JISC DEVELOPMENT PROGRAMMES

Project Document Cover Sheet

COVARM – Course Validation Reference Model

Final Report

Project

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COVARM - Course Validation Reference Model

Final Report

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This document is the final version. The document will be submitted to Tish Roberts for review and feedback from JISC before agreement on wider circulation.

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1 Executive Summary

1.1 Background

The context of this project is constructed around a distilled argument that states that the business aspects of institutional effectiveness and transformation can be facilitated by understanding and providing IT support for key business processes, for example, the Course Validation Process. This particular HEI core business process is a highly collaborative, resource intensive process that impacts most organisational units within an institution. Opportunities to provide support for some or all of this process will therefore be potentially very significant.

The e-Framework, building on its predecessor, the e-Learning Framework (ELF) [1],[2], requires Reference Models for its domain areas that will provide the basis for navigation of the framework and access to its services. JISC has asked for reference models that fall within the domain areas defined by CETIS Special Interest Groups (SIGS). At the outset of this project there were no clear requirements defined for such reference models and the initial set of reference model development teams were given some freedom to explore possible approaches and architectures. This project adopted a model driven development approach to providing an end-to-end development process. This development process was designed to begin with an understanding of a core business process and go all the way to implementing the set of software and people services required for its execution. This project submits a reference model for the Course Validation business process to the wider academic community for review and debate.

1.2 Project Aims

The project aims to define a candidate reference model utilizing a framework of software services to support a canonical business process to carry out course validation. This reference model comprises: a business process model, an information model, a set of software services (specifications and implementations) and a business process execution assembly of the services packaged as a prototype application.

The project deployed a multi-faceted methodology that included detailed case study research at four institutions to derive a synthesised canonical process and information model. The models represented an aggregated view of the course validation process and information. The resulting model was then subject to detailed software engineering methodology (based on RUP principles applied to component based design) using a model based approach. This resulted in detailed descriptions of software services and their specifications described in WSDL. The whole approach was underpinned by a model based approach using UML. The service specifications were implemented and deployed using J2EE technology and choreography of the services were managed and described using BPEL.

1.3 Results and Recommendations

The project has produced the following outputs and results:

The project produced a detailed synthesised understanding and definition of course validation based on analysis of 5 differing higher education institutions. The description of the domain was articulated as a set of UML models and diagrams that included: Process models; Information Models and software specifications in WSDL. These were synthesized into canonical models available in document and model form. The rules that we developed for synthesis are sufficiently general for use in other domains and have been published in an international conference paper. The models were also presented to the stakeholders for feedback.

A set of software services were implemented as WSDL services for a key sub-section of the course validation business process. A client workflow application demonstrating interconnectivity between JSP and BPEL Service APIs was developed. The development lessons learnt could impact JISC projects considering the use of such a technical architecture.

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[1] http://www.elframework.org/

[2] http://www.jisc.ac.uk/elearning_framework.html

The project explored the utilization and integration of a complex set of technologies and adopted a strong model driven architectural perspective. This combination required the specification, development and deployment of new methods and techniques to achieve the project outcomes. Part of the methodology has been captured in the COVARM_PDK as sample content. The rest is documented in a series of research papers.

The call articulated the need for a specific set of outputs that would comprise a reference model that could contribute part of the e- Framework. As specified, this project produced a reference model that comprises a detailed process description of the domain, scenarios of aspects of the domain, technical service descriptions to support the process, an information model that precisely describes the data produced and consumed by the services and finally a business process execution specification of the set of services assembled together. In addition to these artefacts, the project has also detailed a methodology to enable standardized reference model production for any business process that can facilitate practical realisation of the e-Framework vision.

1.4 Recommendations

1. Feedback from the stakeholders clearly indicated that the project was addressing a key need – the resource intensive nature of the course validation process required computer software support to reduce the high administrative burden. More work on the precise points in the process that require most attention need to be identified and future development work should be targeted at those pinch points. One such pinch point is in the tracking of programme configurations and versions.

2. The e-Framework structure, as currently defined, lacks robust methods to support the examination and definition of inter-domain dependencies and we are aware that many core business process in an HEI cross multiple areas of the enterprise requiring complex information sharing and collaboration on activities. The methods and techniques described in this project could have the potential to address these requirements. The methodology should be developed further as a web resource to make it more accessible and usable by other projects in the public domain. Further work to explore generalisation of the reference modelling approach described here needs to be carried out.

3. The project has defined a candidate reference model for course validation paving the way for robust and scaleable tools, that is, products, to be developed to support course validation. The reference model provides a strong technical description to enable a constructive dialogue with potential software vendors to take place.

The COVARM Project Team comprised the following:

Thames Valley University	Prof. Balbir S. Barn (Principal Investigator)
	Dr Samia Oussena
	Dan Sparks
University of Manchester	Dr Hilary Dexter
	Dr Jim Petch
Staffordshire University	Prof. Mark Stiles
Manchester Metropolitan University	Dr Mark Stubbs

2 Background

The COVARM project received funding from JISC's E-Learning Programme under its e-Learning Framework Reference Models call. It was funded from April 1, 2005 until Sept 30, 2006. The project was a collaborative effort with staff from Thames Valley, Manchester, Manchester Metropolitan and Staffordshire Universities. The project was led and managed by Prof. Balbir Barn of Thames Valley University.

The project website may be viewed at http://covarm.tvu.ac.uk/covarm

2.1 Project context and rationale

Currently, Course Validation within the e-Framework is un-developed in the sense that, there is neither an accepted definition, nor a reference model defined for it. For our purposes, given the absence of a definition, we define Course Validation to be:

The process by which a judgment is reached as to whether or not a course and its modules, designed to lead to an academic award of a specified level, meet the nationally accepted criteria for that award.

The Course Validation process is one of the most important business processes within HEIs and between HEIs and other institutions. New courses and the continuation of existing courses are the direct outputs of this process and therefore it effectively controls the primary source of income generation for an institution.

Scope

Our understanding of the scope of the application domain is as follows. Course validation can include the specification of new courses at various levels (sub-Undergraduate, Undergraduate and Postgraduate). 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[3] (for HEIs this is the QAA [4], HESA[5] and UCAS [6]. These bodies collectively ensure that courses are designed and validated to the required level of quality standards.

The scope of the application domain includes the review of existing courses (sometimes using the same documentation and instruments as for the new courses) and also the validation of courses offered in collaboration with partners within and outside the UK (almost always with different instruments).

Increasingly, course validation is complicated by the consideration of the modes of deployment of new courses e.g. based on learning technologies or on traditional modes of delivery to support students, and of the mode of attendance, full time, part time, continuous professional development and distance learning. e-learning in particular, raises further issues of complexity. It is not clear, nor is there any level of standardisation, on the impact of course validation processes on qualifications which are delivered entirely using an e-learning approach.

Given this overall complexity and variance between institutions, this project recognizes that the scope of the application domain is particularly large and our approach (described in more detail later) is to capture a subset of the overarching enterprise information model (i.e. describe the general complexity) and then use scenarios of course validation as a way of detailed understanding of the course validation information and business processes.

[3] http://www.qca.org.uk/

[4] http://www.qaa.ac.uk/

[5] http://www.hesa.ac.uk/]

[6] http://www.ucas.ac.uk/

Even though HEIs may differ in the implementation of business processes to support course validation there are several constraints that provide some standardisation for the validation process and its outputs. These constraints are based on requirements from HESA, QAA and UCAS and other national bodies. These constraints are a basis for defining a canonical business process for supporting course validation.

2.2 The course validation process as a Value Creation Process

For an HEI, "Course Validation" is an important value creation business process. It can be compared with a typical "Product development" process in commercial enterprise, in that the process of course validation involves market research, design, development and launch of a new product into the market.

The validation process is the defining source of core information on programs, courses and modules for an institution (arising out of the Dearing Report). The Dearing Report documented the need for clear and explicit information for students so that they were able to make informed choices about their studies and at what level of study they should aim for. The Programme Specification (PS) became the primary source of information for students. Harrison (2000) and Jackson (2000) both identify how the PS can be used as a source of information by multiple stakeholders both internal and external. For example, Harrison suggests that the PS is valuable to academics (for internal quality assurance), students, and employers. Internally, to an institution, the PS information is typically consumed by marketing, student records, finance (fees section), planning, and many other functional areas of institutions as well as by staff and students who manage selection and progression. By improving consistency and ensuring the availability of information at the right time, alignment of internal supporting business processes will be possible.

Finally, the regulatory framework imposed by the QAA means that course specifications have to be subject to external review and so be developed to a particular standard and form which imposes a considerable burden on under-resourced institutions.

One way to provide IT 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.

2.3 Needs and Benefits

Need for a Reference Model

Course validation is typically a well-defined business process which implements each institution's rules of governance in the production of course designs. There may, however, typically be several ad hoc and different business processes for different types of course validation and for different circumstances as indicated above. The independent nature of UK academic institutions also suggests that there are likely to be differences between HEIs. Each of these factors presents risks for institutions and for collaborative working and indicates the need for a common reference or canonical model.

The need for a reference model also comes from the need to align internal processes. Information produced as a result of the course validation process is typically consumed by marketing, student records, finance (fees section), planning, and many other functional areas of institutions as well as by staff and students who manage selection and progression. So integration and alignment of supporting processes is important.

In summary then, needs for a course validation reference model are:

- A canonical business process with standardised facilities (variation points) that allow individual institutions to specialise or customise to their requirements;
- Mechanisms to help ensure compliance with relevant bodies;
- Simplification of the artefact (documents and datasets) management within the course validation process;

- Support for workflow management.

Benefits of a Reference Model

Given these needs and in particular the recognition that course validation processes may place significant strain on university resources the following benefits have been identified.

- Streamlining of existing processes;
- Alignment of ad hoc and local processes with a canonical process;
- Efficiency in processes for collaborative provision;
- Reduction of burden of documentation which currently is very high;
- Ensures consistency, validity and currency of corporate information;
- Underpins strategic alignment of universities in the support of e-learning.

2.4 Technological and Standards Developments

A business process describes the flow of tasks, the order they need to be performed and the type of data shared between the tasks. The Business Process Execution Language (BPEL) provides a language for an abstract specification of business processes. By doing so, it extends the web services interaction model and enables it to support the business transactions and workflows. BPEL provides abstractions and infrastructure that allows the ability to manage long running process and the business process persistency.

BPEL plays an important role in Service Oriented Architecture by providing powerful means by which it is possible to define an interoperable integration model of web services. The defining characteristics of a service from BPEL standpoint is that it is described in WSDL. Every message exchange is described in a BPEL process in term of port types and operations defined in the WSDL regardless of the implementation of the web service. Furthermore, every executable BPEL process is exposed as web service. Hence, BPEL is a natural language for manipulating web services and powerful tool for functional integration. Juric et al (2005) provide a good reference to the standards and technology around this subject.

2.5 Reference Models

While the original call for projects presented one understanding of a reference model, the project team explored in some detail the industry perceived notions of a reference model. As a result of this review, the team articulated a definition of reference model which extended meaning and artefacts emerging from the reference model to include multiple architectural perspectives. The sources for these perspectives include the ISO Open Distributed Programming (ODP) reference model (http://www.rm-odp.net/index.html), and the Object Management Group's model driven architecture (MDA) [http://www.omg.org/mda/]. This extension of the reference model provided a framework for the development of methods and techniques to support reference modelling of the kind required to support business processes. Details of this aspect of the project were presented in a research paper at ISD'06 and are not included in this project report.

3 Aims and Objectives

The project aims

- to define a candidate reference model utilizing a framework of services to support a canonical business process to support course validation.

Objectives

To meet this aim, the following key objectives have been identified.

1. Evaluate course validation processes of several institutions to define a canonical business process and a set of use cases defining the requirements of the business process.
2. Develop a candidate information model representing the concepts and data required to support course validation;

3. Specify and develop a set of candidate web services to support the canonical business process using any existing ones from the ELF as appropriate;
4. Implement a proof of concept prototype utilizing the services defined for the "Course Validation" area;
5. Review the information models for completeness and develop draft XML compliant specifications;
6. Present the reference model to the Enterprise SIG for external review and completeness check;
7. Ensure dissemination of ongoing activities and outcomes.

The application of business process modelling to key activities in the higher education sector presents an opportunity to provide an empirically based framework for alternative methods of quality control and assurance. This project is concerned with exploring and formally modelling the key business process of course validation using state of the art process modelling techniques. The key question postulated by this approach is:

"Does the process and information modelling approach to course validation provide an appropriate framework and opportunity to improve efficiency in the course validation process and still ensure rigour in the associated quality assurance requirements?"

A supplementary question posed is:

"Is it possible to construct a rigorous canonical process description of course validation that allows an individual institution to describe with precision the points where it differs from the canonical process?"

4 Methodology

4.1 Overview

The characteristics of this project make it necessary to deploy a multi-faceted methodology. There was a need to conduct a detailed business analysis at several institutions requiring case study techniques. The objectives of the project incorporated the need to develop software so software methods were also required. The generally immature nature of the technology being used (BPEL and other workflow technology) meant that existing software methods were not necessarily appropriate so the overall research methodology required adaptation of existing techniques and the development of new techniques during the project in order to deliver the principal objectives.

The defining aspects of the methodology are:

Case Study based

A Case study approach to the problem was adopted as there are several examples in IS research where there is evidence that case study based methodologies are well suited for exploring business processes in an organisational setting (Huang et al 2005, Sedora et al 2003). A case study also allows in-depth exploration of issues. However, given the nature of the course validation process it was important to get an understanding of how different types of institutions implemented their own course validation processes. Consequently we explored, in depth, the course validation processes at four institutions.

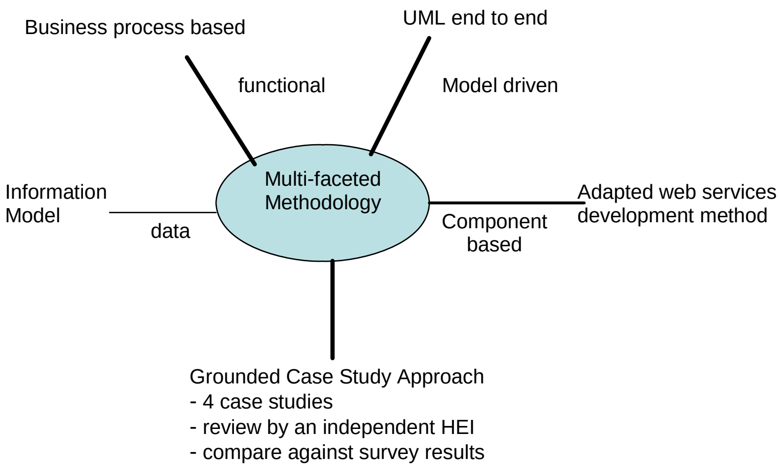


Figure 1 The multi-faceted development methodology

Software Engineering principles

Our method is derived from elements of RUP (Rational Unified Process) (Kruchten 1999, IBM, 2001) and is strongly tailored to the delivery of our main artefact, the prototype implementation. The method takes a model based approach using the Unified Modelling Language (UML) a notational and semantically precise vehicle for capturing the necessary business process models at a domain level. This stage requires the capture of roles/responsibilities (including teams), activities in the process, routes through the process, triggers, information consumed and produced by activities, constraints and interfaces with other information systems.

The essence of our approach was a) to recognize and define the conceptual mappings between Component Based Development (CBD) and SOA, b) to extend and modify CBD methods to support SOA specific requirements and finally c) to ensure that a model based or model driven architectural perspective was rigorously applied from business process modelling through to service modelling.

Prototype Implementation

The software implementation strategy needed to address a number of key issues. We were exploring the use of new technology where there was limited experience. The problem domain was also particularly large and complex. The implementation approach therefore had to address:

- initial proof of concept prototyping – a way of exploring the technologies and how they interrelated and whether our target architecture was actually achievable within the timescales and constraints of the project;
- development of an appropriate testing methodology to address both web service tests and BPEL tests.
- Web service deployments approaches – selection and rationale for selection for web service application servers
- BPEL Deployment – the process by which BPEL processes are deployed to the BPEL Server.

The overall process followed by the project is summarised by the diagram below (Figure 2):

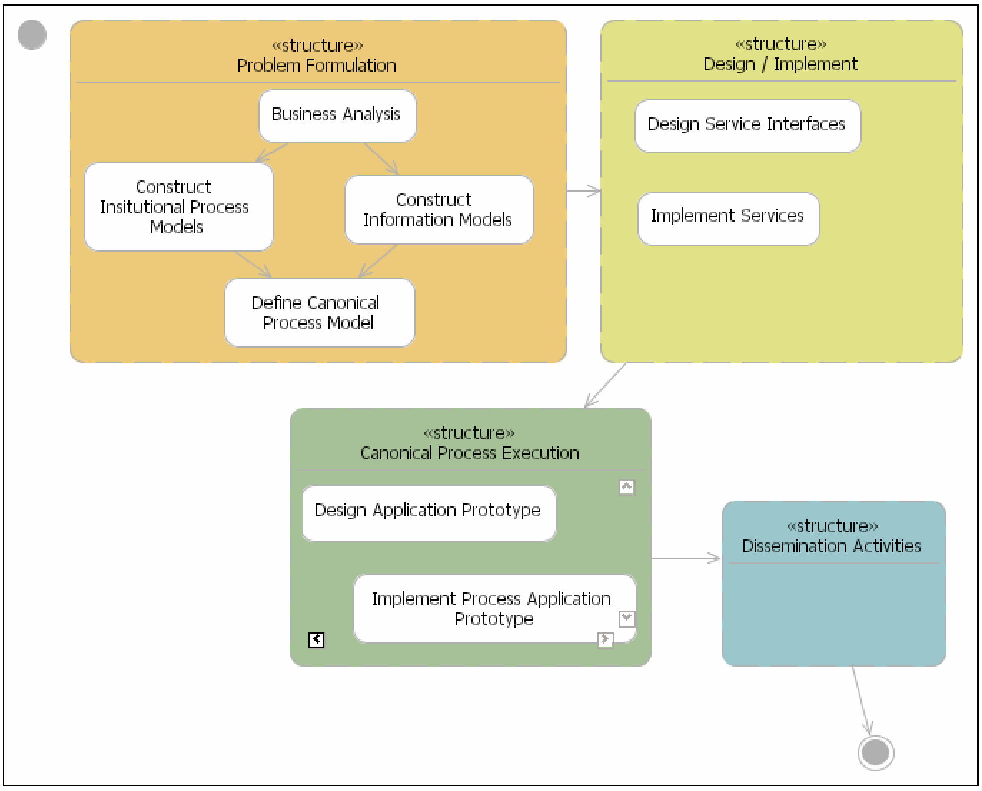


Figure 2 Overall Project Process

5 Implementation

Here we describe the journey from the project inception to the delivery of the major outputs of the project. We have avoided a focus on work packages, rather we discuss challenges and the need to adapt our approach as we learned more of what such reference models require.

5.1 Problem formulation

5.1.1 Modeling the process in each institution

Each institution's course validation process was modeled as a UML Activity Diagram with activities grouped into assemblies (nested activities) corresponding to stages in the business process that were referred to as such by those responsible for setting procedure. An activity was created for each discernible task or action, carried out by an individual or collaboration of people that could be seen to produce a defined output for course validation. The output was either in the form of a document, a decision reached or an organisational structure such as a committee being readied for work.

The description of each activity included the roles involved. If the activity was carried out by a group of people in collaboration (such as a committee) all the member roles and the rules controlling the frequency and ways in which that group operates were collected. The individual and group roles were represented as swimlanes (partitions) in the Activity Diagram and as Classes in the domain information model. Any constraints for activities were noted on the diagram and attached to the relevant activities. These were often based on availability of particular documents or people for committee meetings.

5.1.2 Creating the domain information models

Alongside the Activity Diagram of each institution's business process, a UML Class Diagram was created to capture the set of elements and roles in the course validation domain. This domain information model was kept at a high level of abstraction with only the key relationships between the elements included. An example is given in Figure 8 of part of one of the domain information models that illustrates the main kinds of elements and the level of abstraction.

5.2 Synthesizing the process models

Following the two iterations of interview and model refinement in each of the four institutions, a process model and domain information model of each one were prepared for the synthesis process. The required levels of granularity and abstraction had been directed by a set of guidelines for the modeling, written by the team prior to the interviews and modeling activities, but it was necessary to review all four models alongside each other to ensure that this had been achieved.

A set of characteristics of the processes that had been modelled was proposed as the basis for comparison and synthesis of the four process models. These characteristics were also refined by the team's experience in actually building the models. In producing the synthesis the resulting model was created to represent an aggregation of concepts – that is, we did not employ any "re-engineering" to optimize the process. Details of the synthesis process are described on the Covarm website at http://covarm.tvu.ac.uk/covarm/synthesising_the_process_models.jsp .

5.3 Preparing for design and development

Following the synthesis of the four process models into a single canonical model the next stage of the project was to specify and implement a set of services that could be used as part of an assembly or choreography of an application. At this point several key challenges / issues were raised: Firstly, the nature and interconnectivity of programme specifications meant that it was important to collaborate with other JISC projects where there might be dependencies. Thus the COVARM team worked closely with XCRI, P4P and SUNIWE projects. Secondly there was a distinct lack of software methods to support service oriented architecture implementation projects and so it was necessary for the team to codify and develop an SOA method. Finally, the complexity of the synthesized process and the project timescales meant that it was important to find a route through the development process that captured the process information in one pass through with no duplication. It was decided to place all the detail in the Activity Diagram of the process rather than relying on the originally planned use case driven approach.

5.4 Architecture

The COVARM project prototyped and then deployed a technical layered architecture comprising: Data services (XML based), Web Services (SOAP based), a BPEL layer using the ORACLE BPEL Process Manager and an Apache Web Server for hosting the client application.

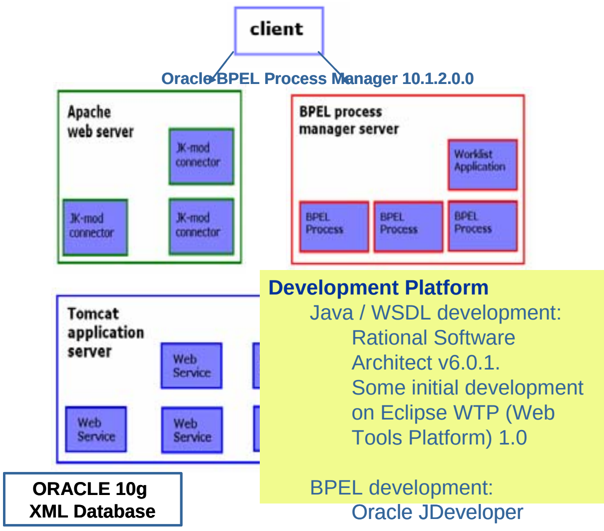


Figure 3 Technical Architecture

This architecture introduced some issues for further investigation: BPEL does not assume SOAP/HTTP are the default bindings – more efficient bindings may be possible (For example, as part of a web server in a Web Services Invocation Framework (WSIF) see http://ws.apache.org/wsif/). User task interactions have been limited because of our reliance on the client provided by the Oracle BPEL process manager.

5.5 Prototyping / Proof of Concept Implementation and Testing

The early development work was focused on understanding the various technologies that were planned for the project. Exploration was done using the Xtreme Programming notions of 'Spike Tests'. The proof of concept code was used as a discussion artefact with team members and external collaborators.

5.6 Development Methodology

MDA principles, technical architecture constraints and a focus on reuse of components were key constraints in the methodology that ultimately deployed. As noted earlier, the timescales meant that we needed to focus on a limited subset of the entire process and we used scenarios to help us scope the problem. Each scenario was taken as a subset of the synthesised process model, and transformed into a narrative. The narratives forming the scenario were modelled as UML sequence diagrams to understand the interaction requirements further and to refine method specifications of each service.

Each service was then modelled within the IBM Rational Software Architect to sufficient precision to enable tool based transformation into XSD definitions for each service. We formulated an approach whereby we created separate models for each service identified, with all its constituent classes (taken from the domain model for referential integrity). From this we have found that it is possible to generate the service–specific XSD data only, which reinforces an SOA implementation in that each service effectively encapsulates its own data types. The XSD documents produced were sufficient to allow us to generate a WSDL specification of each service again within the Rational Software Architect tool.

The WSDL documents were then used to generate the software code with appropriate stubbed services ready for development of the business logic. There were examples where we could not go through to final code generation as a set of automatic transformations and some manual intervention was necessary.

Initial implementation of persistence was done via relational databases. We later explored the possibility of XML storage, using our pre-existing XSD documents, and this has been implemented for the Validation Document service.

While it was not possible to generate BPEL automatically, we were able to apply manual transformations to previous outputs to produce our BPEL specifications. The sequence diagrams became skeletons for each BPEL process, mapping different actors to roles in the BPEL process as User Tasks and Partner Links. From here it was possible to 'drill down' into the specification and add some flesh to the bones.

The nature of BPEL lead us to some refactoring of methods; in order to pass variable-size collections of objects we found it easier with the tools we had to instead make multiple method calls passing individual objects. While this issue has been addressed with extensions to the BPEL specification, these extensions are not supported by any of the BPEL design tools we were using, and required a substantial amount of direct editing of the BPEL code.

Testing of services developed produced some additional challenges. We used multiple IDEs so the normal design, implement, test, modify cycle within a single IDE was not an option that was available to us. Consequently, we developed a testing approach that allowed us to test the software as web services and BPEL processes in an integrative manner. This testing framework has been described in more detail in a draft research paper planned for submission to ISSTA 07 (`http://www.cse.unl.edu/issta07`).

All our web services have been deployed to a Tomcat 5.5 application server, running behind an Apache 1.3 web server, using the `jk_mod` Apache module as a connector between the two servers.

Developed BPEL processes were deployed to local instances of the Oracle BPEL Process Manager. This provides a web interface similar to Tomcat's where a BPEL suitcase (also known as a suitecase) JAR (Java Archive) file containing the packaged BPEL specification and related code can be uploaded. We found though that this method of deployment did not deploy the necessary JSP files needed for User Tasks; this was achievable by deploying directly from Oracle's JDeveloper, which became our IDE of choice for BPEL development.

6 Outputs and Results

6.1 Course Validation Domain Understanding

The project produced a detailed synthesised understanding and definition of course validation based on analysis of 5 differing higher education institutions. The description of the domain was articulated as a set of UML models and diagrams that included: Process models; Information Models and software specifications in WSDL.

A canonical synthesised view of both the process and information models was produced using a well-defined set of characteristics and accompanying rules.

The UML models and accompanying diagrams individual institutions and the overall synthesised perspective are available from the COVARM website. Appendix B provides some sample screen shots of the various diagrams.

The detailed descriptions of the domain have now informed JISC strategy and are part of the call for new project proposals due in November 2006.

6.2 Institutional Issues

A detailed and intensive exploration of course validation and impact on wider institutional business processes was conducted within one university. The purpose of this investigation was to establish the extent of integration or lack of between the validation process and other business processes in the institution. Subsequent discussion with other institutions has confirmed that what is described can be regarded as typical to many universities. Interviews were conducted with:two members of Quality Service; Head and member of Corporate Systems Team; Registrar; PVC (Academic Development); a number of Faculty Quality staff and other Service and Faculty staff. The interviews revealed a number of areas of concern highlighted here. A fuller report on this part of the case study is available on the website.

Certain common problems are highlighted:

- Universities operate robust quality assurance at all stages of the course planning and delivery cycle. However the competitive nature of modern higher education creates tensions for institutions in getting new offerings to market in a short time. This challenges the timing of traditional planning and quality cycles.
- There is a lack of clarity about the audience for much information about courses. The prime example is the programme specification, but this also applies to such things as module descriptors.
- As course information as become more complex, universities have faced challenges in joining information up to serve different systems and audiences. A good example is learning outcomes, where the joining of award and module outcomes in the context of flexible offerings, and the need to link this to benchmarking, poses issues to quality processes, course monitoring and student-facing systems such as PDP.

- Course description information: The provision of accurate and timely information about the nature and delivery of courses to students is problematic. The example of students complaining that assessment patterns of modules had changed between selection and delivery is a common one across the sector. In addition the problem of providing quality prospectus information in the context of planning and addressing new markets is equally difficult. A common approach to the handling of course information would help the provision and interoperation of systems, and the work of initiatives such as XCRI[7] and the work of MIAP[8] are important in this context.

6.3 Software Implementation Outputs

Several scenarios have been implemented. For brevity only one scenario is described in detail.

Scenario 2: Running a Validation Event

Scenario	Running a validation event
Pre-conditions	Validation Documentation Set has been finalised and ready for submission to the final validation The Faculty owning the course specification has requested the university central registry to organise the final event for validation
Description	Gollum has received an email from the Course Validation System that an event is ready to be scheduled and a preferred approximate period (2 weeks) He logs onto the system with the URL supplied in the email to view the documentation set for the course validation. He runs a simple check to confirm that all elements of the validation documentation set are complete. He also checks that the course that is being planned for validation is on the university validation planning list and the name of the course or courses is still the same. The system reports that the course is on the university plan but there has been a minor change in the name. Gollum then needs to identify appropriate panel members so he enters the JACS code from the programme specification to search for potential external reviewers. The system returns 5 possible candidates, further details of the candidates reveal that 3 of the candidates were used in validation events and other QAA events so the remaining two are selected. Gollum then reviews the other roles on the panel that also need to filled – academic registry, internal panel members and administration support. On viewing the validation calendar, Gollum realises that there is only a limited number of days in the required period. He constructs an email that includes suggested dates; an executive summary of the proposed course and requests that email recipients select their availability (or not) by a clicking on relevant links embedded in the email for each of the supplied dates. Some days later, Gollum receives an email from the course validation system that informs him that the panel is complete for one of the days. Gollum then requests a room from the Timetabling Service for the event together with lunch/coffee, and hotel arrangements for external members if required. On receipt of this email, Gollum authorises the COVARM application to package the documentation set to send to colleagues who have indicated that they prefer to receive documents via email. Other colleagues are sent the documentation in

[7] See http://www.elframework.org/projects/xcri

[7] See http://www.miap.gov.uk/index.htm

	a physical form. Regardless, all are sent a formal invitation to the validation via email which includes a link to a form that allows them to provide pre-event feedback of key issues that they want raised. Before the event happens, the Chair of the panel is sent a short report summarising the feedback received from the panel members. The validation event happens and the chair together with the panel members summarises the outcomes of the deliberations at the event. The decision is described in terms of conditions and recommendations and dates by when the conditions must be met. The verbal statements are entered into the COVARM application as draft notes at the time of the event (network access permitting) or as soon as possible thereafter. Some days later, the note taker completes the full minutes and the chair signs the minutes and ensures that the status of the minute is maintained on the covarm application.

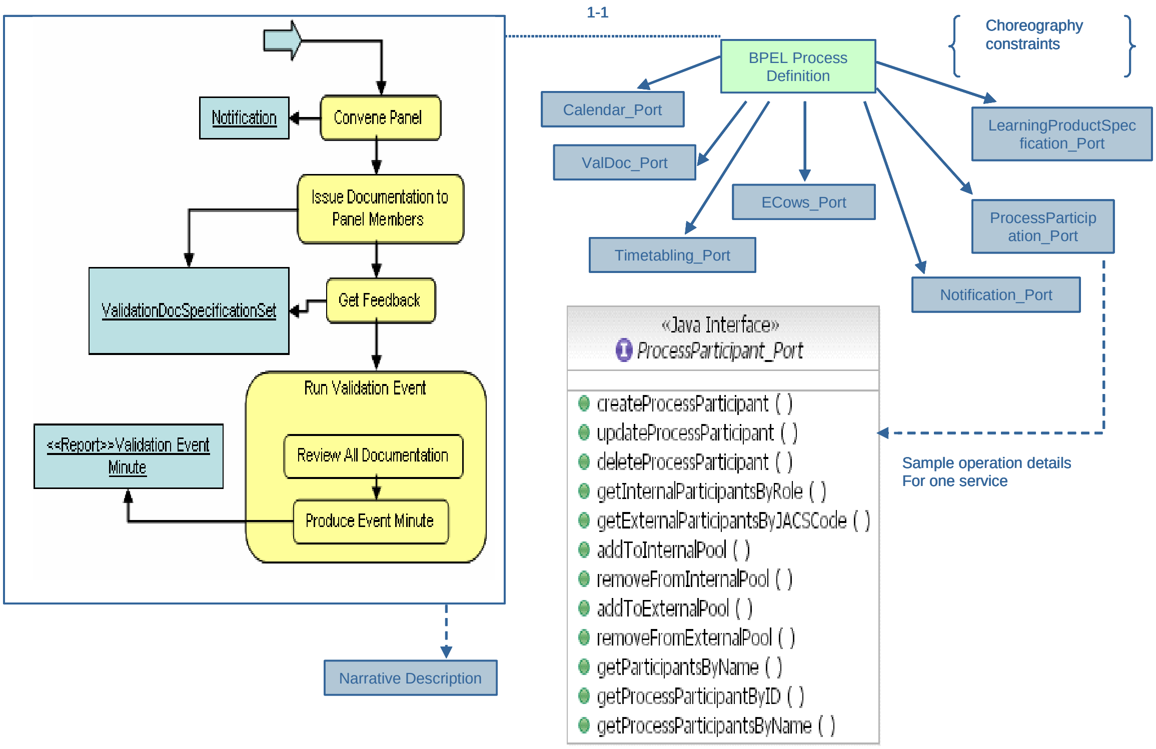


Figure 4 Scenario 2: Running a Validation Event

From the scenario narrative and the sub-process definition (shown above, Figure 4) UML Sequence diagrams were developed and then used to produce a BPEL specification for the scenario. The graphic also illustrates the various services that are consumed by this particular sub-process or scenario. A sample method/operation list for one of the services is also shown. All services, methods and parameters and so on were all captured within Rational Software Architect UML models as explained in the Implementation chapter earlier in the report. A detailed worked example of the scenario is available on the COVARM website. A full list of the services developed is shown in appendix C.

The BPEL flow diagrams have proven useful for explaining BPEL concepts, as well as showing how the process is being implemented, with people not familiar with such concepts. We have used these flow diagrams in meetings, live demonstrations, and videos (available from the COVARM site). While we feel that the time when a non-technical person can simply drag-and-drop to produce a BPEL specification for their business is still a way off, the usefulness of such diagrams as a communication tool should not be underestimated.

6.4 Client Workflow Application consuming BPEL Service Descriptions

One of the objectives in the extension funding for COVARM was to explore the development of workflow based applications. This part of the project considered the layering of a client application which consumed the BPEL processes and providing a mechanism to enable user tasks (user interactions in the workflow) to be acted upon.

The Oracle BPEL Process Manager provides a set of Java APIs which provide interfaces for the querying, retrieval, modification and submission of user tasks, that is, a mechanism for interacting with a BPEL workflow process. The team chose to customise the sample worklist application supplied with the Oracle BPEL Process Manager as there is limited documentation on how to create workflow applications that interact with a BPEL process from scratch.

The worklist application we prototyped provides a relatively familiar user experience. A user will log in to the application via either a web link or a web form. They will then be presented with their main page; the task list.

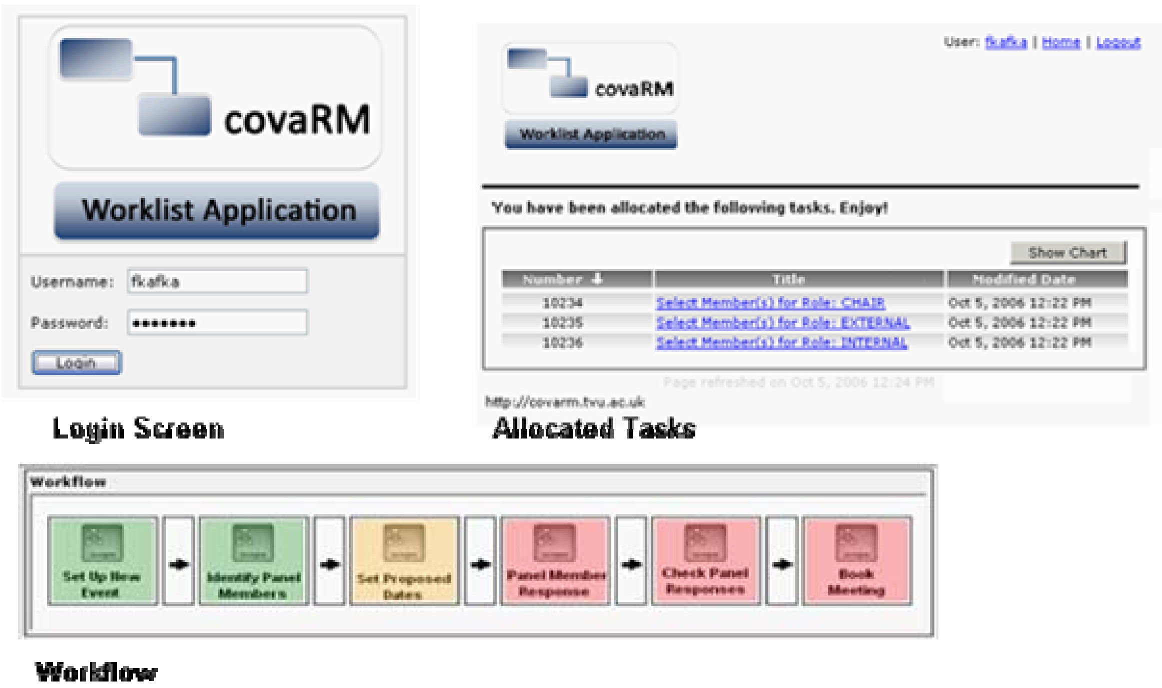


Figure 5 Workflow Application – Sample Screenshots

The task list provides a list of all outstanding tasks for that user. The user can choose to begin any task by clicking on the task name. Doing so takes the user to the task details page.

The task details page contains a workflow diagram, instructions on completing the task, and the information and tools required to complete the task. The main body of the task details page is generated from the user task JSP which is created at the same time as the BPEL process. These pages are deployed to the workflow application and accessed each time a user task relating to that JSP is selected.

The workflow diagram provides some context for the task. Because users may be undertaking tasks in several different processes at the same time, there is no use in having one workflow diagram that sits at the top of their task list, showing them where they are in a particular process. Wanting to still provide some meaning to the user's actions, we decided to place the workflow diagram on each task detail page.

The workflow diagram shows completed parts of the process in green, future parts in red, and the current part in amber. As the process progresses, so the colours change to reflect this.

The instructions to the user are constructed by the BPEL process, and can therefore be customised to each user, providing information specific to that user's completion of the task.

The information and tools to complete the task are provided by an HTML form. The part of the user task construct the user works on is called the payload. The form is dynamically constructed by Java code within the task JSP, to allow for such things as variable-size arrays. Boolean values are not well handled within the Oracle BPEL engine, but integer values suffice, providing the input and output values for checkboxes and radio buttons.

6.5 A service oriented methodology and accompanying PDK with sample content

The lack of appropriate methodological support for service oriented architecture (also noted by the FREMA project) required the project to explore and define appropriate methods and techniques that would support MDA principles and allow us to refine business process models into service based process executions using BPEL. The techniques that we adapted or created were derived from component based development approaches and are summarised in the diagram below (Figure 6). However, in order to apply MDA to the software process as well, we explored the use of the IBM software product – "Method Composer" which provides capabilities to specify development processes and accompanying guidelines for use as a delivery platform of a Process Driven Knowledgebase (PDK). While our experimentation with Method Composer is limited and the content guidelines provided are a small sample, there would appear to be sufficient evidence that this approach could be useful for consideration by the e-Framework. The "Method Composer" supports web site generation of PDK content and is available for viewing from the Covarm website. If adopted by the development community, the knowledgebase, providing guidance content to SOA developers going through the process, may be incrementally enriched by successive projects.

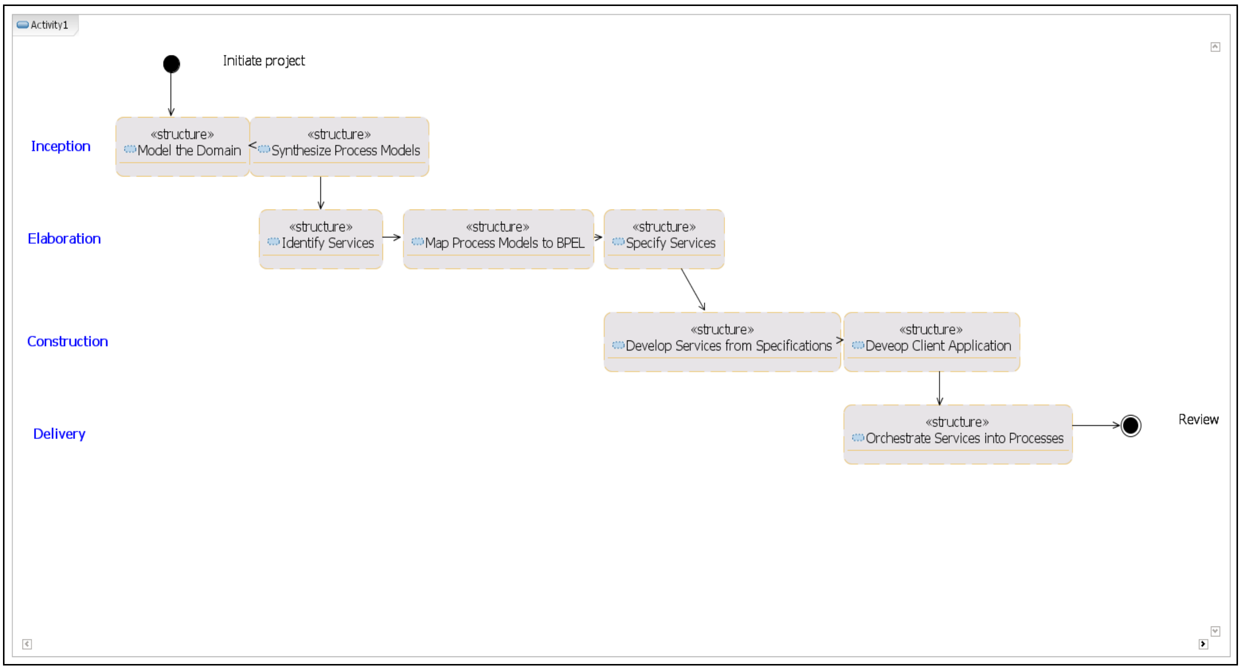


Figure 6 Model of the development process

The PDK for SOA contains a model of the end-to-end development process as it emerged for the COVARM project. The process can be displayed as a UML Activity Diagram or as a Work Breakdown Scheme. Guidance may be added to any of the tasks in the process, providing the developer with white papers, guidelines, standards, examples and templates as appropriate in the process context. Figure 7, below, shows a single screen from the web application from which the developer may view guidance for the task: “create synthesised model”. The PDK may also be used by the development manager to cost and plan the service development tasks, the process authoring tool providing direct input into project management and IT portfolio management tools.

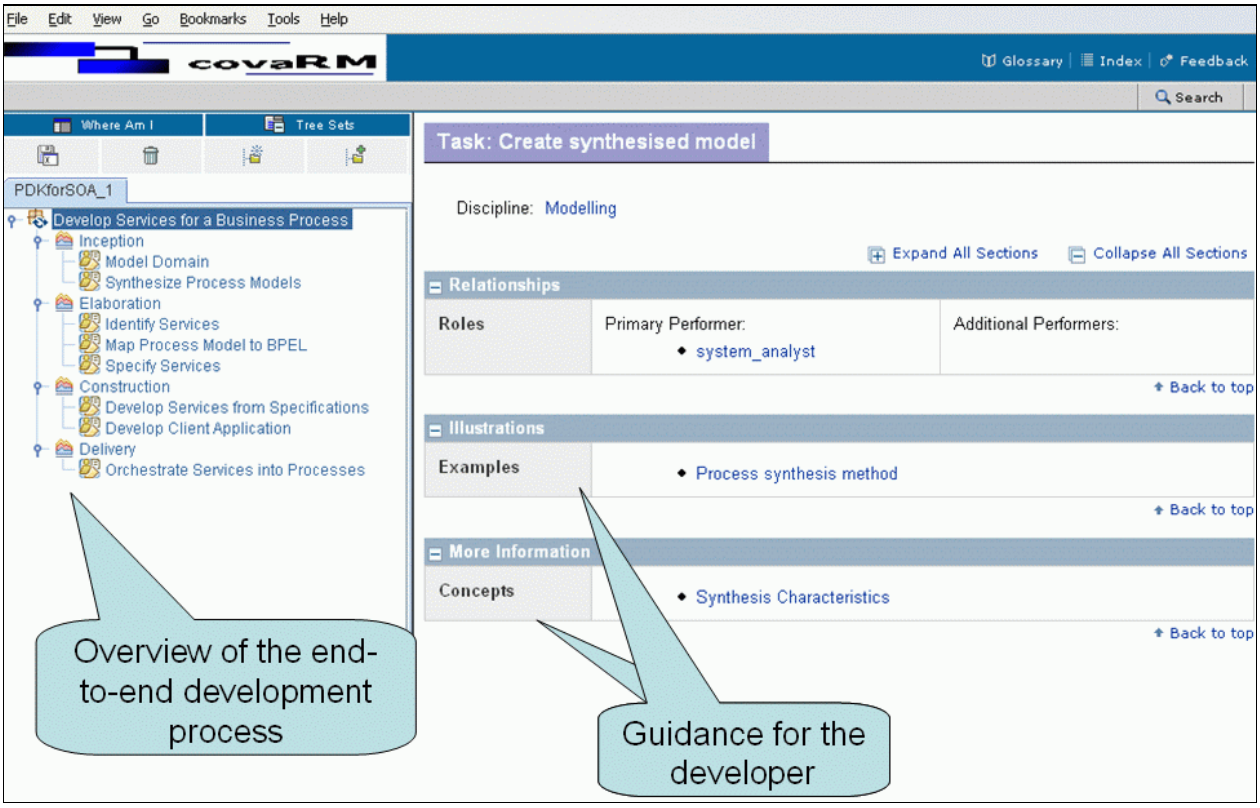
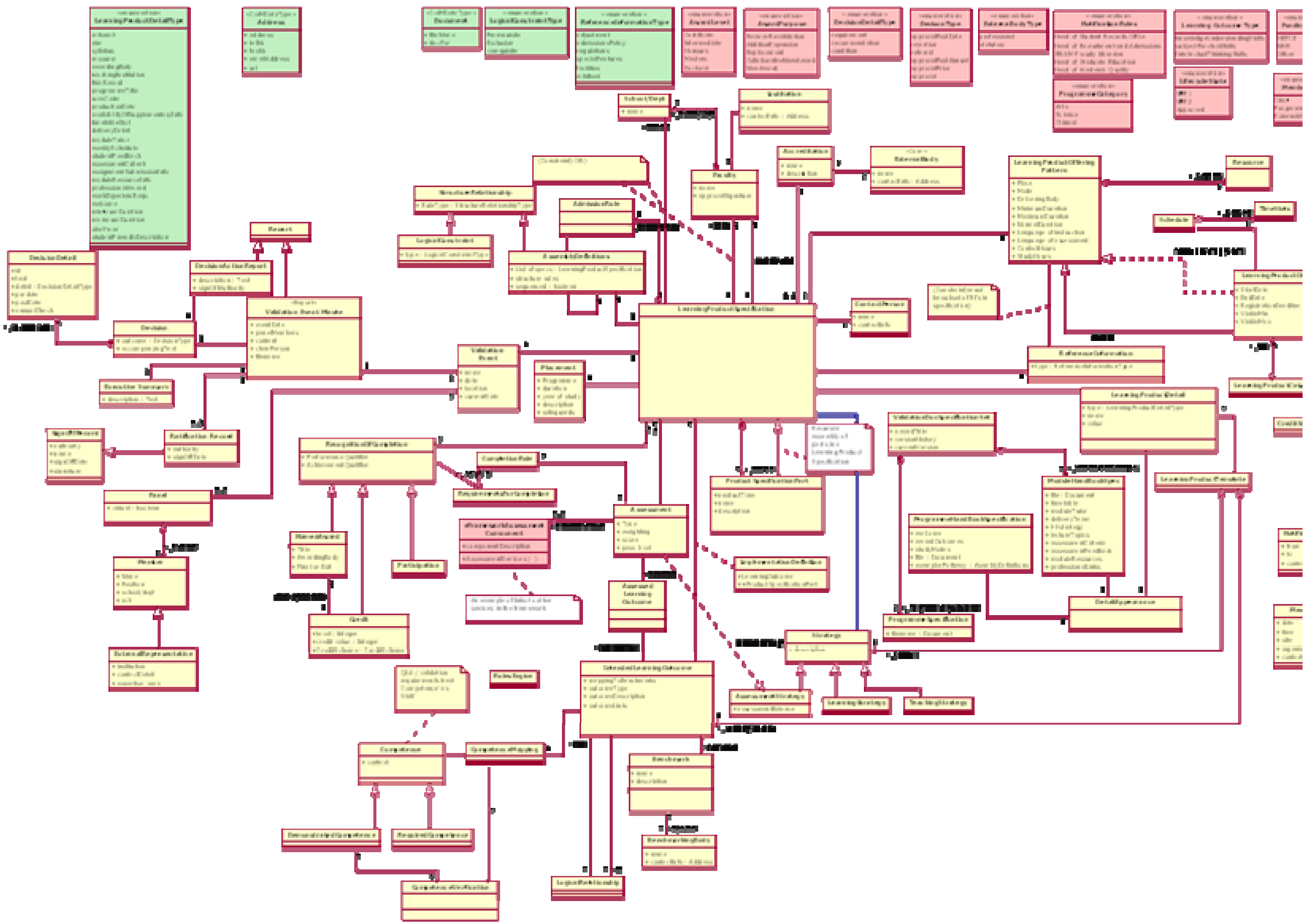


Figure 7 Sample screenshot from the Process Driven Knowledgebase

6.6 Unified Information Model (XCRI, SUNIWE and P4P)

The model was developed by the various projects independently developing information models (using UML and XML) for their own project requirements. Meetings established that there was a significant overlap between information models and if the JISC e-Framework was to work – there was going to be a need to identify more precisely this overlap in order to factor out common services to contribute to the e-Framework. The project information models were then unified by abstracting shared information requirements and by jointly developing areas of the information model that were ambiguous. Perspectives from different project requirements were very helpful in this regard. The resulting information model is presented in this document and demonstrates that UML was an important unifying meta language for enabling experts from different areas to come to a common understanding, a case of ontology in practice.

Figure 8 Unified Information Model



6.7 Dissemination

Results from the project have been disseminated both nationally and at an international level. There is also an ongoing dissemination plan over 2006-7.

National Level

Presentations have been made at numerous seminars, workshops and conferences organized by JISC and CETIS in Glasgow, Birmingham, Manchester, and London. Details of these presentations are available at http://www.elearning.ac.uk .

Invited seminar presentations at the University of Bath (Dept of Computer Science) and University of Southampton (Learning Technologies Group) were used to present the COVARM technical findings.

A business focus paper was prepared for the E-framework website focusing on the business transformation issues by taking a business process led approach.

http://www.elearning.ac.uk/covarmbriefing

A presentation to Higher Education Academy - E-Business Subject Area on reference modelling and E-Business strategy was given in July 2005.

(http://www.ics.heacademy.ac.uk/events/presentations/79_Oussena.ppt)

International

The COVARM reference model was presented at a workshop related to the Educa-Berlin 2005 Conference on E-Learning together with other Reference Model Projects.

A research paper describing our analysis methodology and the process synthesis approaches was presented at IADIS Applied Computing 2006 in Bilbao, Spain, 2006. This was later developed into a fuller description for journal publication (http://www.iadis.org/ijcsis/).

A further paper focussing on various aspects of the software design method was presented at The 15th International Conference on Information Systems Development http://isd2006.bme.hu/ and will shortly be published as part of a Springer series.

Planned Dissemination (2006-2007)

A technical paper focused on characterising and defining the relationship between components and services in has been submitted to the CAISE'07 – Computer aided information systems engineering 2007 conference (http://caise07.idi.ntnu.no/index.php).

A paper focused on the Testing framework is planned for submission to ISSTA-07.

A second paper focused on Business Rules in XML is also due for submission at an appropriate conference.

A Reference Modelling Workshop submission has been made to CAISE'07 – Computer aided information systems engineering 2007 conference (http://caise07.idi.ntnu.no/index.php).

A Reference Modelling Workshop submission has been accepted at the WETICE – 16th IEEE International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises (http://www-inf.int-evry.fr/WETICE/)

Both workshops have a programme committee that includes members from other Reference Model Projects.

A business perspective paper has been accepted for presentation to Association of University Administrators Conference – April 2007 http://www.aua.ac.uk/events/conference/

Plans to disseminate the COVARM PDK include targeting the EUNIS conference (http://www.eunis.org/events/congresses/eunis2007/)

A business perspective paper has been accepted for presentation to Association of University Administrators Conference – April 2007

7 Evaluation: Outcomes, Conclusions and Implications

We conclude this report by outlining recommendations and areas for further work.

7.1 Outcomes

The main gap between what we set out to achieve and what we did achieve in the time, has been due to two key challenges: the complexity of the subject domain and immaturity of the technology. Course validation processes were much more complex and larger than we expected but we were able to demonstrate the validity of using MDA from business through to BPEL. The final layer of using BPEL APIs to connect to an application has not yet been achieved although we do have a clear picture of the required method for this. The use of complex and relatively immature technology has provided an additional challenge to the project but we do now feel confident in our selection of tools and approach. Importantly, we have identified an integrated set of tools and technology that will deliver the MDA vision.

The project has been challenged by the complexity of the domain, the state of current / leading edge technology and overall scope – the model driven architecture approach. The progress that has been made is substantial and broadly meets the aims and objectives of the original project.

A key emerging theme from all the Reference Model projects was the difference in approach and interpretation of what is meant by a reference model. This variation in approach has influenced the JISC e-Framework in that there is now an alternative set of terms for describing these types of projects – Domain Maps. A potentially informative outcome could be derived by conducting a detailed comparison and contrast of the various projects. COVARM adopted a strong software engineering approach whilst other projects focused on high level scenarios or as in the case of XCRI – rapid / xtreme programming approaches to develop usable software.

The COVARM approach – high level business process modelling of a domain through to low level service based execution of the parts of a business process confirms the need for higher education to understand various sub-domains at a level of detail that enables strategic IT support for HE functions. The fact that several of the case study HE institutions were seeing for the first time the overall holistic complexity of their course validation processes suggests that formal business process modelling has considerable potential for HE to understand their own environments. The nature and presentational style of business process models provided a natural conversational framework for sharing between different types of stakeholders.

Much of the COVARM project focused on exploring key emerging technologies. For example there is limited concrete experience of model driven architecture from UML through to service execution using BPEL. The experiences and the documented evidence from COVARM provide substantial experience for other future projects to utilize.

The deployment and integration of various technologies also required the development, adaptation and use of methods to ensure that the project would meet its aims and objectives. We found that using and adapting component based development principles to service oriented architecture was effective. We recognize that this is a single instance of the overall approach that we have documented and that further evidence is required, but none the less there is practical, useful guidance on using UML based tools to support service oriented architecture. We have made an effort to provide sample content of the knowledge and documentation that we have produced into what we have ambitiously called the COVARM_PDK (process development kit). This is intended to be a sustainable resource as it is strongly aligned with the research interests of several members of the group.

From a research perspective, much of the development work – the use of MDA principles for SOA and implementation of BPEL technologies provides a body of applied research knowledge which has led to several publications in conferences and e-journals. We expect to continue to draw on this knowledge gained.

Locally at Thames Valley University, the various services we have developed are now part of a library of software which is being used to encourage students to undertake projects and dissertations at both UG and PG level. The case studies have also been used in the design of assessments.

Despite the distributed nature of the project team (Manchester, Staffordshire and TVU), the team worked successfully using a variety of meeting techniques. We held regular project meetings at various sites and were heavy users of Skype. We would strongly recommend using Skype or similar technology. We would have benefited considerably from software that enabled distributed application sharing. Some of our modelling was done over Skype but the experience would have been much richer had we utilized some form of application sharing. Beyond doubt, the project worked well as a team and much of the success of the project can be attributed to the wealth of experience within the team.

7.2 Conclusions

This report has provided in some detail, the methods, results and outcomes from the COVARM reference model project. Some of the most important results have been:

- An articulation of a reference model as per the JISC call requirements
- A case study of methods and techniques to support SOA
- An end-end model driven output form a description of a business domain described in a language that stakeholders are comfortable with to a set of precise service specifications and implementations of services that allow assembly into a partial workflow application described and supported by BPEL and related technology.

Within the original e-Framework (the e-learning framework aka ELF), course validation was box – this project has provided real and tangible evidence that that simple abstraction hides a level of complexity that surprised many people. The complexity of the business process, its integration with most areas of an institution meant that the reference model presented in this report describes potential dependencies and requirements to other aspects of the e-Framework and thus provides a clear and substantive argument for the values of a reference modelling to understand the larger e-Framework strategy currently being developed and promoted by JISC. In particular, its is worth repeating that the methods and techniques described in this report provide a useful approach for understanding the necessary “glue” to support the e-Framework.

The report has also demonstrated that while the project was funded from the e-Learning programme, some of the largest potential benefits may arise from adapting and applying outcomes from this project to address other areas within higher education. This has been recognised and supported by the JISC by the provision of further calls for projects to explore other areas of University administration functions.

7.3 Implications

Three key outputs have implications for the wider community. The need for detailed business level understanding of domains within the HE enterprise is paramount. If that knowledge can be captured in Domain Map form – (e.g. information models, process models) it can be used as a medium of communication between different stakeholders. For example, the models and knowledge can be used to shape requirements for product selection; or communication with software vendors. Business models captured in UML form can then be the basis of software design and implementation strategies for bespoke development. While there are some clear benefits that emerge immediately, much deeper and sustainable benefit can be reaped if the HE community considers training and staff development in these areas.

The recent calls for projects to produce Domain Maps suggests that the need for detailed business understanding of areas within HE (administration focus) has been recognised by the JISC and funding to explore this area is now available.

The extensive use of UML and modelling tools per se throughout the project lifecycle as part of a model driven approach has identified a several areas that need further investigation. Project teams considering the use of such approaches should consider exploring the evidence presented as part of this project before they embark on particular technologies. COVARM considered a bespoke development approach to business process implementation. The complexity of a process however can make this particularly challenging. Technologies, for example, Business Process Management Tools such as Intalio could present viable alternatives.

COVARM produced a detailed process model of the course validation business process. While there is confidence regarding the business rules and governance of this process, further verification of the articulation of the process definition and its transferability to alternate technologies such as BPMN tools mentioned above would be beneficial to the community.

Reference modelling (the production of the now-called Domain Maps) requires the use of methods and techniques that are still evolving. We would encourage the use of modelling techniques to further add to the body of knowledge for JISC and other public sector funded projects.

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9 Appendix A: Glossary and Acronyms

Acronym	**Full**
A	
API	Application Program Interface
B	
BPEL	Business Process Execution Language
C	
CBD	Component Based Development
CETIS	Centre For Educational Technology Interoperability Standards
COVARM	Course Validation Reference Model
E	
ER Diagram	Entity Relationship Diagram
ELF	e-Learning Framework
F	
FREMA	e-Learning Framework Reference Model for Assessment
H	
HE	Higher Education
HEA	Higher Education Academy
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institution
HESA	Higher Education Statistics Agency
HTTP	Hypertext Transfer Protocol
I	
IADIS	International Association for Development of the Information Society
IDE	Integrated Development Environment
IEF	Information Engineering Facility (from Texas Instruments)
IS	Information Systems
IT	Information Technology
J	

J2EE	Java Platform, Enterprise Edition
JISC	Joint Information Systems Committee
M	
MDA	Model Driven Architecture
MDK	Methodology Development Kit
MIAP	Management Information Across Partners
MIS	Management Information Systems
P	
P4P	Pathways For Progression
PDK	Process Driven Knowledgebase
PDP	Personal Desktop Publishing
PG	Postgraduate
PS	Programme Specification
Q	
QA	Quality Assurance
QAA	Quality Assurance Agency
QCA	Qualifications and Curriculum Authority
R	
RIA	Rich Interactive Application
RM-ODP	The ISO Reference Model for Open Distributed Processing
RSA	Rational Software Architect
RUP	Rational Unified Process
S	
SIG	Special Interest Group
SOA	Service Oriented Architecture
SOA-MDK	Service Oriented Architecture Methodology Development Kit
SOAP	Simple Object Access Protocol
SQL	Structured Query Language
SUNIWE	Surf NIIMLE WETN
T	
TQI	Teaching Quality Information Initiative
TQM	Total Quality Management

U	
UCAS	Universities and Colleges Admissions Service
UG	Undergraduate
UML	Unified Modelling Language
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
W	
WSDL	Web Service Definition Language
WSIF	Web Service Invocation Framework
WTP	Eclipse Web Tools Platform
X	
XCRi	eXchanging Course Related Information
XDE	Rational Software eXtended Development Environment
XML	eXtensible Markup Language
XP	Extreme Programming
XSD	XML Schema Definition

10 Appendix B Process Model Samples

Looking at the four process models alongside each other, four principal phases of a canonical course validation process were identified: Proposal; Intermediate Approval; Final Approval and Post Validation.

The following diagram (Figure 8) shows the naming of these phases as they appear in each of the institutions modelled.

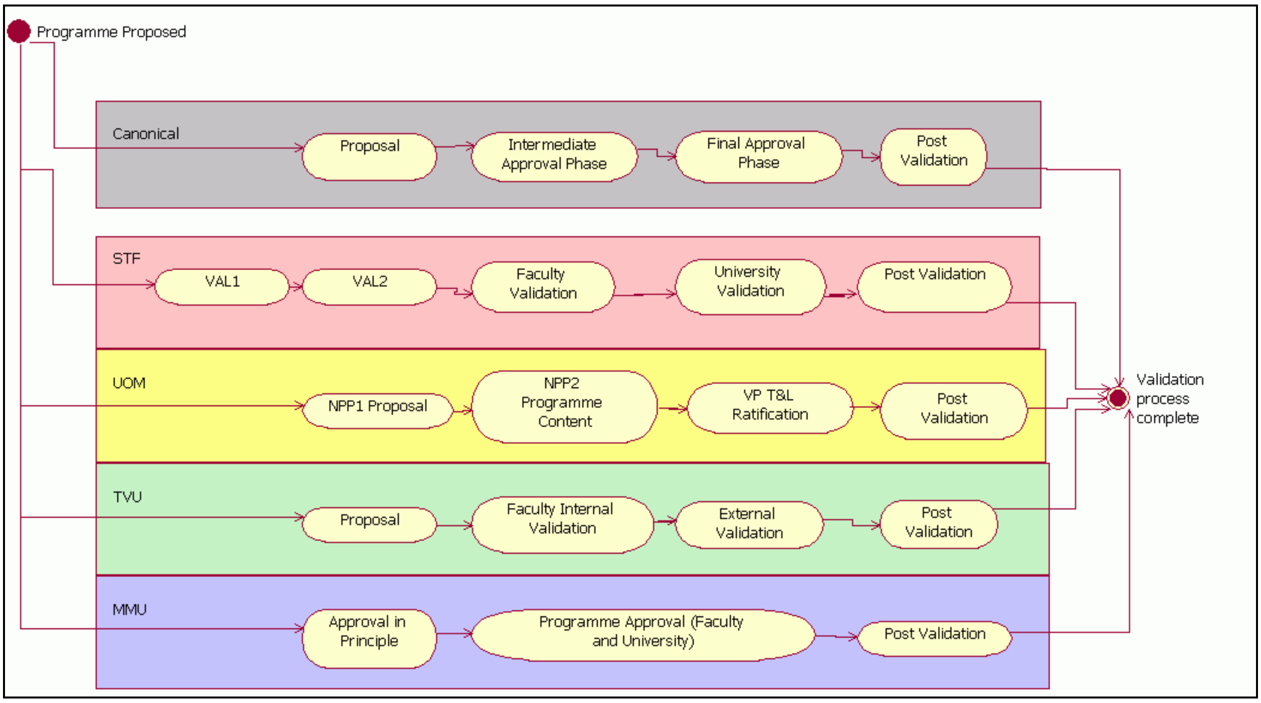

Figure 9 High level alignment of the processes from four institutions

Detailed process models for all four institutions may be viewed in the web report on the project website (URL). The web report allows model browsing and scrolling of the diagrams for more convenient viewing. Following, are three small sample sections taken from each of the first three phases of the process.

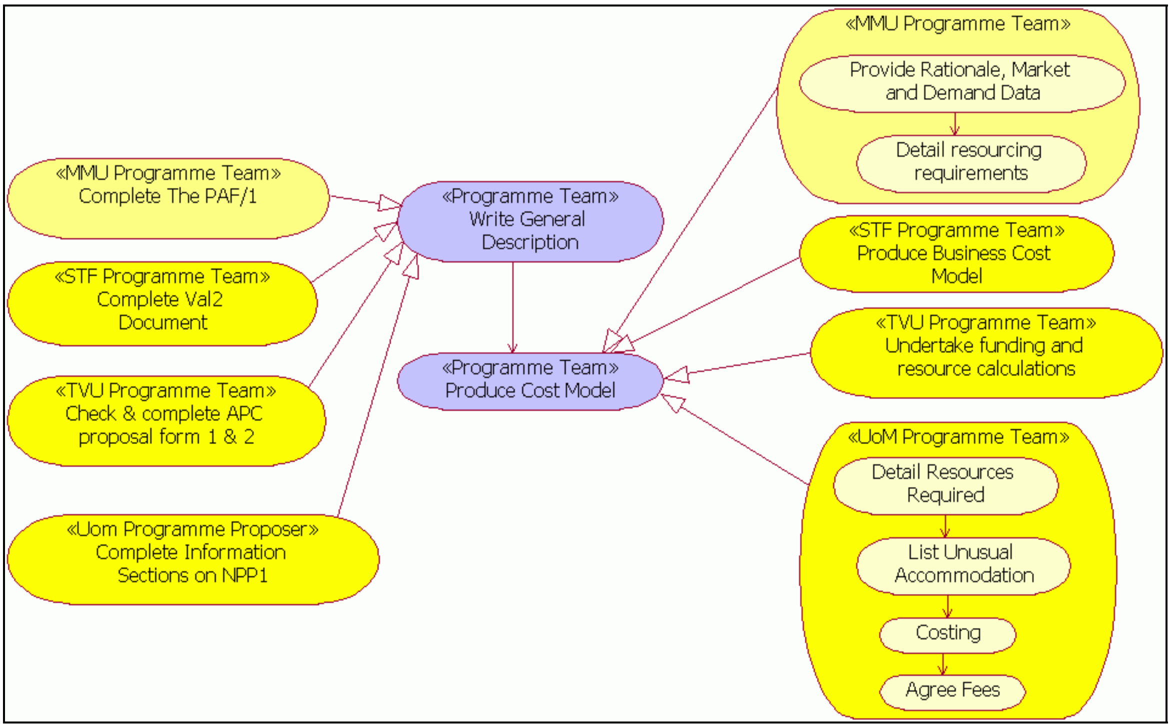

Figure 10 A Sample Section of Phase 1 (Proposal) of the Synthesised Course Validation Process

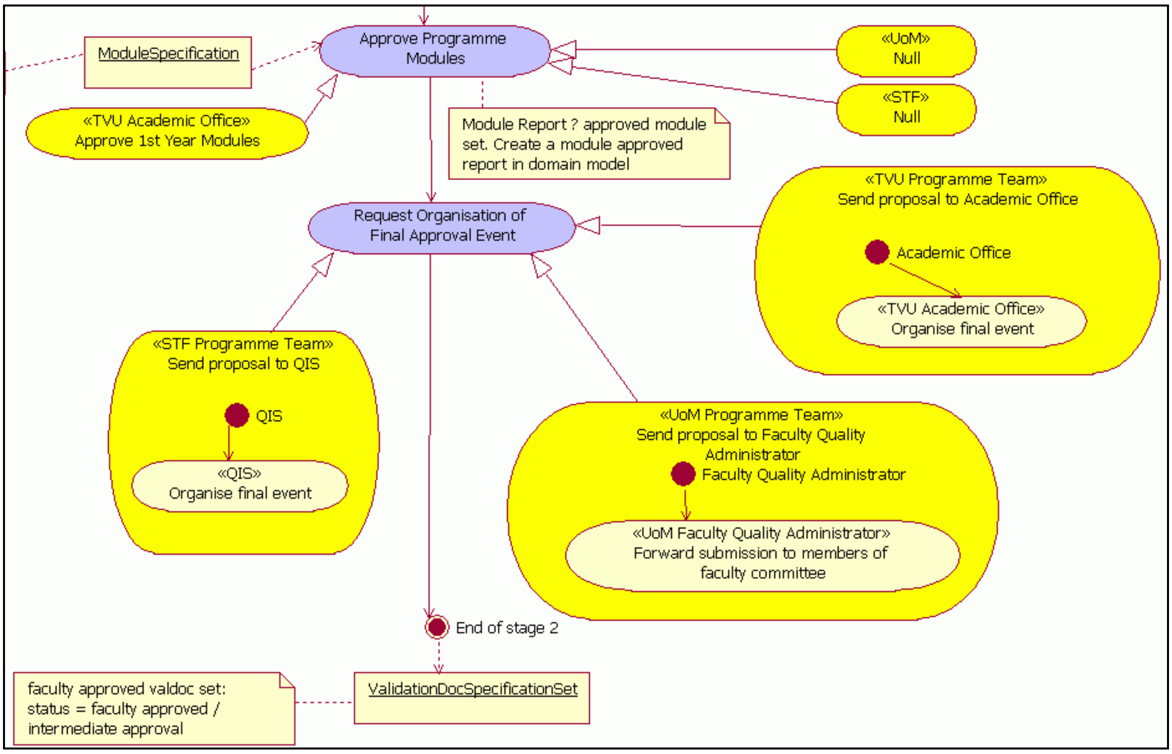

Figure 11 A Sample Section of Phase 2 (Intermediate Approval) of the Synthesised Course Validation Process

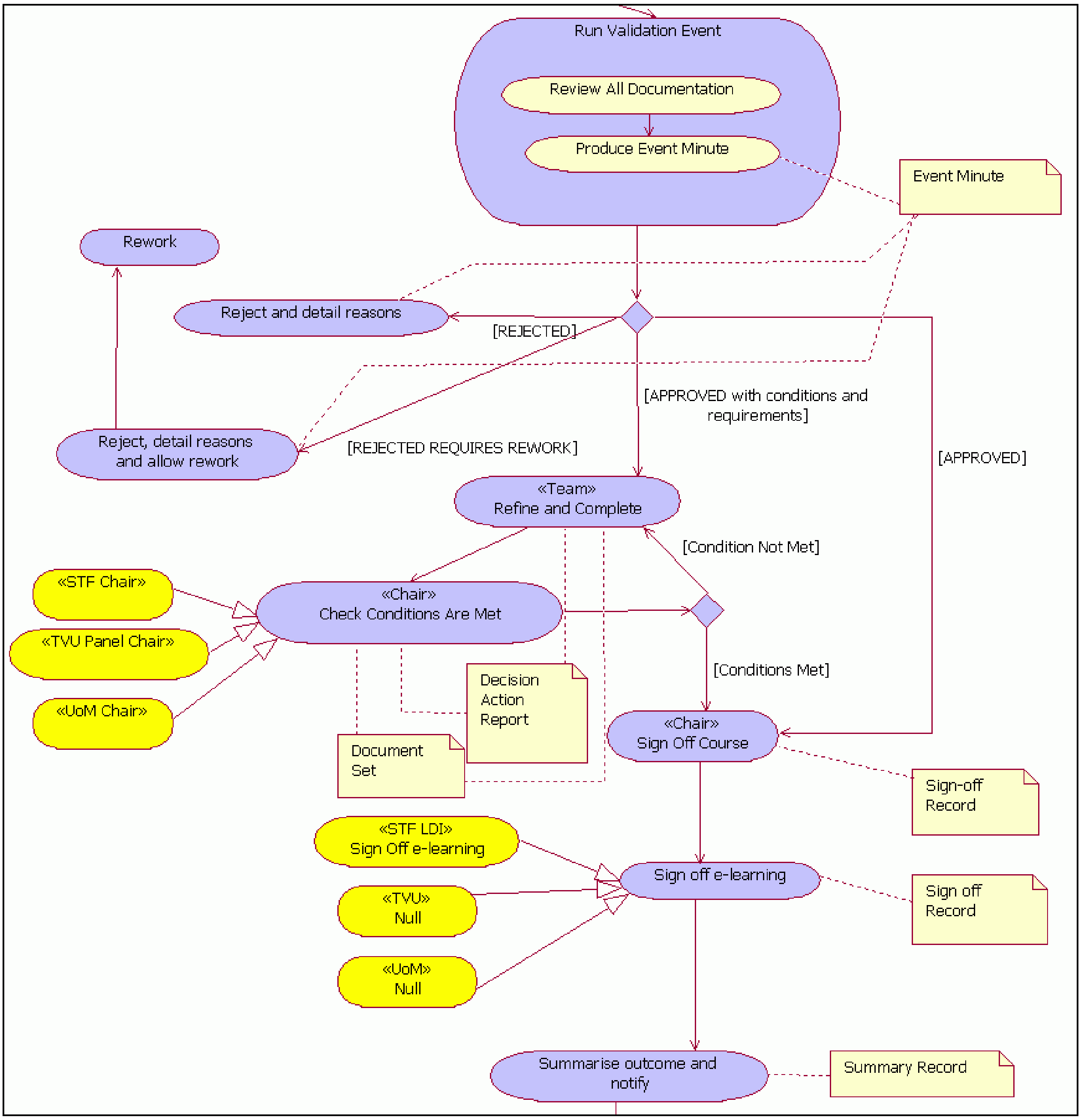

Figure 12 A Sample Section of Phase 3 (Final Approval) of the Synthesised Course Validation Process

11 Appendix C: Software Services Developed

Service : ecows

Description

The service is responsible for the management of a validation event. You can set up an event, retrieve and updating information about an event, set up a panel (the structure of the panel is specific to each institution). Set up the panel is supported by getPanelRole, getViabledate and processVabledate. Prior to the event data, all members are sent the validation document set and their feedback is automatically added to the set and passed also to the panel chair.

Methods

- `Event createEvent(String createEventRequest)`
- `String processDateResponse (ProcessDateResponseRequestType processDateResponseRequest)`
- `String processFeedback(ProcessFeedbackRequestType processFeedbackRequest)`
- `String setProposedDates(SetProposedDatesRequestType setProposedDatesRequest)`
- `String setPanel(SetPanelRequestType setPanelRequest)`
- `GetViableDatesResponseType getViableDates(String getViableDatesRequest)`
- `Event getEvent(String getEventRequest)`
- `GetPanelRolesResponseType getPanelRoles(String getPanelRolesRequest)`
- `GetFeedbackResponseType getFeedback(String getFeedbackRequest)`
- `String updateEvent(Event updateEventRequest)`

Service: valdoc

Description

This for the management of a validation document. A document is considered to be made of metadata section and set of sections. Some methods are to deal with the whole daocument such as getDocumentById or CreateDocuments and others are for managing the sections. It assumes that for each document type there will be a template.

Methods

- `boolean validate(Document validateRequest)`
- `String sendForQualityCheck(java.lang.String sendForQualityCheckRequest)`
- `Document showQualityReview(java.lang.String showQualityReviewRequest)`
- `boolean submitForReview(java.lang.String submitForReviewRequest)`
- `boolean submitQualityReview(Document submitQualityReviewRequest)`
- `boolean createDocSet(DocumentList createDocSetRequest)`
- `boolean addToDocSet(AddToDocSetRequestType addToDocSetRequest)`
- `DocumentList getDocListByName(String getDocListByNameRequest)`
- `Document getDocumentByID(String getDocumentByIDRequest)`
- `Document createDocument(CreateDocumentRequestType createDocumentRequest)`
- `boolean addSection(AddSectionRequestType addSectionRequest)`
- `boolean updateDocument(Document updateDocumentRequest)`
- `String registerNewType(java.lang.String registerNewTypeRequest)`
- `Section getSection(GetSectionRequestType getSectionRequest)`
- `boolean updateSection(UpdateSectionRequestType updateSectionRequest)`
- `GetUncompletedSectionsResponseType getUncompletedSections(String getUncompletedSectionsRequest)`
- `GetSignaturesRequiredResponseType getRequiredSignatures(String getRequiredSignaturesRequest)`

- `GetDocSetResponseType getDocSet(String getDocSetRequest)`
- `String getData(GetDataRequestType getDataRequest)`

Service : learningProductSpecification

Description

This id for the magement of a course or a programme. Only method needed for the two implemented scenarios have been implemented.

Methods

- `String getJACSCode(java.lang.String getJACSCodeRequest)`
- `LearningProductSpecification getLearningProductSpecificationByID (String getLearningProductSpecificationByIDRequest)`

Service: ProcessParticipant

Description

This is for the management of the people associated with the validation process. It assumes that a pool of external and internal will be kept up-to-date.

Methods

- `boolean createProcessParticipant(Participant createProcessParticipantRequest)`
- `boolean updateProcessParticipant(Participant updateProcessParticipantRequest)`
- `boolean deleteProcessParticipant(String deleteProcessParticipantRequest)`
- `ParticipantList getInternalParticipantsByRole (String getInternalParticipantsByRoleRequest)`
- `ParticipantList getExternalParticipantsByJACSCode(String getExternalParticipantsByJACSCodeRequest)`
- `boolean addToInternalPool(java.lang.String addToInternalPoolRequest)`
- `boolean removeFromInternalPool(String removeFromInternalPoolRequest)`
- `boolean addToExternalPool(java.lang.String addToExternalPoolRequest)`
- `boolean removeFromExternalPool(String removeFromExternalPoolRequest)`
- `ParticipantList getParticipantsByName(String getParticipantsByNameRequest)`
- `Participant getProcessParticipantByID (String getProcessParticipantByIDRequest)`
- `ParticipantList getProcessParticipantsByName(String getProcessParticipantsByNameRequest)`

Service notification

Description

This is a service that construct a message and send t by email.

Methods

- String sendNotification(Notification_Type sendNotificationRequest)

  Service timetabling

12 Appendix D Additional References

Further readings that have contributed or have been used by the project.

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