope.

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[49] PRINCE 2 http://www.prince2.org.uk/home/home.asp

[50] Rational Unified Process (RUP) for SOA: http://www.ibm.com/developerworks/blogs/page/johnston?entry=rational_v7_launch_and_rup

[51] HeLM (Horuse e-Learning Management) http://www.medicine.manchester.ac.uk/helm

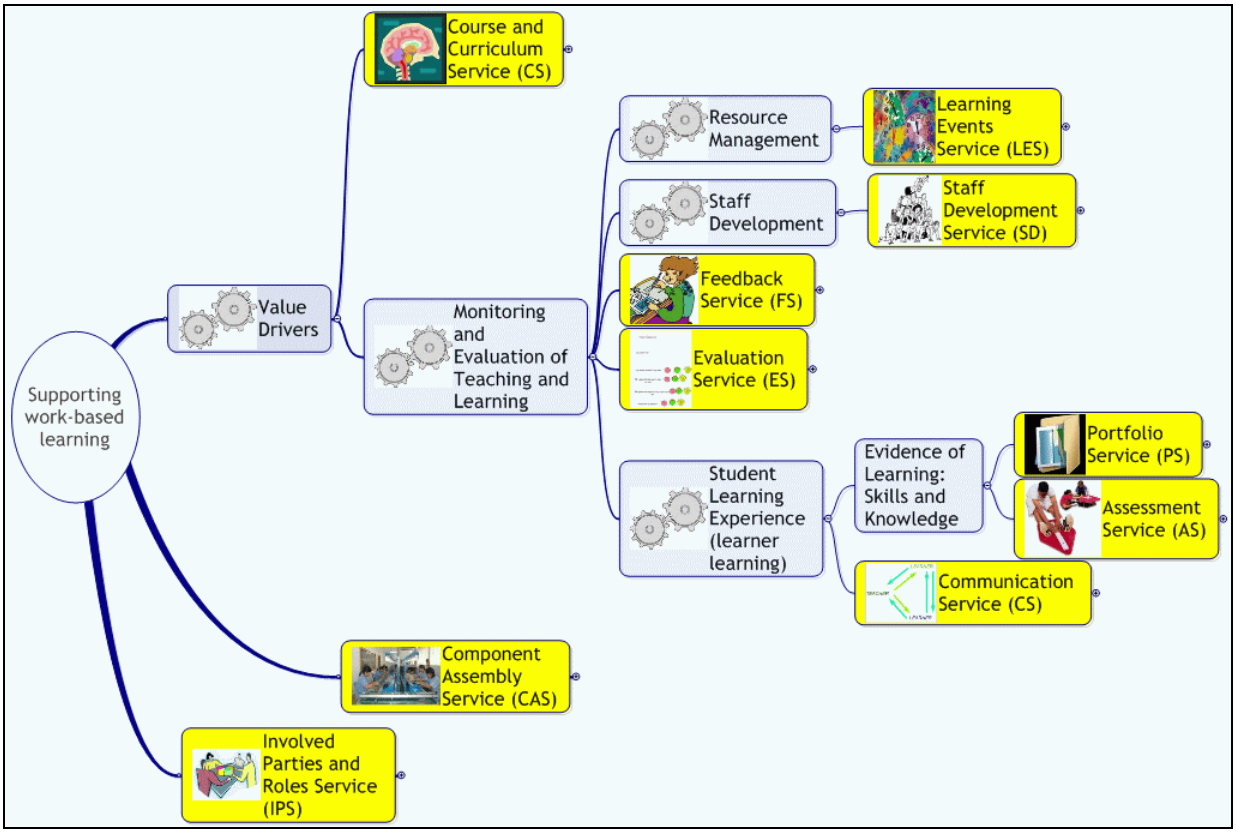


Figure 14: Overview of HeLM topics

HeLM is a two year project that began in October 2006. The development process in HeLM follows that illustrated in Figure 12 with continuation to code generation from the models using an MDA tool.

A selection of the outputs from the HeLM project has been entered into the HILDA knowledgebase to illustrate the use of a Domain Map to support system development (see section HeLM Domain Map elements in HILDA).

B.9 Using and enriching the HILDA knowledgebase

For each individual and collaborative role there is:

- a set of tasks or activities;
- a set of questions that could be addressed to the HILDA knowledgebase;
- a set of outputs or deliverables mapped to the HILDA metamodel;

Note: abbreviations used: For the particular problem domain (PD) there is a system under development (SUD). The mapping to the HILDA metamodel is indicated by [*element*] e.g. [Function] or [Use Case]. This shows where the element could be entered into the knowledgebase.

1. Role1: Domain Expert

    a. Tasks:

        1) Define the problem and problem domain requiring support from a software application. The precise boundaries of the problem domain may not be clear prior to completion of the requirements analysis.

        2) Consider how the PD may be broken down into sub-domains. These may then form the basis for planning development iterations.

3) Write usage narratives for the SUD. A usage narrative is an unstructured text account of an area envisaged for the system to support.

4) Define the set of roles in the PD.

5) Identify objects (artefacts), used and produced by the activities in the PD.

6) Create structured Use Cases from the usage narratives. Each Use Case will have a clear goal or purpose and will describe the value output. Each Use Case describes a piece of functionality of the SUD and is a functional requirement for the SUD.

b. Questions/functions for HILDA

1) Finding other users and developers for sharing information.

2) Understanding which part of the T&L lifecycle is being supported (scope and boundaries).

3) Understanding theoretical requirements for particular part of the T&L lifecycle.

4) Finding out what sort of things happen to a learner at a particular point in the learner lifecycle and examining whether these point to requirements.

5) Reaching an agreed vocabulary for the stakeholders in the PD.

6) Locating existing usage narratives, high level scenarios and Use Cases in the PD.

7) Identifying roles that have been identified in this PD.

8) Viewing information models and lists of artefacts in this PD.

c. Deliverables and their mapping to HILDA

1) Clear boundaries of the PD with an understanding of the set of concerns of the SUD.[HE Subdomain Subdivision]

2) Set of Roles [Role]

3) Set of usage narratives [Sub-Process]

4) Set of Use Cases [Use Case]

5) Set of non-functional requirements [Rule]

6) Set of artefacts [Artefact].

2. Role2: Systems Analyst and Domain Experts collaboration

a. Tasks:

1) Create context diagram (scope).

2) Create Use Case model.

3) Create ontology or glossary for the SUD.

4) Create information model.

5) Model all the Use Case flows.

6) Plan iterations of Use Case modelling and prioritise Use Cases.

7) Synthesise Use Cases into system and sub-systems model.

b. Questions/functions for HILDA

1) Are there other reference models (DMs) that address any of this SUD? If so who are the contacts?

2) Does the scope of this SUD map to other sub-domains, processes or sub-processes?

3) Are there Use Cases that relate to the concerns of the SUD?

4) Are there artefacts of interest to this SUD?

c. Deliverables and their mapping to HILDA

1) Context model [Use Case]

2) Use Case Model [Use Case]

3) Set of full Use Case documents [Use Case]

4) Use Case flow models [Process]

5) Set of functional requirements [Function]

6) Set of non-functional requirements [Rule]

7) Prioritisation of Use Case development passed to Development Manager [Use Case]

8) Ontology and or glossary for the SUD [External Document] attached to [Application].

3. Role3: Systems Analyst and Technical Architect collaboration

a. Tasks:

1) Model requirements traceability.

2) Create system architecture (a.k.a. solution architecture).

3) Write platform (technology) independent service specifications.

4) Make service provisioning plan (use/modify/build i.e. source the services from own repositories, open source repositories, e-Framework etc or develop new).

5) Plan iterations for service development, based on risk analysis and prioritisation of services.

b. Questions/functions for HILDA

1) Is this PD covered by any component architecture models or SUMs

2) Are there relevant service specifications?

3) Are there relevant implemented services?

4) For found services or service specifications is there documentation?

5) For found services or service specifications are there contacts?

c. Deliverables and their mapping to HILDA

1) Requirements mapping from Use Case through to service specifications. [Service]

2) A component model for the proposed system architecture [Service Usage Model].

3) Platform independent specifications for services [Service] [Service Genre].

4) A provisioning plan indicating the source for all services [External Document] attached to [Application].

5) An iteration plan for prioritised service development [External Document] attached to [Application].

4. Role4: Technical Architect

a. Tasks:

1) Select platform(s) for the SUD.

2) If there is an enterprise architecture in own organisation, use it to set standards for code and system integration.

3) Write technical service specifications for the chosen platform.

4) Plan system integration.

b. Questions/functions for HILDA

1) If no enterprise architecture in own organisation, is there a suitable one in HILDA? If so, what are the standards for platform and code for this particular implementation?

2) Are there relevant examples of service integration?

3) Are there service expressions available for the SUD?

4) Are there composite applications that cover all or part of the PD?

c. Deliverables and their mapping to HILDA

1) Platform dependent service specifications (including Service Expressions) [Service] [Service Expression].

2) Application composition design (including SUMs [Service Usage Model].

3) Application integration design [Reference Model].

4) Selected standards for service integration and code [Reference Model].

5. Role5: Programmer

a. Tasks:

1) Write code to the service specifications. If using an MDA tool, the skeleton code may be generated from the models.

2) If an MDA approach, possible with code generation, is used a single coherent model for the SUD is maintained.

3) Document code.

4) Create test harnesses for services and application.

b. Questions/functions for HILDA

1) If adapting existing services, who were the developers? Can I consult them?

2) If directed to an enterprise architecture, what are the standards for code for this particular implementation?

c. Deliverables and their mapping to HILDA

1) Implemented services with documented code [Software Service].

2) A composite application (choreographed set of services) and user interface [Application].

6. Role6: Development Manager

Note: The Development Manager works with all the other roles and with any management and steering committees of the SUD. He may be, or work in collaboration with, the overall project manager. The tasks here relate to the development of the SUD only.

a. Tasks:

1) Create project task list and development plan.

2) Monitor milestone deliverables.

3) Monitor issues logs (All roles maintain issues logs).

b. Questions/functions for HILDA

1) Are there development managers from similar projects listed as contacts?

2) Are there relevant development methods that have proved useful?

c. Deliverables and their mapping to HILDA

1) Task list and development plan [External Document] attached to [Application] or [Reference Model].

2) Milestones [External Document] attached to [Application] or [Reference Model].

3) Issues logs [External Document] attached to [Application] or [Reference Model].

7. Role7: Tester/Evaluator (Quality Assurance team)

Note: The Tester/Evaluator works in collaboration with all the other roles according to the context of the development outputs under review.

a. Tasks:

1) Evaluate iterations' scope.

2) Create test cases.

3) Evaluate models.

4) Evaluate outputs/deliverables.

5) Carry out risk analysis at each iteration.

6) Monitor requirements coverage.

7) Validate requirements.

8) Run test cases.

9) Evaluate pilots.

10) Review issues logs.

11) Evaluate the development process.

12) Evaluate SUD with stakeholders.

b. Questions/functions for HILDA

Note: These are in addition to those questions posed by the other roles who will be collaborating with the Evaluator in each evaluation task.

1) Are there relevant Use Cases and scenarios to test this SUD?

2) Are there evaluation plans in the external documentation of other relevant projects?

c. Deliverables and their mapping to HILDA

1) Evaluation reports for all outputs from iteration plans, requirements analysis, service specification and service/application implementation [External Document] attached to [Application] or [Reference Model].

2) Risk analysis reports at iteration milestones [External Document] attached to [Application] or [Reference Model].

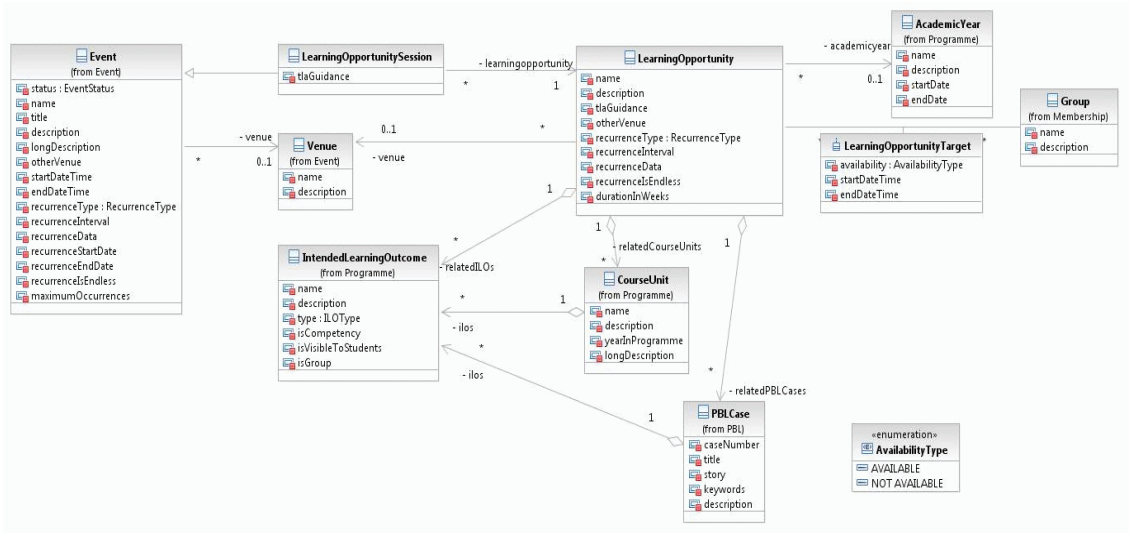
3) Evaluation report on the development process with recommendations for refinement [External Document] attached to [Application] or [Reference Model].

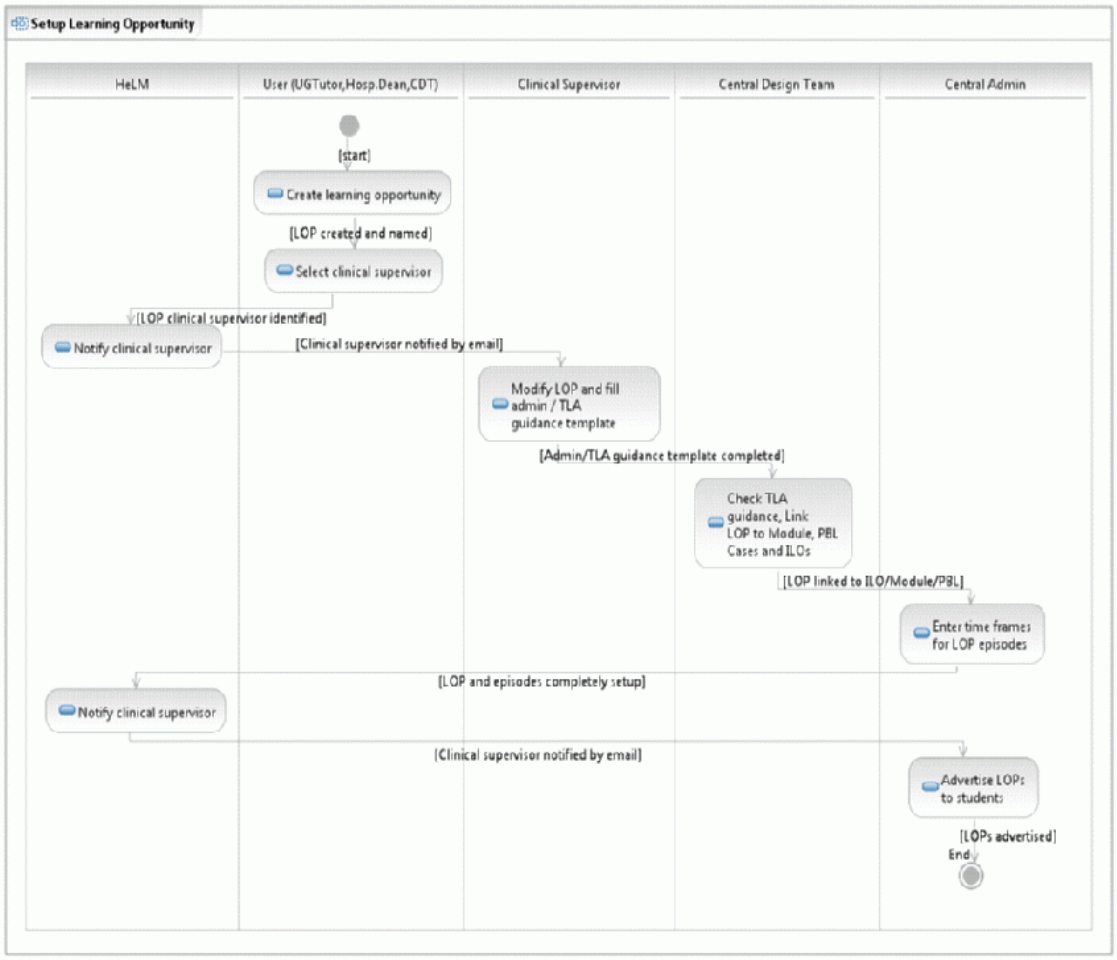
B.10 HeLM Domain Map elements in HILDA

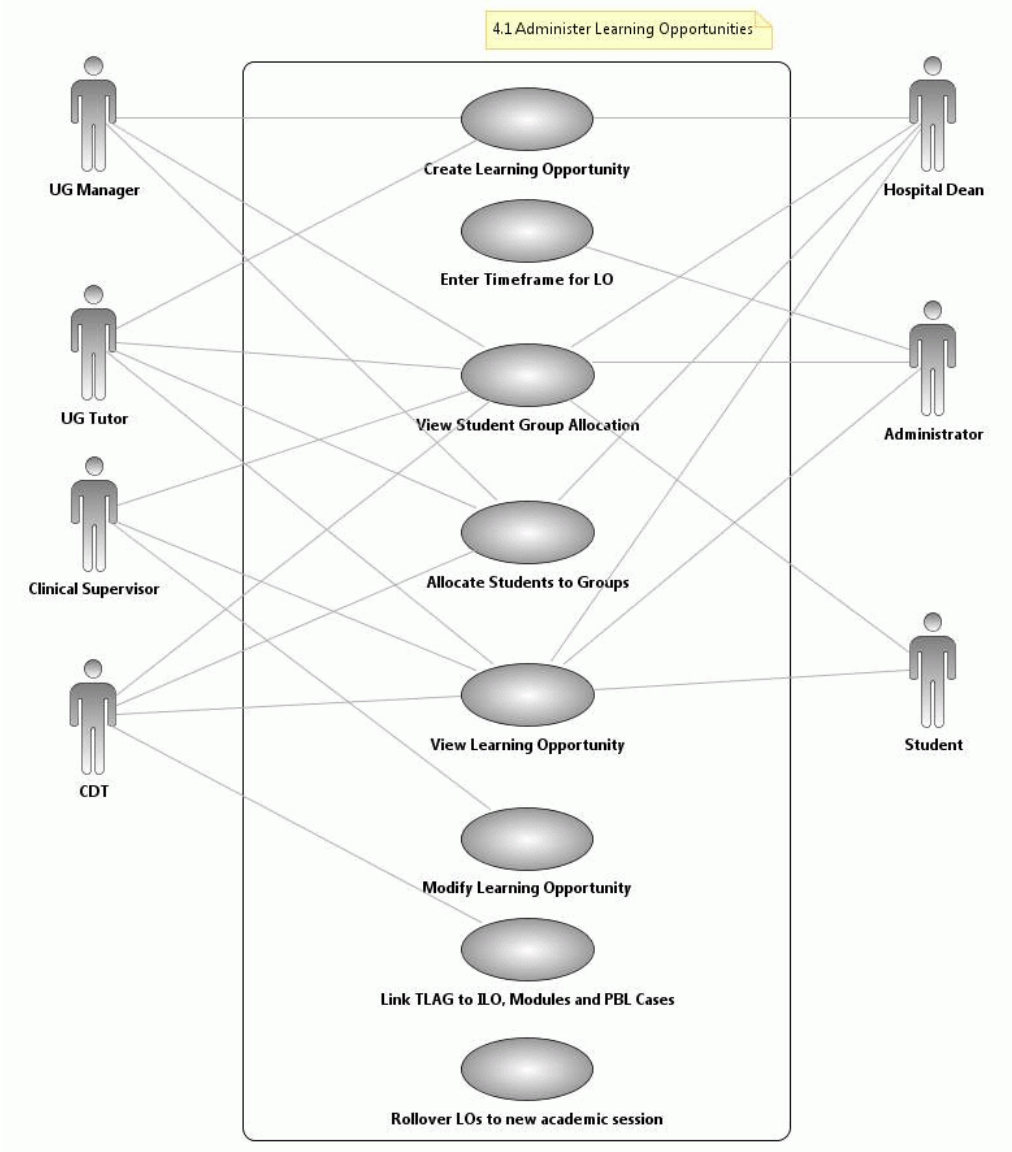
The following table contains examples of elements from HeLM for each of the HILDA metamodel elements in the reference model (DM) viewpoint:

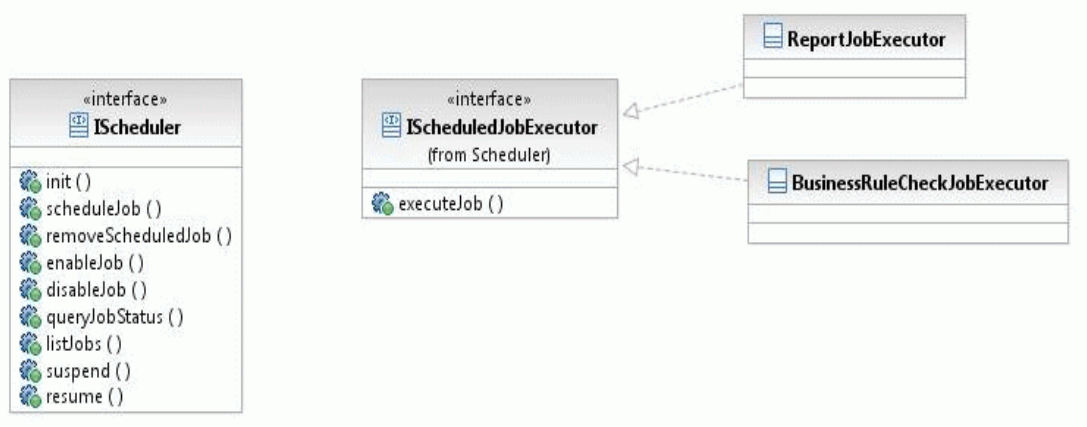
Table 10: Examples from HeLM for the Reference Model viewpoint

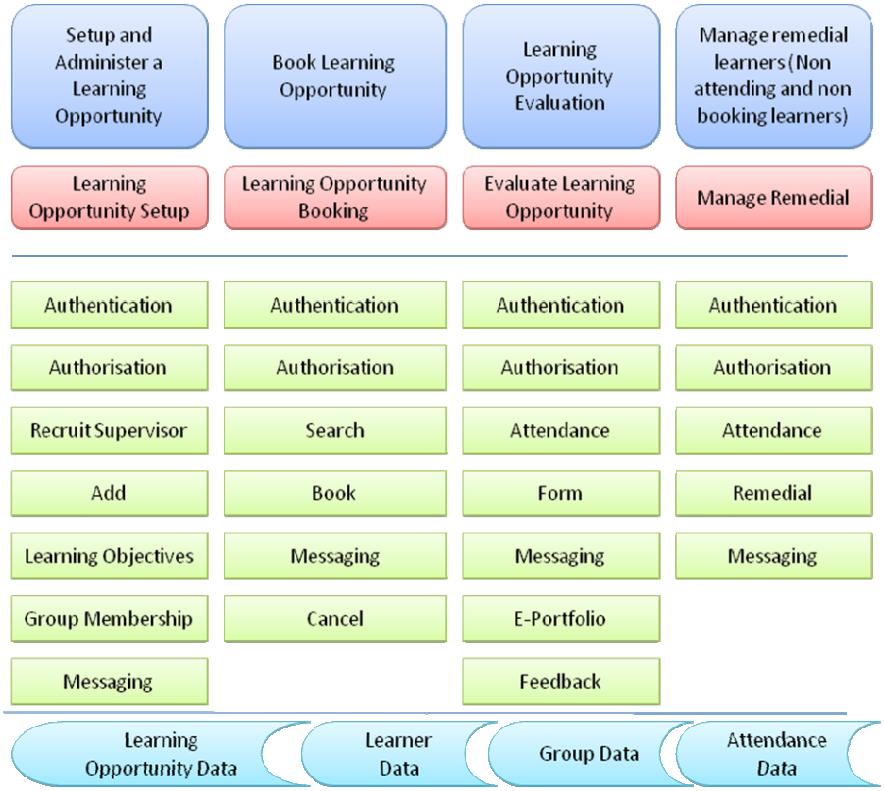
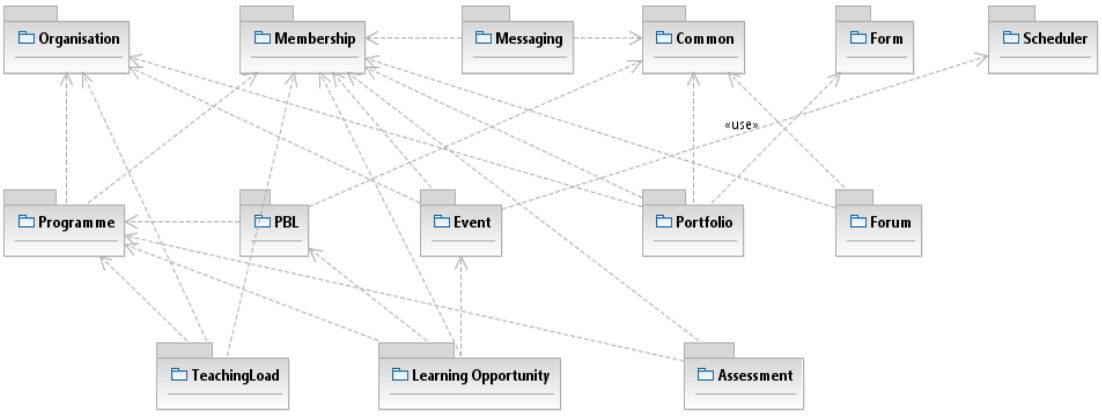
HILDA element	**Example from HeLM**
Artefact	Some Classes from Learning Opportunity Management

HILDA element	Example from HeLM
	 **Figure 15: HeLM UML Class diagram** Classifiers AvailabilityType LearningOpportunity LearningOpportunitySession
Function	The following are functions in Learning Opportunities Management: Maintain a databank of learning opportunities Enable learning opportunity administrators to create and allocate learning opportunities to target groups Enable students to choose and book learning opportunities. Enable students to provide feedback / evaluation of learning opportunities attended to teachers. Enforce the business rules as described in the usage narratives with respect to attendance and non-attendance of learning opportunities by students Enable attendance monitoring of learning opportunities and enable the scheduling of remedial actions for defaulting students.
HE-Sub-domain	Learning Opportunities Management - support the administration processes needed for flexible cross-institutional provision of workplace learning
Process	The set up learning opportunity process:

HILDA element	Example from HeLM
	 **Figure 16: Learning opportunities management: setup learning process**
Reference Model	HeLM Horus e-Learning Management
Role	Some of the roles from Learning Opportunities Management work area shown in a Use Case Diagram:

HILDA element	Example from HeLM
	 **Figure 17: Learning opportunities management use case diagram**
Service (software or people)	Some services used in Learning Opportunities management

HILDA element	Example from HeLM
	 **Figure 18: Some services used in learning opportunities management**
Service Expression	Under development
Service Genre	**To be submitted (Genre + brief description of functionality)** 1. **Forum** – administer forum, add and search posts, export to portfolio 2. **Form** – create, retrieve, serialise and de-serialise forms 3. **Export** – Select from a list of items and export using a converter to a desired format 4. **Tag** – Tag a selection with a list of tags from one or more tag sources / types 5. **Recruitment** – Recruit people for a set of activities based on well defined criteria 6. **Booking** – Booking service for learning events 7. **Attendance** – Attendance management for learning events 8. **Converter** – Convert between various data formats 9. **Remedial –** Administer remedial actions to a group of individuals not meeting certain requirements. 10. **Feedback –** Service for exposing a collection of items for others to provide feedback
Service Usage Model (SUM)	**Learning Opportunities Management**

HILDA element	Example from HeLM
	 **Figure 19: Learning opportunities management SUM**
Software Service	This is the component architecture for the SUM  **Figure 20: component architecture for the SUM**
Sub-Process	• To setup learning opportunities, • Hospital Dean/UG tutor/UG manager recruit clinic supervisors • Clinical supervisors receive TLA guidance template and completes on screen • Clinical supervisors complete learning opportunity admin template on screen

<table>
<tr><td>HILDA element</td><td>Example from HeLM</td></tr>
<tr><td></td><td>

CDT team checks TLA guidance and links to ILOs, modules and PBL cases
Central admin confirm timeframe dates and with sectors/UG managers/UG tutor/Hosp Dean
Central admin enter timeframe into system
When TLA guidance and admin template complete system send confirmation to clinical supervisor
Monitoring information of recruitment rates sent to UG manager by system
At the end of the academic year report of student attendance at learning opportunities to all parties
Clinical supervisors can add/ alter learning opportunity dates, venues
The completed learning opportunity TLA template can be altered by CDT
Timeframe can be entered at any time before the learning opportunities are advertised to the students
Clinical supervisors can change TLA guidance and learning opportunity admin details at the end of the academic year in preparation for the next academic year - Hospital dean, UG tutor, UG manager, clinical supervisors, CDT emailed and updates requested

</td></tr>
<tr><td>Use Case</td><td>
<table>
<tr><td>Use Case ID</td><td>USE CASE 4.1.1 – CREATE LEARNING OPPORTUNITY</td></tr>
<tr><td>Brief Description</td><td>Set up learning opportunity in system (User = Hospital Dean, UG tutor, UG manager)</td></tr>
<tr><td>Basic Flow of Events</td><td>User enters name of learning opportunity and selects a clinical supervisor from a list for the learning opportunity

System notifies selected clinical supervisors of learning opportunities for which they have been recruited along with instructions for filling the TLA guidance and administrative information.

System saves information necessary for monitoring recruitment rates of clinical supervisors for learning opportunities.</td></tr>
<tr><td>Alternate Flows</td><td></td></tr>
<tr><td>Pre-conditions</td><td>1. User has been identified to the system by a user name and password.

2. List of clinical supervisors registered in the system.</td></tr>
<tr><td>Post-conditions</td><td>1. New learning opportunity is registered in the system

2. Recruited clinical supervisor receives notification for the learning opportunity</td></tr>
<tr><td>Extensions</td><td></td></tr>
<tr><td>Special Requirements</td><td></td></tr>
</table>
Table 11: Use cases for create learning opportunity
</td></tr>
</table>

The following is a table showing the HILDA reference model (DM) viewpoint for a small sample section of the HeLM project as it is stored in the HILDA knowledgebase.

Slot Name	Value
contributor	HD

description	HORUS e-Learning Management (HeLM) is a two year project that focuses on the provision of e-Portfolio services to promote lifelong learning.
	
	Project partners * University of Manchester: * School of Medicine (Lead Partner) * Distributed Learning Group * NHS * Lancashire Teaching Hospitals NHS Foundation Trust * Salford Royal NHS Foundation Trust * South Manchester University Hospitals NHS Trust
	
	This project is being conducted by the team that developed Horus, an e-technology to help doctors-in-training learn in workplaces. It started out with the realisation that medical students were unaware what they should learn from their various workplace experiences, despite teachers' best efforts. Horus presents learners with their objectives and gives both general advice and objective-specific support to help learners achieve those objectives. It serves as a portfolio for learners to keep a reflective log of their learning and their attainment of targets prescribed by the curriculum. The same process of reflective evaluation provides teachers with feedback on the quality of the learning experiences they have provided. Horus can also record workplace assessments and help teacher and learner manage the appraisal cycle. It provides sophisticated tools to derive quality management data from learners' entries. HeLM is an implementation project, which aims to increase the range of Horus services available to undergraduate medical students across a wider range of hospitals and other clinical workplaces. It will strengthen Horus support to in-depth reflective learning, extend the support to teachers as well as students, scope the application of Horus services to other higher education courses, and draw together learning and assessment within a single virtual learning environment. The project is being conducted in the University of Manchester, largely within the School of Medicine, but extending to Pharmacy, Dentistry, and other courses within the University. The goal is to build capacity to conduct further research and development and to make the Horus toolset more widely available to the Higher and Further Education Sector.
	
	Aims and objectives
	
	Aim Extend Horus learning management services to a wider range of applications, institutions, and stages in the lifelong learning continuum and link them to the JISC-funded UK Collaboration for a Digital Repository (UKCDR) and MANSLE projects.
	
	Objectives
	• Extend Horus's e-Portfolio services to support in-depth reflective learning
	• Extend Horus to support teachers' learning from students' evaluations of their teaching
	• Extend Horus to support the sophisticated administration process needed for flexible cross-institutional provision of workplace learning
	• Extend the implementation of Horus services beyond medicine by scoping how the services could be applied to:
	  • Two other exemplars of workplace learning in higher education: Dentistry and Pharmacy
	  • Further education by deriving a requirements specification and scoping the extension of Horus's new services to the JISC-funded MANSLE collaboration * Establish pedagogic and technical means of linking

Slot Name	Value
	e-Learning to formative assessment by bridging Horus with UKCDR * Build capacity that is sustainable and can be extended to the widely e-Learning community
display name	HeLM: Horus eLearning Management
has external documentation	HeLM project website
Lead Institution	University of Manchester
name	HeLM: Horus eLearning Management
RefModel addresses Role	Student, Clinical Supervisor, Buddy, Course Director, Assessment Administrator
RefModel describes Subdomain	Student Portfolio, Teacher Portfolio, Learning Opportunities
RefModel has_Artefacts	Annotation, Portfolio Item, Learning Opportunity, Learning Opportunity Session
RefModel_has_Functions	Manage Student Portfolio, Manage Teacher Portfolio, Manage Learning Opportunities
RefModel_has_Processes	Manage Student Portfolio, Manage Teacher Portfolio, Manage Learning Opportunities, Set up learning opportunity
RefModel_has_Service Expressions	Form Service Expression, Event Service Expression
RefModel_has_Service Genres	Form Service Genre, Event Service Genre
RefModel_has Subprocesses	PREPARATION FOR PERSONAL AND PROFESSIONAL DEVELOPMENT REVIEW, REFLECTIVE DISCUSSIONS BETWEEN STUDENT GROUPS, LEARNING OPPORTUNITY ADMINISTRATION
RefModel_has_SUMs	Calculate teaching load
RefModel_has UseCases	Record Reflections, Download Reflective Pieces, Create learning opportunity, Link TLA guidance to ILOs, modules and PBL cases, Roll over learning opportunities to new academic session

Slot Name	Value
RefModel specifies Services	Form Service, Event Service, Membership Service, PBL Service
source	HeLM Project Website
url	http://www.medicine.manchester.ac.uk/helm

In the current HILDA knowledgebase it is possible to run simple queries. For example, a search for all Artefacts containing 'portfolio' in their name, produces a set of 5 elements as shown in Figure 21 below. Double clicking an item allows tracing to its source, in the case shown to the eP4LL reference model. Such queries can help to address the questions laid out in section Using and enriching the HILDA knowledgebase.

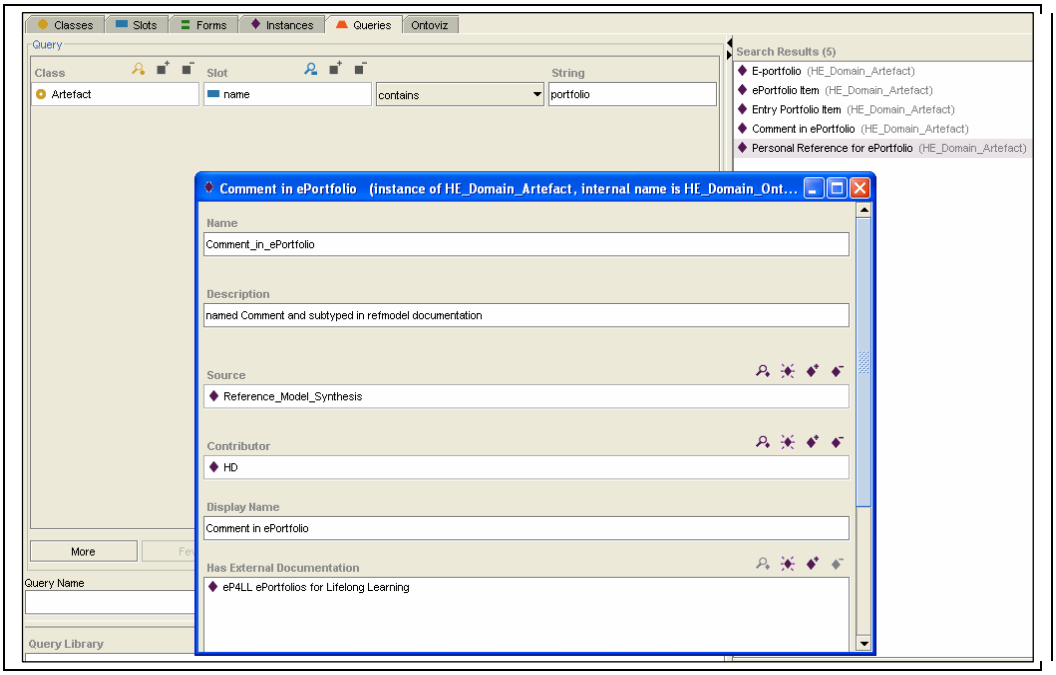


Figure 21: Running queries in HILDA

B.11 Recommendations

Recommendation 36: Complete data entry to HILDA from all the reference models.

Because the HILDA knowledgebase is only a proof of concept development at this time and is not richly populated, it is not possible to evaluate the kinds of information that would be returned in answer to the questions listed above. A next step might be to enter all the data elements from the eP4LL and FREMA reference models which would allow cross-references with HeLM to be examined.

Recommendation 37: Provide rich queries capability in the HILDA knowledgebase.

The questions in section B.9 provide a set of requirements for further development of the HILDA knowledgebase and its user interface.

Recommendation 38: Encourage service and application development projects to enter their outputs into HILDA during their development lifecycle.

It is quite straightforward to populate the HILDA knowledgebase during the development of an SOA application or set of services and this activity could easily be made part of the development workflow. To facilitate this, an intuitive user interface is required for the HILDA knowledgebase, rather than requiring people to use the Protégé environment directly.

C Appendix C: Service Usage Models created in the synthesis project

Prior to this synthesis project's consideration of SUMs the e-Framework editor produced a SUM from eP4LL's work. This can be see at http://www.e-framework.org/Default.aspx?tabid=911

Two Service Usage Models (SUMs) were extracted from the reference model projects during the course of this synthesis project. The SUMs were both derived from the COVARM Project. These SUMs have been submitted to the U.K. e-Framework editor for potential inclusion in the e-Framework.

The SUMs are:

- A relatively low-level SUM concerned with meeting scheduling. This is used in the following SUM, and may be reused elsewhere.

- A SUM that covers the entire course validation lifecycle as characterised by COVARM.

The SUMs are defined at genre level.

Three comments are in order:

Experience was that it was relatively difficult and time consuming to create these SUMs from COVARM project documentation. This was surprising, because the reason COVARM's output was selected for this exercise was that its outputs were quite formal in nature, comprising a UML domain map and UML activity diagram for the canonical models. The synthesis project did not have time to investigate the reasons for this difficulty and can only point at the difficulty of building generalised models (in this case for SUMs) from information that is at a different level of description.

Also, when constructing genre level models, it became apparent that at best genre level SUMs can only be approximations of service level SUMs that describe actual (reusable) implementations. Low level technical design considerations, including engineering tradeoffs, are liable to mean that genre level descriptions constructed before service implementations and their SUMs are not fully accurate with respect to the resultant service level SUMs.

Finally, to only work at the level of SUMs would be a great mistake. User considerations mean that a method like the lifecycle method must be employed to ensure user needs, requirements and interests are properly catered for.

D Appendix D: Model based design

There is an emphasis on usability and user involvement in the design process in this section because, while the four projects studied had exemplary user contact, they failed to involve users in some other processes that contribute to end usability of developed systems, namely, participatory design and early and ongoing formative evaluation of he developing design.

Recommendation 39: Projects need to emphasis user involvement in participatory design and in early and ongoing formative evaluation of the developing design

One of the reasons for the adoption of a model based design is to base the design of a system on user, domain and process characteristics and to bring order to the often challenging matter of considering design requirements and how a system design may be founded on those design requirements.

However, adoption of model based design is of itself little use in the endeavour of building usable systems. Model based design should be coupled with participatory design by both users and technical staff to significantly help ensure maximal usability.

Interested readers should see the web site for further details on usability[52] and participatory design[53].

In brief, model based design has three primary concerns:

- Collection of user requirements and creation of a vision of the future system.
- Construction of abstract models of the system, and abstract models of the system and user interaction with the system.
- Detailed technical design and implementation. For the reference model projects this includes work at the services level.

If, for a moment, we think of project work centred on each of these concerns as a linear progression through three stages, the general appeal of model based design is that:

- Early envisioning is likely to involve thinking about the functionality of the system at the user interface with, probably, some inappropriate design assumptions that, if carried through to implementation, might well cause sub-optimal usability.
- With sufficiently high-quality design work, abstracting from early visions leaves inappropriate assumptions behind and provides a clear, coherent and sound abstract model of the system to be constructed.
- Detailed technical design should be based on clear, coherent and sound abstract models. If so, the technical design is far less likely to incorporate sub-optimal design, and is far more likely to form a coherent usable design.

However, this is a rather skewed and purist conception because in practice errors invariably creep into the design process as a result of inevitable design failures: Important design factors are not considered, or some aspects of the design are incorrectly specified. Thus the important question is how one might avoid these errors being propagated and embedded in the end user system.

Two approaches help in avoiding design problems and increases system usability for end users:

- Real and meaningful contact with users that contributes to the system design when users are consulted for domain information and system requirements.
- Involving users in a participatory design process that involves early and continuing formative analysis of the developing design.

The latter is even better for the usability of the end product of the design and implementation process. It is relatively easy to involve users in the testing of both abstract models of the system and mockup prototypes of the system 54.

[52] http://misc.jiac.ac.uk/refmodels/analysis_and_synthesis/usability.html
[53] http://misc.jiac.ac.uk/refmodels/analysis_and_synthesis/participatory_design.html

It is particularly important that participatory design that results in the design of content, functionality, and user interface at the same time. These are all deeply interlinked determinants of the usability of the end system. In general changing one will cause changes in the others may well cause changes in system usability for end users.

It should be noted that the four projects considered and synthesised here were model-based methods, and each had a sound and noteworthy initial user consultation phase that will be discussed below.

In the execution of model based design it is particularly important that project teams are skilled in all the representations and design techniques that are likely to be used in project execution, including participatory design and UML modelling.

Recommendation 40: The JISC should provide project training for project staff in methodology sufficient for effective use of the lifecycle method and its likely constituent parts.

Recommendation 41: The JISC should facilitate growth of UML skills in its development communities — unfortunately this is not just a matter of providing introductory courses; to use UML well generally takes six months of use in an environment where help and guidance is being provided to learners by experienced UML modellers.

Recommendation 42: The JISC should facilitate growth of participatory design skills in its development communities. There is a scarcity of participatory design skills in the design and development community; these skills are one pre-requisite to the construction of highly usable systems.

D.1 Ordering of activities in model-based design

D.1.1 Stages, order and user involvement

All the four projects adhered to the general form of activities in model based design and engaged in same four components or 'stages' in a model based design process, although with some variation as to what the stages were, and some differences in how tightly the different components were bound together in different projects.

The components are:

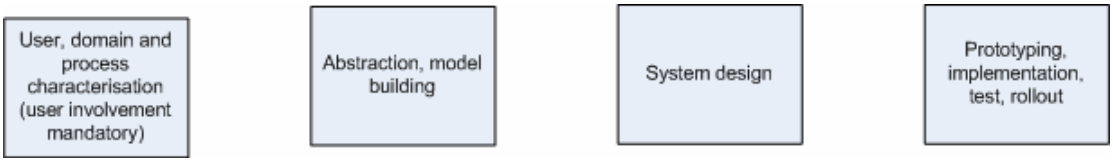


Figure 22: Activities in model based design

At this stage nothing is said about ordering of these components in a project lifecycle, apart from that components on the left must be finished before components on the right. Thus, the components could be connected together in a waterfall method:

[54] A look at a a model based design method called The Bridge will provide exemplars of how to test abstract models. The relevant parts of the method can be seen at http://books.google.co.uk/books?id=RC9faRWAqTkC

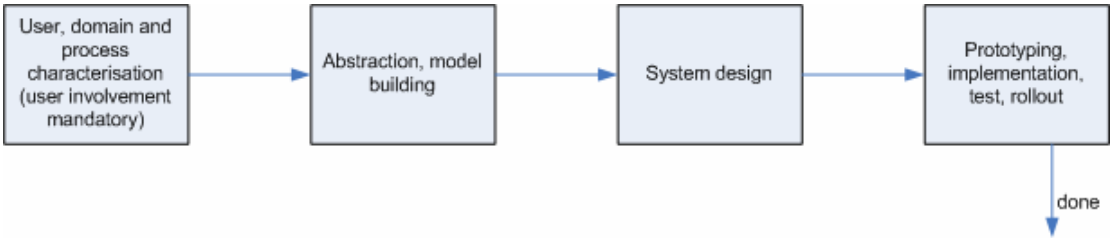


Figure 23: Undesirable linear waterfall method in model based design

A waterfall method is undesirable because the designers can, as discussed above, produce a sub-optimal design. If this has happened during an earlier stage and is discovered in a later stage there is no way of correcting it. To correct such problems an agile approach allows for revisiting and reworking earlier design when earlier problems are discovered in the course of later work:

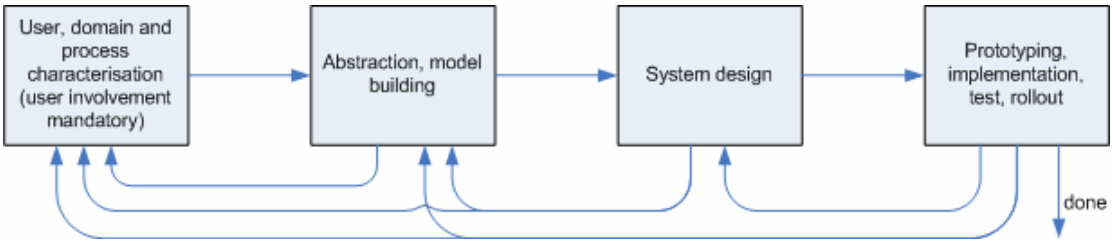


Figure 24: Feedback in model based design

A strong degree of user involvement in design can take place at different stages. The involvement may only be with respect to requirements gathering or may involve participatory design. This is harder to diagram, but we could use a background rectangle to show user involvement. Most often user involvement occurs only early in the project lifecycle:

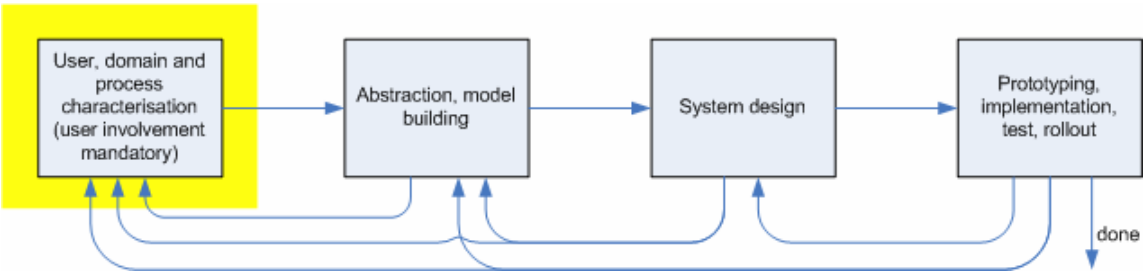


Figure 25: Minimal involvement of users in model based design

Users can be involved more; e.g. in the design process that results in the construction of abstract models that express scope, content, and functionality.

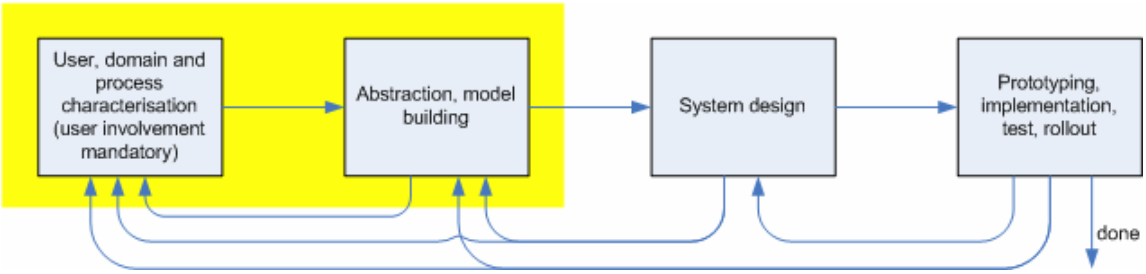


Figure 26: Minimal involvement of users in model based design to maximize usability

User involvement at the abstract model formation stage means that users are participating in design. In order for users to be able to play a design role the design team has to use non-specialist notations for design. User-understandable notations used in The Bridge are shown below:

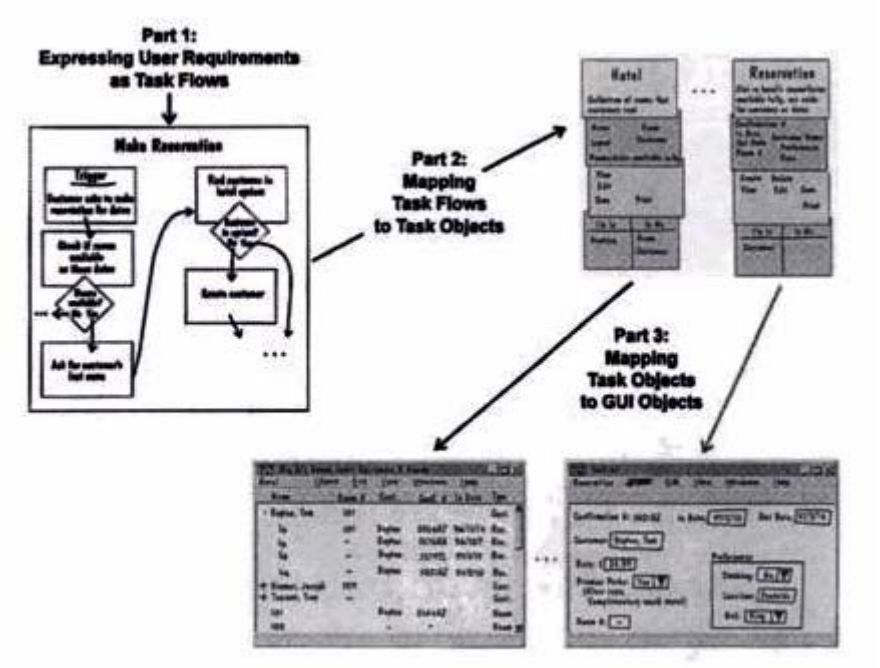


Figure 27: User understandable notations as used in The Bridge

The technical staff in a participatory design team will use more formal notation, typically UML, 'behind the scenes'; accurately translating user-understandable notation into the more formal UML.

There are strong drivers in some design methods that speak for user involvement in all phases of the development lifecycle, even through to rollout and beyond. Thus the Dynamic System Design Method (DSDM)[55] is a wrapper for particular development methods but promotes user and technical participation during the entire development lifecycle.

D.1.2 Iteration and explicit formative evaluation.

Because initial design may be wrong, iterative design with user test based formative evaluation and redesign is important. This can take place within a stage above, or can take place across all stages. Thus we have an iteration pattern:

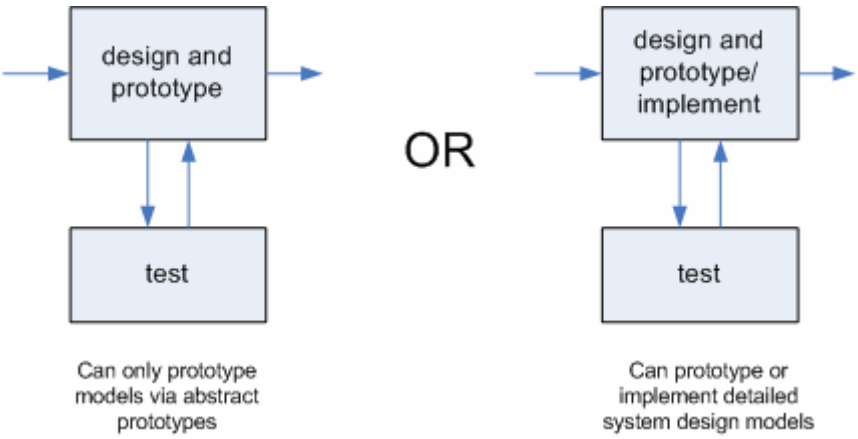


Figure 28: Design – prototype/implement – test iteration

This pattern can be applied in stages and across stages as follows:

[55] http://www.dsdm.org/

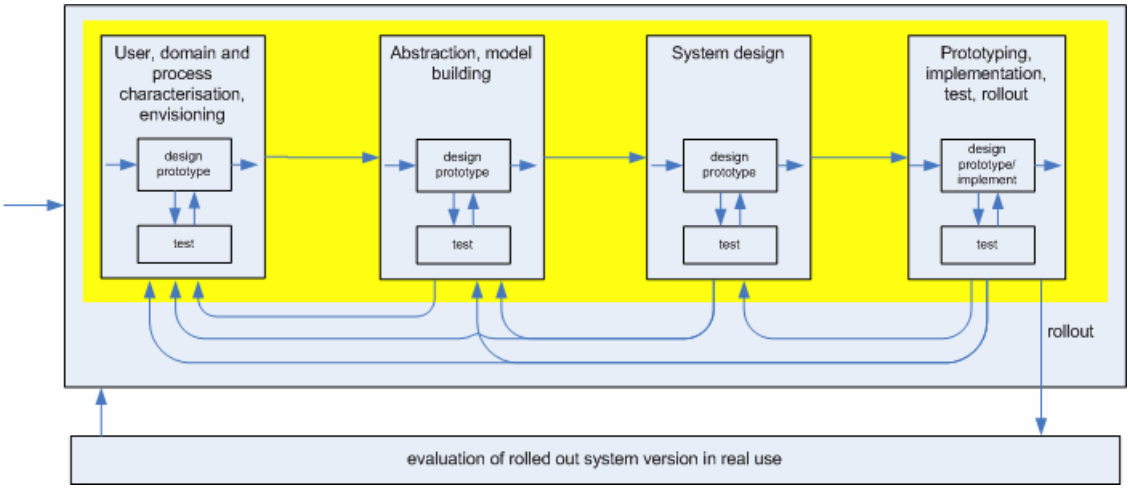


Figure 29: Full model based design cycle(s)

On successive iterations of the outer design-implement-test loop some activities in the upper containing block may be omitted or performed as needed.

This provides us with an idealised design and development method that is the basis of the lifecycle method.

D.2 The lifecycle method as a synthesis of reference model project methods

The lifecycle method was itself designed as a result of studying and performing a methodological synthesis of the COVARM, eP4LL, FREMA and LADiE. Having done that piece of work, it is for reporting purposes then convenient to view the four projects in the framework provided by the diagram above.

First, however, we provide a characterisation of the four stages[56]:

User and domain investigation and characterisation	User facing activities like interviews, observation, collection of domain artefacts, discovery of business processes and domain contents and structure. Scenario generation. This may involve some design. Characterising and modelling the existing domain by considering domain content and structure, business processes, and use cases. Use cases are an abstraction from particular scenarios.

[56] Because of the iterative patterns discussed above, and the opportunistic design habits of experienced designers who will move between design activities and different levels of consideration of the developing design as needed, it is on one level nonsensical to talk in terms of stages. However the term remains useful and is employed here with the strict proviso that thee is no waterfall-like ordering of stages.

System design -- concerned with system scope, contents, functionality and user interface	The interdependent activities of • Selection of scope (the area and extent of operation). • Determination of contents of the system (what objects and attributes are in the system). • Deciding on the functionality of the system (what operations implement task support for users). • Design of the user interface (how the users will invoke and be supported in their everyday tasks). Changing any design artefact produced here will likely necessitate changes in other design artefacts.
Detailed system design for implementation including service decomposition	Detailed design of the system. In reference model projects (and generally for the e-Framework) this includes service-related design.
Implementation, rollout, and maintenance	Implementation, and technical and user tests. Rollout, and maintenance.

Post-rollout extension is done via iterations in the first diagram above because invariably some redesign is necessitated.

E Appendix E: Survey results from projects

The following table contains the results of the survey, as supplied by the projects.

Project Name **Question**	**COVARM**	**XCRI**	**eP4LL**	**LADiE**	**FREMA**	**PLE**
Please briefly state the project scope and objectives (feel free to use a url link to a specific web page that contains this information).	Please see: http://covarm.tvu.ac.uk/covarm/aims_and_objectives.jsp	to create a specification that facilitated the exchange of course-related information	http://www.nottingham.ac.uk/epreferencemodel/index.htm	http://www.jisc.ac.uk/whatwedo/programmes/elearning_framework/elfref_southhampton.aspx	These links to the frema site give a brief outline of the approach that the frema team developed through the project. http://www.frema.ecs.soton.ac.uk/projectJournal/index.htm#sorm http://www.frema.ecs.soton.ac.uk/projectJournal/index.htm#system Our intention has been to provide a dynamic, evolving and interactive resource for e-assessment community to collaborate in developing interoperable services in the e-assessment domain. Our expectation is that being able to share existing services and knowledge from other projects will improve the capability of the community to support e-assessment.	To define, investigate, elaborate, prototype, and produce recommendation on services to support a "personal learning environment" as an alternative to enterprise VLEs.

Project Name **Question**	**COVARM**	**XCRI**	**eP4LL**	**LADiE**	**FREMA**	**PLE**
Within the selected domain area which business processes were selected for analysis? Please list.	Course Validation	quality, marketing, enrolment and reporting processes that involved course information	Application to UK HE via UCAS	Interactive design workshops with practitioners and the development of subsequent use cases	The FREMA team surveyed the e-assessment domain for processes and existing software/ services and standards. http://www.frema.ecs.soton.ac.uk/projectJournal/index.htm#conceptmaps The team were able to characterise the e-assessment domain as a 'brownfield site' because of the amount of pre-existing software development. The domain is also broad and diverse, there is no one canonical process, unless you abstract to a level that produces a model of no practical value. The FREMA wiki allows the community to collaborate to define process models in areas of the domain of interest to them and to represent these models in a common format to aid community wide shared understanding. The FREMA team seeded the wiki with process models to provide exemplars and to kickstart community engagement. We chose one model that is commonly understood: summative assessment and two others where there has been little community activity to date: external examiner peer review/assessment	Personal learning, information management and social coordination

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
For each business process please list the use cases you identified.	We did not use use cases as a technique - it did not scale	assembling, managing and versioning curriculum components such as programmes, courses and modules advertising courses applying to courses enrolling students on courses reporting on students on courses reporting on student achievement on courses	Add a comment or reference Assign access rights to ePortfolio items Create personal statement Edit personal statement Get course information Populate personal statement Search for courses Short list courses Submit application to UCAS	See report - total of 16 produced	http://frema.ecs.soton.ac.uk/wiki/index.php?title=Category:Use Cases Remember that this is dynamic and that what you see when you follow the link is a snapshot of the use cases represented today.	Use case analysis was not used.

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
Considering any gap analysis performed, please list the main shortcomings that were uncovered in the domain area.	I don't really understand the question. Is that a domain knowledge perspective or the process applied in the domain. From a domain perspective: 1. Huge business process - many activities and length of process 2. Institutions did not have system closure on activities. This is not a shortcoming more a finding.	we found a poor match between available electronic standards for the whole domain area, and hence began work on our own specification	Learners' use of social networking to seek informal advice and guidance Web services allowing HE admissions staff to assess applications Services needed for aggregation of feedback for institutions Need to integrate learning results from assessment and learning Lack of generally agreed lightweight standards	gap analysis undertaken comparing the range of potential pedagogies and the use of particular tools. Most use cases fell within a narrow subset	The FREMA wiki has a dynamic gap analysis tool that is available all of the time. The gap analysis evolves as the domain evolves; the gap analysis reveals the 'state of the gap' whenever the analysis is run. If you mean by 'shortcomings' use cases not supported by services or services, then see the following paper: http://frema.ecs.soton.ac.uk/wiki/index.php?title=Category:Use_Cases	Services for lightweight and distributed coordination and workflow.
To what extent could you use UML Use Case diagram notation.	Not at all	Not at all	Where ever possible	In some instances	Exclusively	Not at all
To what extent could you use Use Case narratives.	Not at all	Not at all	Mostly	Where ever possible	Mostly	Not at all

Project Name **Question**	**COVARM**	**XCRI**	**eP4LL**	**LADiE**	**FREMA**	**PLE**
Did you use any other techniques to record or otherwise document Use Cases?	We used event scenarios - as a way of decomposing a large business process. These were documented as scenarios and sequence diagrams	blogged everything we found and received community critique via email, workshops and special "summits" in suitable restaurants	TQM notation for expression of feedback cycles	Initial review documented the range of different forms of representation that are possible for describing a learning activity.		We did not use a Use-Case approach as this project was concerned with future scenarios and pattern analysis; processes did not exist to model with use-cases.
Please list any ELF defined services you identified as relevant to your domain area.	is this services in existence already? In which case none.	I always described XCRI as the project that would be a Reference Model when it grew up, the domain was not sufficiently mature for analysis of opportunities for service re-use	Authorisation Search Rating/annotation	See final report and in particular the technical framework document. A reference model was developed for learning activities which articulated the components and services involved and their relationships.		See: http://wiki.cetis.ac.uk/Ple/Report#Services_and_Toolkits

Project Name **Question**	**COVARM**	**XCRI**	**eP4LL**	**LADiE**	**FREMA**	**PLE**
Do you consider any of the identified services to be appropriate candidates for reuse in domains other than the primary focus.	No	No	Yes	Yes	Yes	Yes
If any services are candidates for cross domain reuse please list them here.			All of above	Most are applicable in other domains, most are not specific just to learning deging	notify track metadata tagger validate metadata authenticate and authorise	All of the Common Services ones!
Please provide a summary description of any reference model implementation(s) the project produced.	Available in report - downloadable from the website	XCRI produced a demonstration implementation of a curriculum catalogue from which XCRI XML could be extracted using book-markable URLs that included XPath selection	One HTML demonstrator and two proof of concept prototypes, GetEntryProfile service (which also incorporated some of the GetPortfolioItems functionality) and GetPortfolioItems)	See three layer reference model documentation produced	This question doesn't really fit the nature of the e-assessment domain or the frema dynamic model. However the wiki includes patterns for process designs. The frema team provided reference exemplars of interoperating services, including source code and working implementations. http://frema.ecs.soton.ac.uk/wiki/index.php?title=Category:Patterns	Plex (Desktop rich internet application) PLEWeb (Web LifeRay Portal version)

Project Name **Question**	**COVARM**	**XCRI**	**eP4LL**	**LADiE**	**FREMA**	**PLE**
To what extent has the reference implementation supported development of the reference model?	Essential for successful development of the model	Was beneficial but not essential	Greatly eased development of the model	Implementation detracted from necessary model development (i.e. too soon in cycle)	Implementation detracted from necessary model development (i.e. too soon in cycle)	Greatly eased development of the model
What form did the reference model implementation take?	As a proof of concept only	As a proof of concept only	As a proof of concept only	As a proof of concept only	As a complete production system	As a proof of concept only
Were there any related Distributed e-Learning Programme Regional Pilot Projects to which this project was able to offer advice?	Yes	Yes	Yes	Yes	Yes	No
Please list any such projects.	SUNIWE XCRI	Hertfordshire LLN, Liverpool and Manchester LLNs	RIPPLL, EELS	There wasn't at the time but all the design for learning work is highly relevant	These are projects we know to have used FREMA in finding gaps, scoping their project, looking for reusable software/services, use cases r2q2 asdel peerpigeon cats minibix	

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
Please outline, or link to, supporting information that the project provided to any Distributed e-Learning Programme Regional Projects.	Information Model - available at: http://covarm.tvu.ac.uk/covarm/images/synthesis/domain.gif	Personal visits and presentations	Key staff from the RIPPLL team were also involved in eP4LL. The idea of a 'thin ePortfolio' began to be exemplified in the RIPPLL Shibboleth work, as the project demonstrated both the 'pass the parcel' and distributed models for moving learner data to support transition. RIPPLL's practical experiences using UK LeaP in turn informed some of the eP4LL conclusions about standards. Work on the prototype for the project influenced the thinking of Phosphorix, who also carried out technical development for the EELS project.		http://frema.ecs.soton.ac.uk/wiki/index.php?title=Main_Page standards gap analysis process FREMA SUMS: -use cases -service interaction diagrams - SRCs service responsibility and Collaboration Cards	None. Project was not part of RM programme and not aligned with DEL.

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
Please list any papers delivered at conference or publications resulting from reference model development.	Barn B.S., and Oussena, S. (2007) Applying component modelling concepts to service oriented design and architecture: A case study. 2nd International Conference on Software and Data Technologies. Barcelona 2007. Barn B.S., Dexter H., Oussena S. Petch J. (2006) “A Synthesis approach for deriving reference models for SOA frameworks” In IADIS INTERNATIONAL JOURNAL ON COMPUTER SCIENCE AND INFORMATION SYSTEMS, pages 100-116. Vol. 1,	Joined with FREMA and e-Portfolio to showcase the Reference Model work at Berlin Educa Interest in XCRI grew massively during the project, leading to continuation funding, the creation of a 2 year XCRI support project, support from BSI to make XCRI the UK	Presentations at CETIS Portfolio SIG (April 2006, June 2006) 4 x Invitation workshops held at University of Nottingham (June 2005, July 2005, Feb 2006, July 2006) Workshop at Eduserv 'I before E' event on Identity Management Presentation and workshop at JISC DeL programme meeting, Dec 2005 ePortfolio strand workshops at CETIS conference 2005 Briefing paper for joint JISC-SURF consultation event, Feb 2006 Paper on ePortfolio and eAdministration for Los Angeles meeting of the	Significant - see project documentation and google project name and authors. Not going to list here as too numerous. Connections included linking into the UNfold learning design community in Europe and the various learning design work in Australia	Millard, D., Howard, Y., Abbas, N., Davis, H., Gilbert, L., Wills, G. and Walters, R. (2007) The Service Responsibility and Interaction Design Method: Using an Agile approach for Web Service Design. In: the 5th IEEE European Conference on Web Services (ECOWS), November 26-28 2007, Halle, Germany http://eprints.ecs.soton.ac.uk/14925/ Wills, G., Bailey, C., Davis, H., Gilbert, L., Howard, Y., Jeyes, S., Millard, D., Price, J., Sclater, N., Sherratt, R., Tulloch, I. and Young, R. (2007) AN E-LEARNING FRAMEWORK FOR ASSESSMENT (FREMA). In: International CAA Conference, 10th - 11th July 2007., Loughborough UK. http://eprints.ecs.soton.ac.uk/14109/ best paper award) Millard, D., Bailey, C., Davis, H., Gilbert, L., Howard, Y. and Wills, G. (2006) The e-Learning Assessment Landscape. In: International Conference on Advanced Learning Technologies (ICALT) 2006, 5-7 July, 2006, Kerkrade, The Netherlands. http://eprints.ecs.soton.ac.uk/13083/ Millard, D., Howard, Y., Chennupati, S., Davis, H., Jam, E. R., Gilbert, L. and Wills, G. (2006) Design Patterns	Too many to mention! Papers have been presented at ECTEL, SURF, ALT-C, ED-MEDIA and many, many more. A special issue of ILE journal has been edited by the team.

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
	2. Barn B.S., Dexter H., Oussena S., Sparks D. (2006) "SOA MDK: Towards a Method Development Kit for Service Oriented Development". Information Systems Development 06 (ISD 06), Budapest, Hungary. Published as LNCS Proceedings. Barn B.S., Dexter H., Oussena S. Petch J. (2006) "An Approach to Creating Reference Models for SOA from Multiple Processes" In: IADIS Conference on Applied Computing, Spain (2006). Barn, B.S		eFramework partners, Aug 2006 Presentations at EDUCA, Berlin 2006 Research paper 'Building ePortfolio Bridges: developing a large-scale research framework', Elizabeth Hartnell-Young & Angela Smallwood		for Wrapping Similar Legacy Systems with Common Service Interfaces. In: European Conference on Web Services (ECOWS) 2006, 4-6 December, 2006, Zurich, Switzerland. http://eprints.ecs.soton.ac.uk/13084/ Davies, W. M., Howard, Y., Millard, D. E., Davis, H. C. and Sclater, N. (2005) Aggregating Assessment Tools in a Service Oriented Architecture. In: 9th International CAA Conference, 5-6 July 2005, Loughborough. http://eprints.ecs.soton.ac.uk/10940/ Millard, D., Howard, Y., Bailey, C., Davis, H., Gilbert, L., Jeyes, S., Price, J., Sclater, N., Sherratt, R., Tulloch, I., Wills, G. and Young, R. (2005) Mapping the e-Learning Assessment Domain: Concept Maps for Orientation and Navigation. In: e-Learn 2005, 24-28 October, 2005, Vancouver, Canada. http://eprints.ecs.soton.ac.uk/11553/ And many presentations at Jisc and jisc-cetis conferences and Assessment SIG: http://www.frema.ecs.soton.ac.uk/presentations/	

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
	(2007) "Supporting and enhancing the course validation process using a software driven process workflow application"; Association of University Administrators Conference, Nottingham. "Managing quality and improving efficiency in the course validation process" Online Educa-Berlin, 2005. Paper available at: http://www.elearning.ac.uk/features/covarmbriefing					

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
Please list any websites produced to disseminate relevant information and advice to the community.	http://covarm.tvu.ac.uk/covarm	Used elframework.org/projects/xcri and JISC-mail lists for dissemination	www.nottingham.ac.uk/epreferencemodel	See initial link provided	http://www.frema.ecs.soton.ac.uk/ http://frema.ecs.soton.ac.uk/wiki/index.php?title=Main_Page	http://wiki.cetis.ac.uk/Ple/Report http://www.cetis.ac.uk/members/ple Lots of third-party sites grew up around this, e.g. http://en.wikipedia.org/wiki/Personal_Learning_Environment or see http://del.icio.us/tag/ple
Were any such collaborations of particular note?	N/A	Yes	N/A	N/A	N/A	N/A
If so, in what manner?		Collaboration with a wide range of partners is the secret of XCRI's success				
Which SIGs were you able to work with?	CETIS Enterprise SIG	XCRI spun out of the Enterprise SIG, but XCRI has also participated in portfolio and metadata SIGs	Portfolio SIG		Assessment SIG	Pedagogy Forum

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
In what manner did participation in any SIG help reference model development?	discussion	Inspirational input to the spec definition proces, prototype creation by SIG members and informed critique of draft specs and blog entries was essential to XCRI's development	Feedback on findings presented contributed to the final model		Providing expert advice to identify e-assessment processes and practices. Providing information to populate the domain map, Evaluation at each stage and of the wiki and tools embedded in the wiki. http://www.frema.ecs.soton.ac.uk/projectJournal/index	We had a very useful workshop followed by an open SIG meeting on PLEs. This generated a lot of ideas and opened up collaboration with people in other sectors.
Were you able to collaborate with any other of the reference model projects?	Yes	Yes	Yes	Yes	Yes	No
If so, please list the project names.	XCRI	COVARM and e-Portfolio	COVARM, FREMA, XCRI	Frema	Ladie COVARM	
What form did the collaborations take?	joint modelling	Regular email exchanges and participations in meetings and modelling/domain mapping workshops	Shared discussions at eFramework workshops	Mapping pedagogical domain aspects to the e-assessment area that frema was working on	LADiE: early, and tentative exploration of common domain boundaries COVARM: discussion of modelling approaches	
Please use this space to add any additional comments		The space in which XCRI was operating was new		I found this survey very difficult to complete - the	Some of the questions in the survey were not really appropriate to Frema and were quite tricky to answer, the	Please note that the PLE project was procured

Project Name Question	COVARM	XCRI	eP4LL	LADiE	FREMA	PLE
you would like to direct to the synthesis project?		territory. XCRI was funded as a small spin-off from the CETIS Enterprise SIG that set out with a particular remit of doing something about the lack of standard for course information that had been identified by that community. By working closely with that community, the other reference model projects, the regional pilots and engaging with key agencies, such as UCAS, UFI LearnDirect, MIAP, etc, XCRI enjoyed high levels of informed interest, which led to pioneering specification development work that was grounded in real practice. The approach taken did not follow the		questions are either unclear or asking for information which is already publically available via the project website and elsewhere. You would find alot more out about LADiE by reading the numerous reports we produced. Can I also suggest you may want to talk to Isobel Falconer who was the key researcher involved in the project.	sections on model implementations particularly. One point that I would like to raise concerns some recent synthesis project presentations that I have seen. One slide comparing reference models shows frema as not defing any processes: this is clearly wrong. To use an analogy to illustrate some of my thoughts. A watch is an instrument for telling the time. You can take the watch apart and describe each component in detail: the cog wheels, spindles, screws, bearings, escapement etc, but then you have piles of components, none of which individually tell the time. Frema is an instrument for a community to collaborate to produce interoperating services for their domain. It would have been really useful if you had met all of the projects face to face at possibly a one day workshop, much like the workshop in which the projects learned from one another the lessons from doing the projects.	separately to the RM programme, and has very different objectives and criteria. Information such as the tender document are available on request.

Project Name **Question**	**COVARM**	**XCRI**	**eP4LL**	**LADiE**	**FREMA**	**PLE**
		formal UML model-driven approach, although XCRI engaged closely with COVARM's efforts in that regard, participating in joint information modelling activities. At the end of the day, XCRI was seeking to develop a specification by the community for the community, and doing its best to keep everyone posted on its development decisions by regular blog postings through the elframework site				
First Name	Balbir	Mark	Sandra	Gráinne	Hugh	Scott
Last Name	Barn	Stubbs	Kingston	Conole	Davis	Wilson