A High Level Domain Architecture for Higher Education

Final report

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Introduction

This report describes the issues that need to be addressed in developing a fully functional domain map of higher education, and the creation of a proof-of-concept domain map that demonstrates the viability of the concept and the value of the techniques proposed here.

The introduction summarises the main issues addressed and results of the project and will provide the reader with an overview of the results and the recommendations for further action. These are further expanded, and extensively illustrated, in the main body of the report. Technical details are confined to the appendices, along with two tables that bring together brief answers to the questions asked in the invitation to tender (ITT) and comment on the suggested sources of information. It is suggested that people with limited time may want to read the introduction and consult Appendix 3: Terms of Reference and Appendix 4: The use of data sources in the ITT.

The invitation to tender (ITT) on which the work is based asked a number of questions (see Appendix 3: Terms of Reference for the full set of questions and brief answers to them) including:

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

This report answers these questions, and with the proof-of-concept domain model which we have built, proves that a domain model can be built and would be of great value to the community.

The introduction provides a brief overview of the four questions posed above.

What is a domain map?

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 "admit 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.

It is worth considering the relationship between the domain map and the e-framework. The domain map can be used to support exploration beyond the domain map itself, and in particular can support access to the e-framework by providing a view onto the e-framework that is top-down, rather than bottom-up. That is, a view based on the work of a university rather than the technology to support that work. The domain map is situated at a higher level than the e-framework, and comprises functions, and processes (including sub-processes). The processes can be linked to appropriate service usage models in the e-framework, which are connected to appropriate service genres and service expressions, leading ultimately to service implementations (which may themselves be outside the e-framework).

The use of the domain map to provide a view onto the e-framework can be extended to the relevant JISC projects such as the existing domain map projects, Programme Specification Domain Map (P-SPEX)[1] and Admissions domain map (ADOM)[2]. This would have the advantage that all such projects could be integrated. Indeed, the P-SPEX project is already considering making use of the domain map to support their work.

There are then a number of ways in which the domain map can be viewed. We have developed four - work area (or domain), application, life-cycle, and external agent (or organisation). We have also recognised the possibility of a fifth view, by role (or user type). These might be teacher, librarian, estates manager, learning support officer etc and would show the domain map form their point of view. This is discussed further under Visualisation of the model. Other views have their foundations prepared in the model, such as a good practice view and an enterprise architecture view and these are discussed in Appendix 2: The Domain map's model.

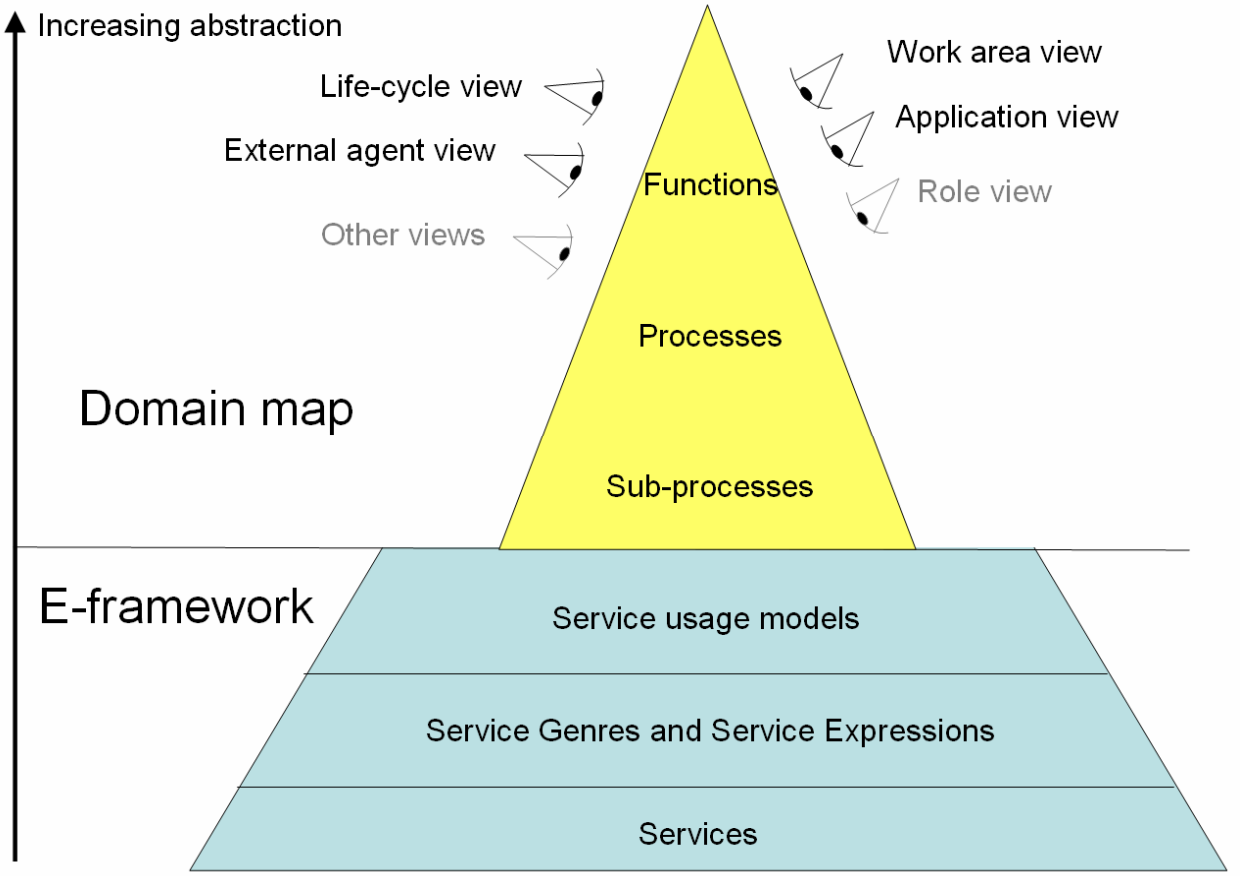

Figure 1: Diagram of the relationship between the domain map and the e-framework

Who would use a domain map? and what would they use it for?

It is difficult to separate these two questions in a meaningful way, as the uses that the domain map affords will determine who might want to use it, and the audiences that it is aimed at will determine the uses that it needs to support. We will therefore discuss these questions together. For clarity we list some of the key audiences for the domain map and some of its main functions. We then discuss some of these. A fuller treatment of two is given in the section Scenarios, and a table showing the stakeholders that we have identified and the uses that they might make of the domain map is shown at Appendix 3: Terms of Reference.

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[1] http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/courseinfo/pspex.aspx
[2] http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital/admissions/adom.aspx

We have identified about a dozen different types of user for the domain map including:

- Business analysts within universities
- JISC programme staff and committee members
- Developers
- Standards bodies
- Commercial sales staff

Among the uses that a domain map would support are:

- Enhancing understanding of the workings of universities
- Identifying areas in need of work or development
- Supporting business analysis by providing a rigorous model as a starting point
- Providing task-related access to the e-framework
- Supporting institutional planning
- Supporting the development and implementation of the institutional IT strategy
- Supporting process improvement and change management

A domain map shows the way in which a university functions, the ways in which information flows round the university and the processes that support these. A domain map is therefore of interest to anyone who wants to improve their understanding of how a university works. They might want to:

- Contextualise one part of the work of the university in its wider context, for example to see how and where the work of accounting department relates to other functions within the university. This might be important if the university were considering the implementation of e-purchasing, for instance.
- To understand flows of information within the university, for example to see where information flows into and out of the student record system.
- To identify all the processes that support some function such as course validation.

Beyond understanding how parts of the university function it can be used to identify areas where further work is needed. This might be because the information does not flow automatically as required, because problems have been identified with the way something works or because external pressure (such as changes in regulations) is forcing change.

One place where the domain model could make a real difference in universities is in business analysis. Currently, each university does this independently, and analysts need to build up complex models in order to do their work. The provision of a generic map would greatly ease their task. While they would need to customise the domain map to local practices, it would significantly reduce their task. Further, it might suggest important issues that would otherwise not occur to them.

JISC programme managers would not only be able to use the map to identify points where it would be appropriate for JISC to fund work they could also use it as a programme management tool to coordinate projects working in related areas and as a powerful tool for the dissemination of results to the wider community. By providing a coherent model of universities it becomes much easier to contextualise the work being done and present to a wide audience. Similarly, commercial sales staff would be able to use it to explain how their products and services fit into the overall university ecology.

Developers and standards bodies will be able to contextualise their work more easily, and use it as a tool for identifying work that has been done before that they could build on or reuse.

Is it feasible to build a domain map?

To build an effective domain map one must first create a robust model that the domain map can help one to navigate. The model itself needs to be built up from a manageably small number of types of entity. We believe that we have identified the core essential entity types that need to be included in the model, and these are enumerated in the glossary at Appendix 2: The Domain map's model: Glossary.

One of the critical issues for a domain map is that it needs to have enough information to be useful, but people will be unwilling to contribute unless they can see that the domain map will be useful; that is it needs to achieve a critical mass. We note that the proof-of-concept model already has nearly 550 functions taken from the JISC Infonet Business Classification Scheme together with other data taken from the e-learning maturity model and two of the reference model projects. While the current model does not contain sufficient detail for serious planning it does already provide a sound basis for further work. Indeed, building the proof-of-concept domain map was only a small part of a ten week project. We therefore believe that it would be possible to extend the model to achieve a critical mass relatively quickly. This could include the incorporation of data from the P-SPEX and ADoM projects, and supported by the production of guides on how to use the domain map.

We have made a strong start of building a domain map, and this can currently be seen at http://130.88.2.245:8088/hilda. Note that this is not a server, but a development machine and as such we are not able to guarantee that the domain map will be available at all times.

Report structure

The remainder of the report first illustrates a number of ways in which the a domain map can be used to support work in the higher education sector for a number of different actors, through the use of examples illustrated with screen shots from the actual proof-of-concept domain map. This demonstrates the breadth of activity that an effective domain map can support and makes the subsequent discussions of the domain map itself and how it works more accessible.

Following this we discuss the domain map as built during the project, explaining the key design decisions and what they afford. This is followed by a discussion of what we have achieved, and a number of suggestions for taking the work on the domain map forward to deliver something of lasting value to the community.

There are also a series of appendices which provide more technical detail on the meta-model that underlies the domain map and on the software (Protégé) that has been used to implement the domain map.

Recommendations

This work was to undertake a proof of concept, and recommend how to move forward. We therefore make the following recommendations in the report, which are brought together here:

Recommendation 1: Domain model projects, such as P-SPEX and ADoM, should consider using the domain map as way of making their results available in a common, widely usable form.

Recommendation 2: JISC fund work to identify additional sources of information that can be incorporated in the domain map, and add the information to it. These should address both (static) information elements and functional (behavioural) elements within HE's concerns.

Recommendation 3: Wherever possible the domain map should be connected to the e-framework, and in particular the e-framework editors should incorporate links to service usage models into the domain map as SUMs are added to the e-framework.

Recommendation 4: JISC should organise an expert workshop to validate the model underlying the domain map, and to recommend any appropriate changes to it before significant additional work is done to the domain map.

Recommendation 5: JISC should fund a project to work alongside the Enterprise Architecture projects to be funded under the JISC Capital Call in order to capture the information that they produce and link it to both the domain map and the e-Framework.

Recommendation 6: JISC should determine whether work areas are a sensible and sustainable way of exploring the higher education domain, and if so should there be built a consensus around an appropriate set of work areas and their sub-divisions.

Recommendation 7: The user interface to the domain map should be significantly enhanced, including the ability to show more information on screen and greater detail for printing.

Recommendation 8: The user interface should be further developed to enable users to input information to the domain map.

Recommendation 9: It is recommended that JISC put in place a process that would enable projects, analysts and others in the community to contribute to the domain map.

Recommendation 10: JISC should consider funding further population of the domain map, with an emphasis on the areas of Learning and Teaching, Research and Libraries and Information Management

Recommendation 11: It is recommended that the e-learning maturity model be incorporated into the domain map in order to provide additional ways of understanding the higher education domain and to make the e-learning maturity model more widely available.

Recommendation 12: A process driven knowledgebase for Service Oriented Architecture (SOA) be developed, as an extension of the HE domain map, to support developers in producing elements for the e-Framework and for SOA in their own institutions.

Scenarios

In this section we illustrate some of the uses for the domain map that we have created, which demonstrate the breadth of scope for the domain map and some of the ways that it could be utilised. A number of other scenarios (used in the interim report) are outlined much more briefly in Appendix 1: Usage scenarios.

The scenarios are, inevitably, somewhat forced as we have made them reasonably brief to allow them to show some of the ways that the domain map can support work across the sector. The first scenario shows the domain map being used to support the work of a business analyst considering the replacement of a student record system. The second scenario is based on the work of JISC, starting with defining a programme and working through to a programmer writing a set of services to implement an application.

All the screen shots used to illustrate the scenarios are actual screen shots with data from within the domain map. However there are currently very few service usage models (SUM) defined within the e-framework so that we have invented a few in order to illustrate how the domain map relates to the e-framework.

Scenario 1: A Business analyst - replacing the Student Record System

The University of Wigan is a medium sized university that recently merged with Warrington College of Higher Education and needs to unify the various systems found in the two institutions in order to fully merge the universities and achieve economies of scale. Both of the institutions had well established systems that, over the years, had been customised to handle local practices. As part of the merger process it was recognised that processes would have to change and that a new student record system (SRS) would have to be acquired and implemented across the joint institution. In order to achieve the greatest benefit it was agreed to undertake a detailed requirements analysis across both the old institutions looking at existing processes and how they could be improved, and the functionality that would have to be provided by the new SRS.

In order to do this the University appointed a business analyst with a brief to:

- Investigate existing processes,
- Propose improvements to the processes,
- Recommend the scope of the new system,
- Outline key concerns in the development or implementation of the new system.

This would then be followed by a more detailed specification of requirements which would be incorporated into an invitation to tender to supply the new system.

The first task for the business analyst is to talk with a variety of stakeholders about their interest in the system, what they are doing, why they are doing it, how the current system supports their workflow and ways in which they believe the workflow could be improved.

In order to support this, the business analyst first needs to brief himself on the scope of student record systems and secondly devise some aids to support his discussions with stakeholders. To gain an overview of student record systems he goes to the domain map, and using applications as his entry point selects the student record system.

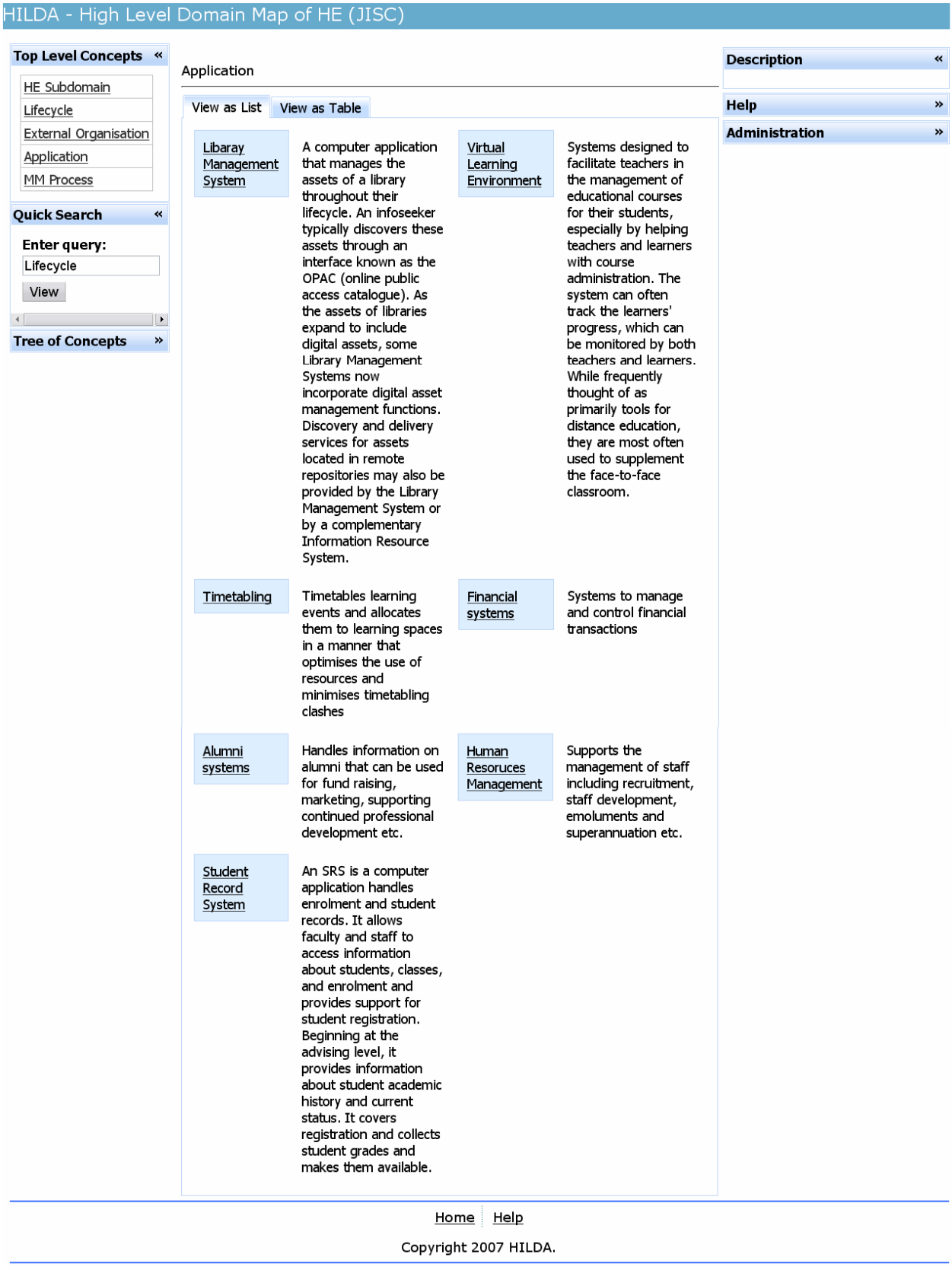

Figure 2: Applications view of the domain map

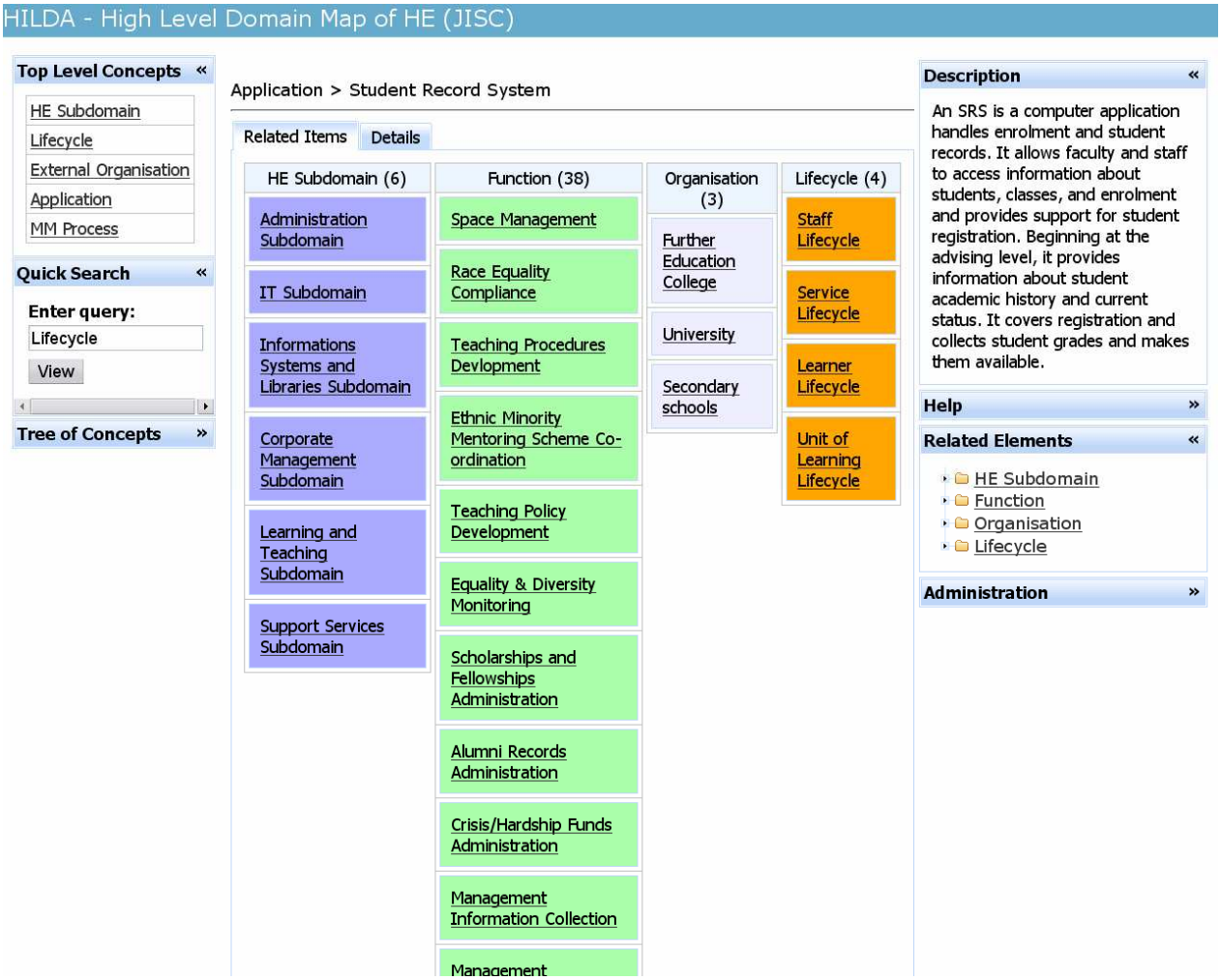

Figure 3: Overview of Student Record System

This immediately gives him an overview of the application by showing which work areas (HE Subdomains in the current model) in which it is used, the life-cycles that it supports and the functions that it needs to support once deployed, and the external organisations from which it will receive information, or to which it will send information. On the details screen he can also see which other applications at the University of Wigan the SRS will have to interact with.

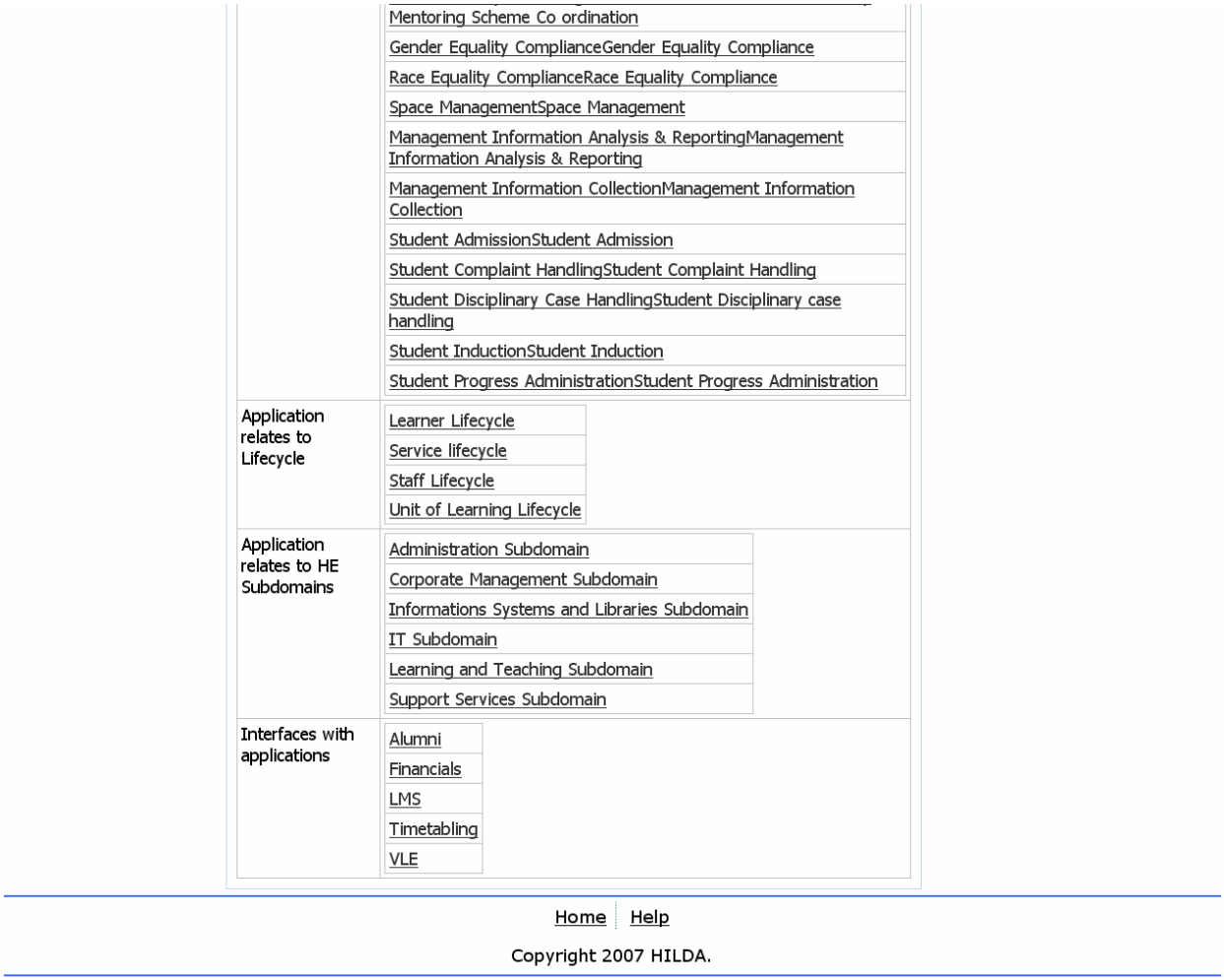

Figure 4: Detail screen from the Student Record application showing which other applications it needs to interact with.

This high-level overview will form a useful starting point for some of his discussions, so he prints the view, together with a more detailed one which prints the description for each item with that item (not currently available).

One of his first people he is able to talk to is the head of admissions. For this he thinks that it might be appropriate consider the admissions process from the learners' point of view, and thus to use the "aspiring learner" and "admissions" phases of the learner life-cycle and approach the discussions from there. He therefore looks at life-cycles:

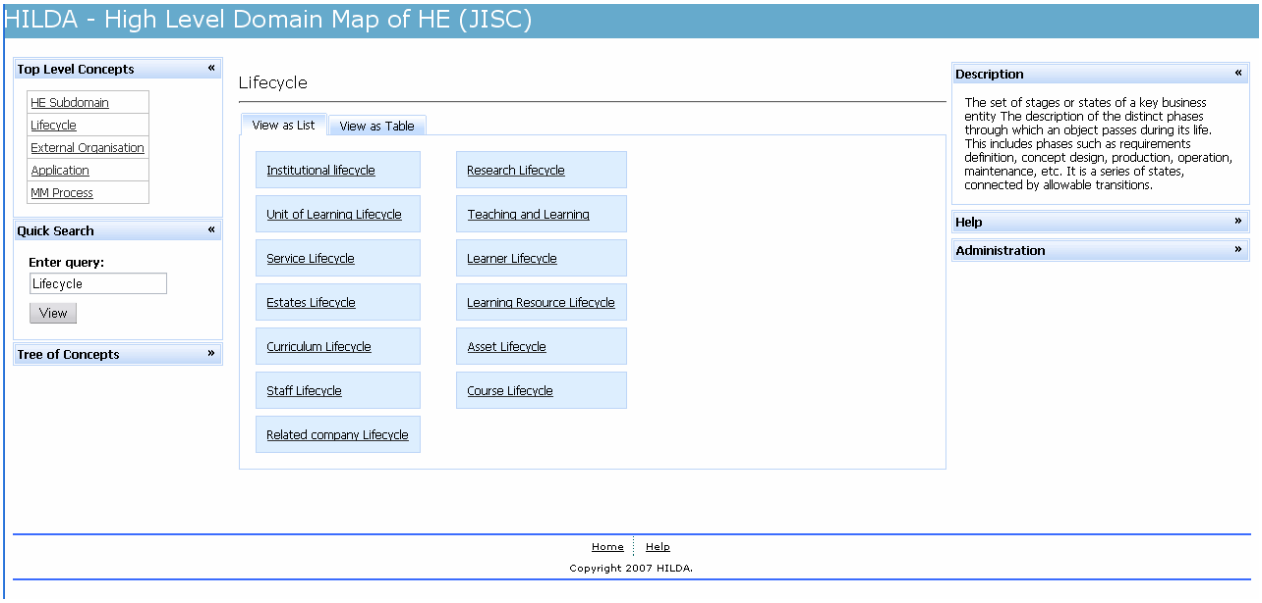

Figure 5: The life cycles in the domain map

and selects the learner life-cycle:

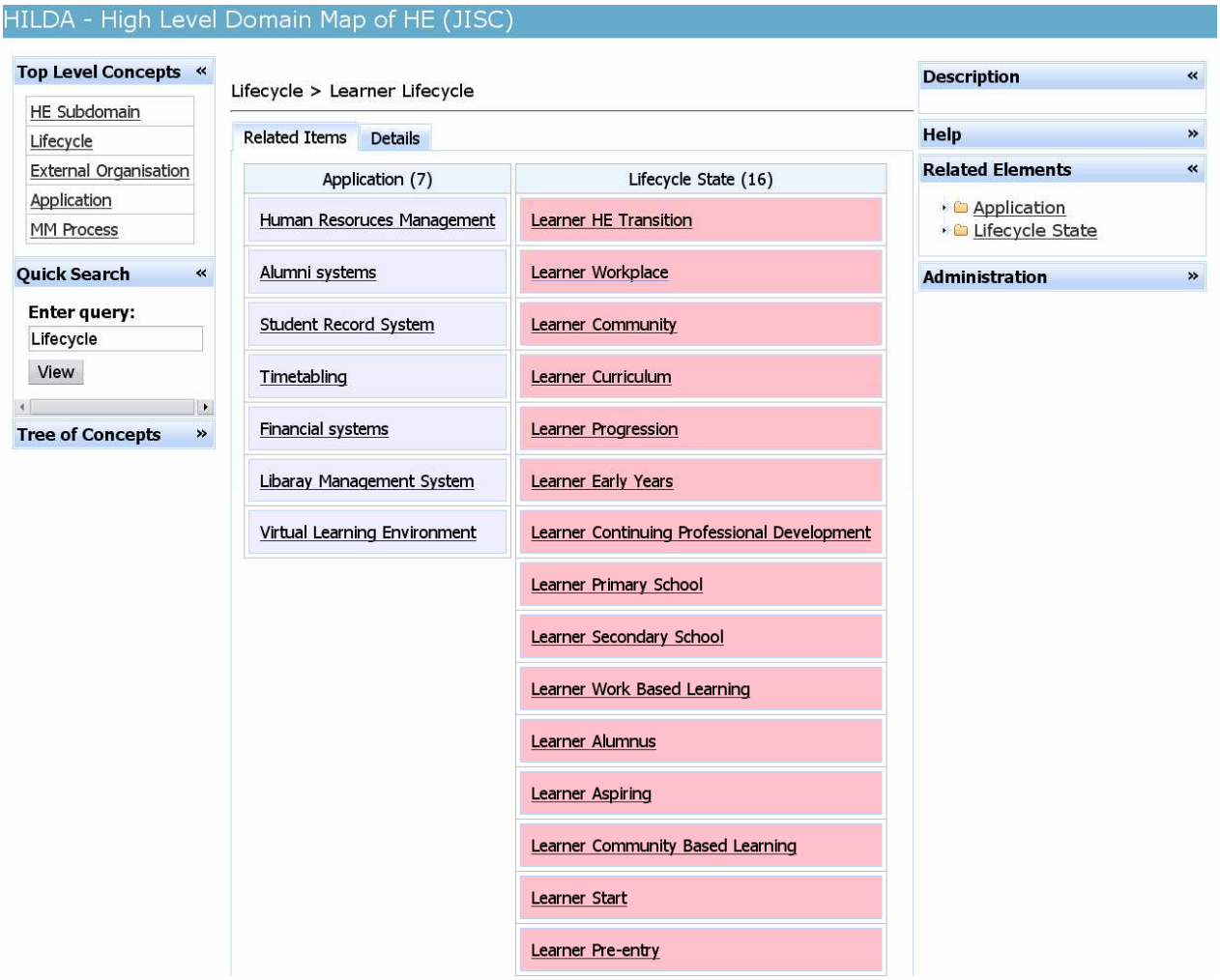

Figure 6: The Learner life-cycle showing the life-cycle states within the life-cycle, and the applications associated with it

which shows the applications that support the learner life-cycle, and the various states within the life-cycle. (At this stage they are shown as a simple list, but with a little more work it would be possible for them to be arranged as a cycle as each state records the possible subsequent states in the cycle).

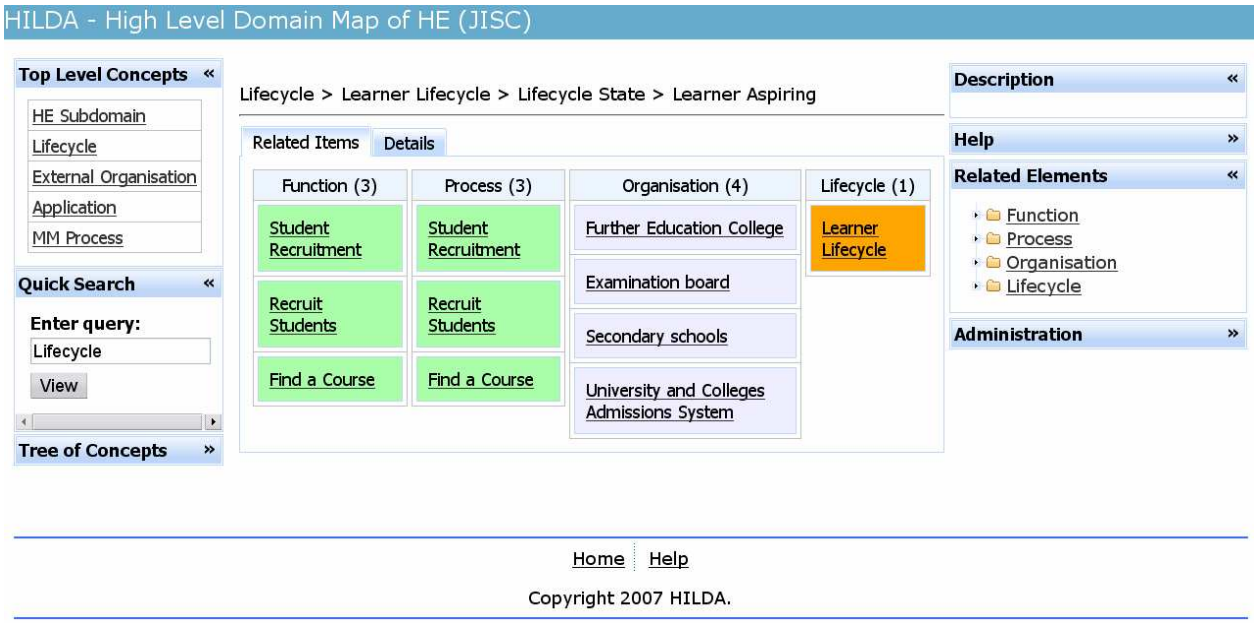

Figure 7: Aspiring Learner Life-cycle State showing functions, processes and external organisations

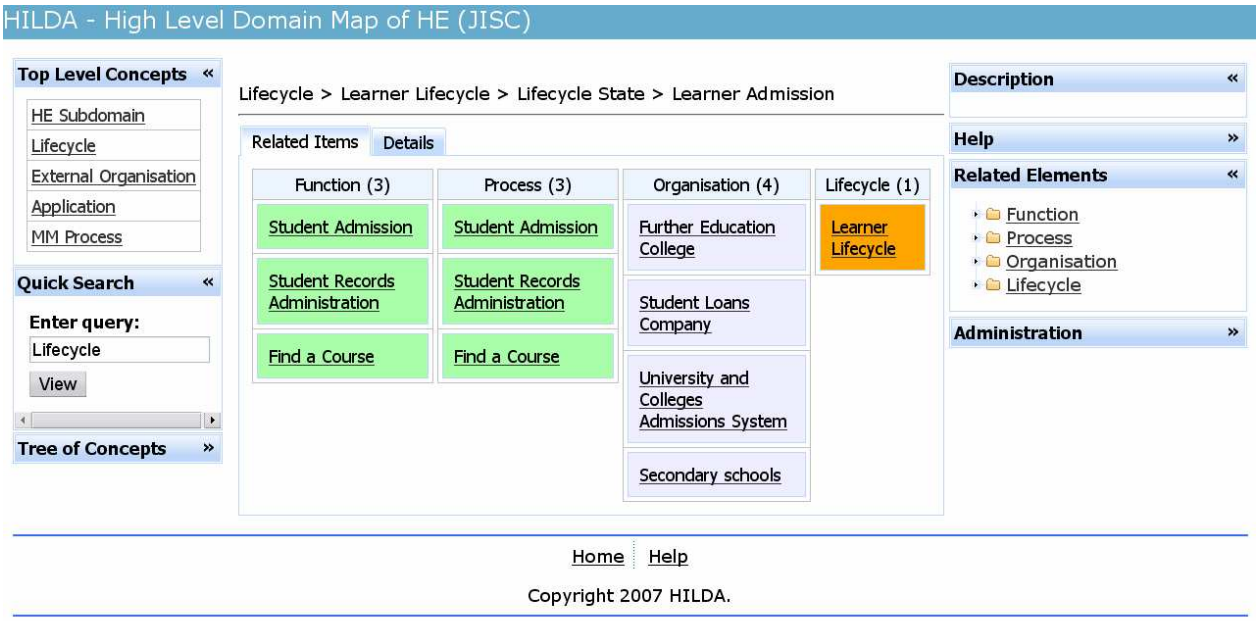

Figure 8: Admissions Life-cycle State showing functions, processes and external organisations

He can see the functions, processes and external agents (organisations) that are involved in, and prints the view (both summary and detailed) for use in discussion with the Head of Admissions.

As an aside it may be worth saying that function describe what people or systems do to achieve their goals. How these functions are carried out is shown in its processes. Each possible process for a function comprises flows of activities that show how the function is undertaken. The work areas, applications, life-cycles and external organisations are then ways in which these functions can be grouped together to facilitate understanding.

Our business analyst can also drill down and look at the functions that support each life-cycle state and processes that implement them.

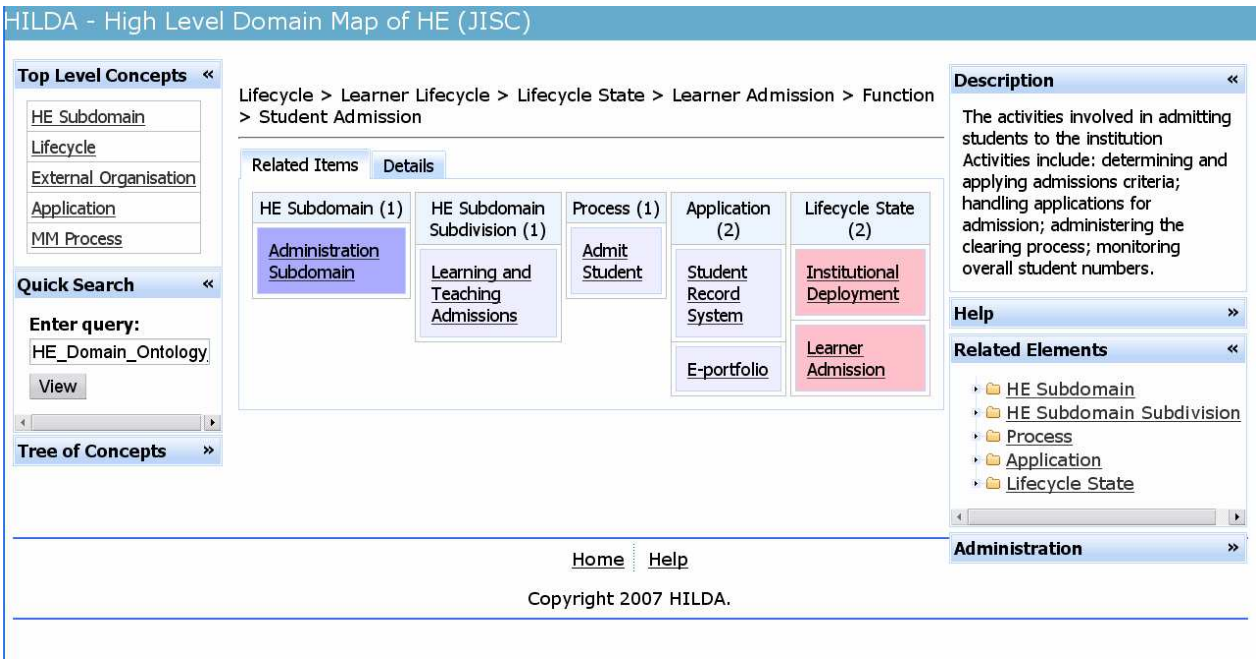

Figure 9: Student admission function. Note the explanatory description

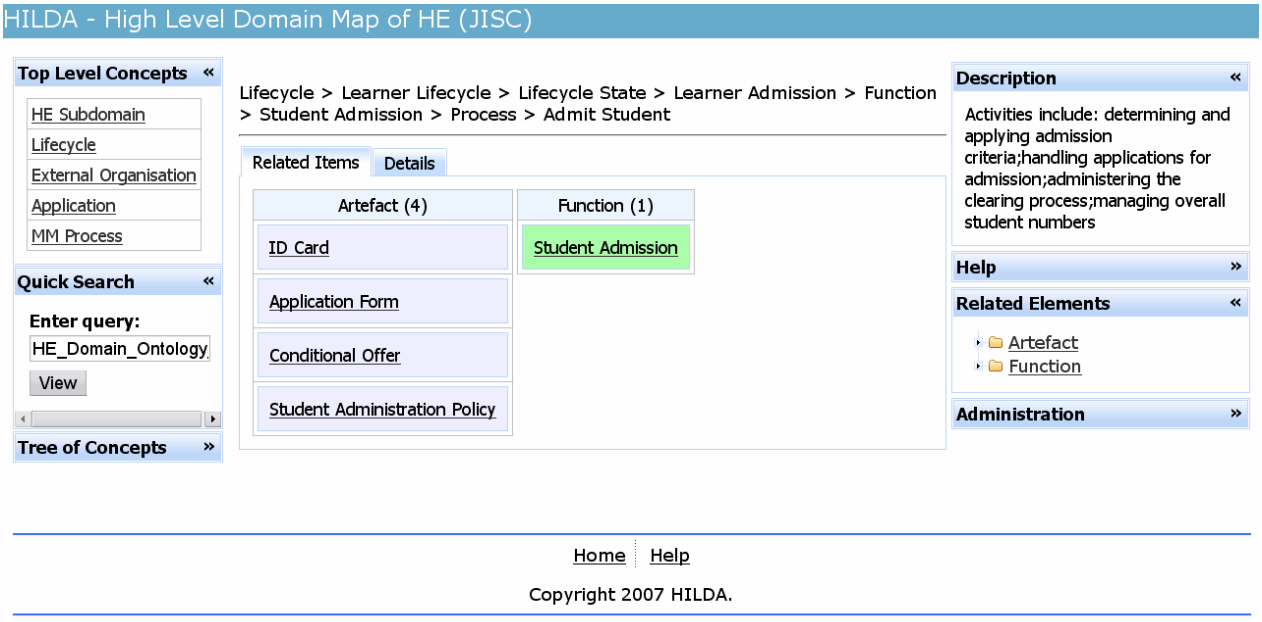

Figure 10: Admit student, one of the processes in the student admission function

Each function and process can be viewed in this way, and form the basis of a discussion about practice in the university, and what is needed in order to either support or enhance current practice.

This can be repeated for the various people that the business analyst needs to see. The use of the domain map will give a greater coherence to their analysis because much of the analysis has already been done (albeit in a generic or canonical manner) for them to build on and because they will have a framework in which all the discussions and analysis can take place, and a variety of ways in which the ideas and relationships can be discussed. Different views may be appropriate for different people. For instance, when discussing applications with IT staff it might be appropriate to use the application view, and to be considering the relationships between the various applications and the data flows between them and the standards that are needed to support this.

Using the model, our business analyst can understand the flows of data between the various systems, the relationships with external organisations (for instance UCAS for admissions and HESA for reporting) and the standards that are needed to support those communications.

From there they would be able to look at the functions that the student record system needs to support and the interactions and data flows between them. For instance, taking the admissions process, they can see that data has to be taken from UCAS in particular ways and passed to particular groups of people for processing within the university before returning information to UCAS for processing by them.

Once the business analyst has determined the scope of the application, he can begin to explore the functions that it needs to support in greater detail. Some of these may be common across the sector and be specified in the domain map already, others may be specific to the University of Wigan and may need to be recorded as such. We envisage that the University of Wigan could take a local copy of the domain map and record in it the results of analysis, and local variations from the model; they could also feed back into the generic model results that are of wider interest, or where the model is incomplete.

Processes can then point to service usage models (SUMs) within the e-framework; although we have not included this level of detail as there are currently just five SUMs within the e-framework:

- Blog
- Early Notification
- Identity and Access Management (IAM)
    - MAMS - Federated IAM
    - Authenticated Harvest.

For a more detailed treatment of SUMs see Appendix 2: The Domain map's model: Reference Model View

Once the business analyst has determined the scope and functionality of the application, a specification for the student record system may be produced. The domain map can support this work by showing all the functions and processes involved, and the dependencies and data flows between them. It might also be possible using the domain map to identify services which could be used to build the application.

Programmers building the system can use the domain map to get an overview of the system that they are building, which can help them to build a more robust system whose interfaces work better. They could also use the domain map to identify SUMs in the e-framework, and from there they may be able to locate actual working services that they can employ in developing the system.

Scenario 2: Defining a JISC programme

It should be noted that the scenario is not entirely realistic in order to keep it brief. In particular it ignores many of the processes that are not currently instantiated in the domain map such as writing committee papers, securing funding and discussions with colleagues. The domain map does cover these people-processes as well as software-processes and when real scenarios are detailed for the map, they will include both types.

This scenario is based on the assumption that the Department for Innovation, Universities and Skills (DIUS), in conjunction with the Department for Children, Schools and Families (DCSF) has just announced that e-portfolios are to be a key area for development in order to ensure that transition across the areas covered by the departments are integrated from the learners point of view. Clearly, there is already work proceeding in this area, some of which stems from the requirements from the Department for Education and Science. As a result of the initiatives from DIUS and DCSF, HEFCE gives JISC £2.5 million to help the sector to make effective use of e-portfolios to support progression into and from universities. It is likely that Becta would be involved in the work too as it involves schools as well as colleges and universities. However, for the sake of simplicity, Becta can be ignored for the purpose of this scenario.

A programme manager, Michelle, is given the task of drawing up a proposal to go to the JISC Committee for Learning and Teaching for a programme to put this into effect, which should include a draft invitation to tender. While Michelle has some familiarity with e-portfolios, and knows many of the key players, such as the Centre for Recording Achievement, she wants to think about how they fit in with other university processes and therefore what might be useful work for JISC to fund.

She thinks that there are three ways that she could tackle the use of e-portfolios to support admissions.

- the applications that support e-portfolios,
- the admissions process,
- the use of e-portfolios in learning and teaching.

In order to get a better idea she decides to use the domain map to explore each of these approaches and get a better understanding of the problems that universities are facing in making effective use of e-learning.

First she turns to the domain, which offers four ways of exploring the higher education domain: by work areas (sub-domain), by application, by life-cycle and by external agent. Each of these approaches is relevant to e-portfolios, and she decides to start with work areas, and in particular with the learning and teaching work area, which shows a number of sub-areas.

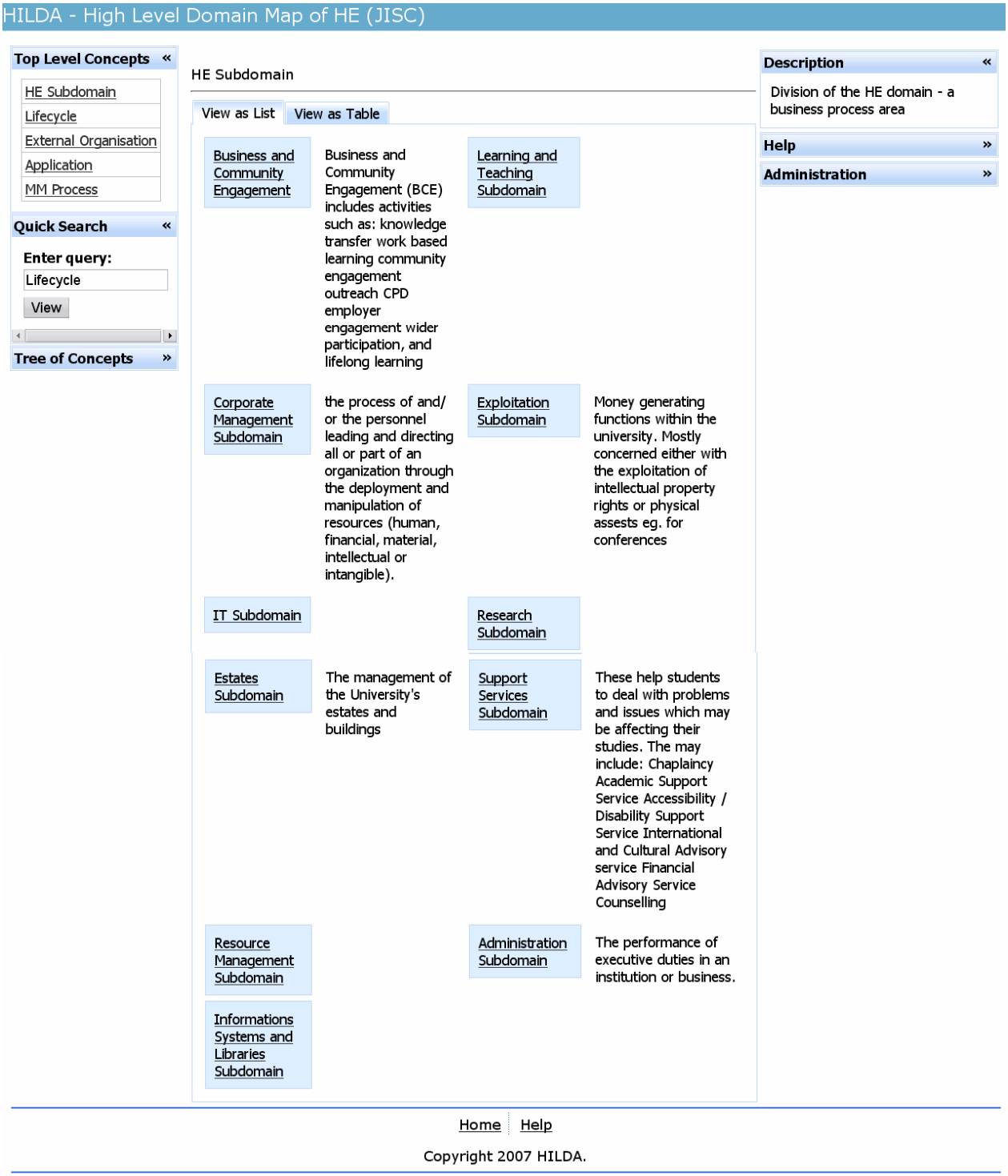

Figure 11: The work areas in higher education

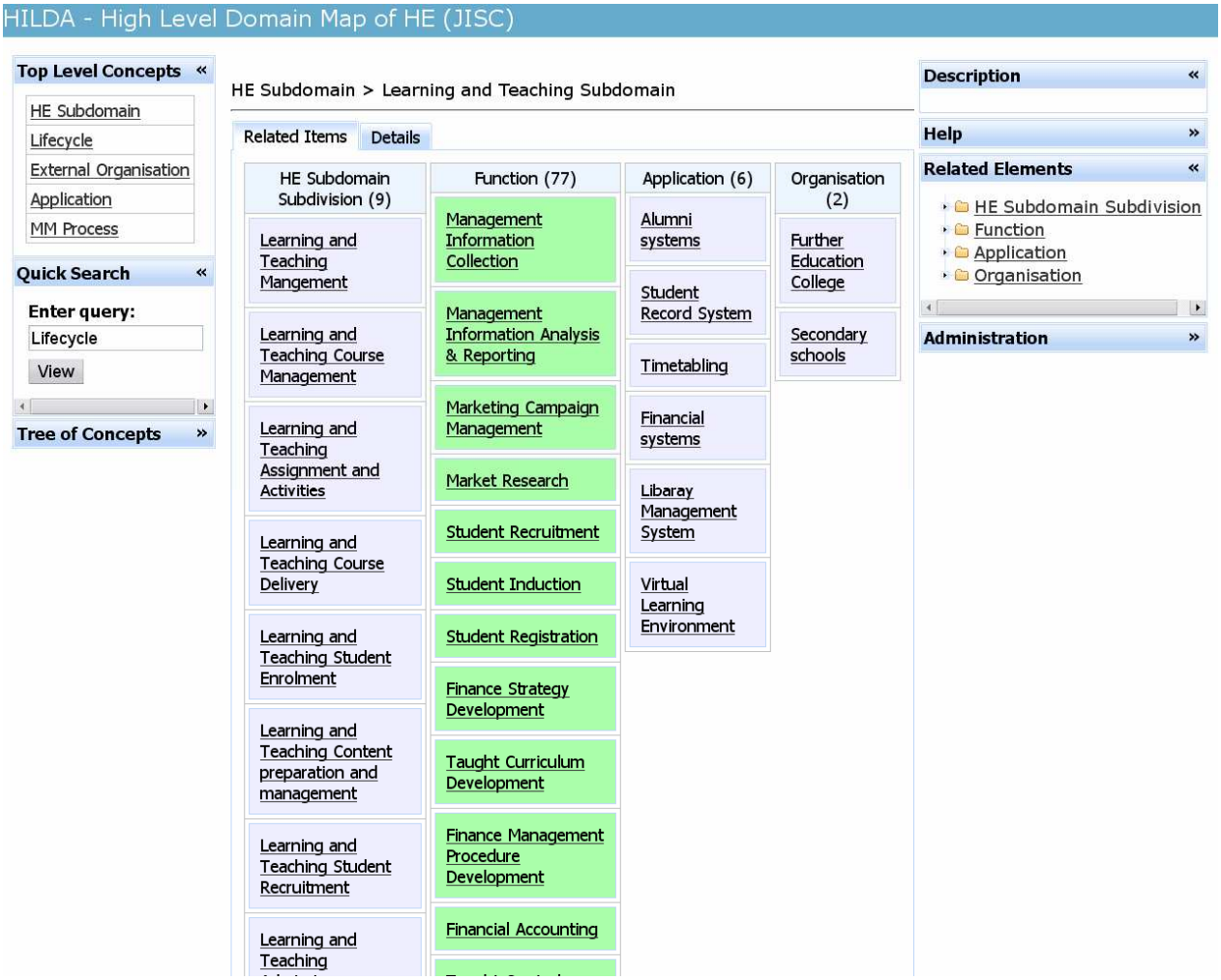

Figure 12: The learning and teaching work area showing the subdivisions of the work area, functions, applications and external organisations

She spots student applications as one of the sub-domains of learning and teaching, and as she is particularly interested in the use of e-portfolios to support transition from schools and colleges to universities this seems an admirable place to start.

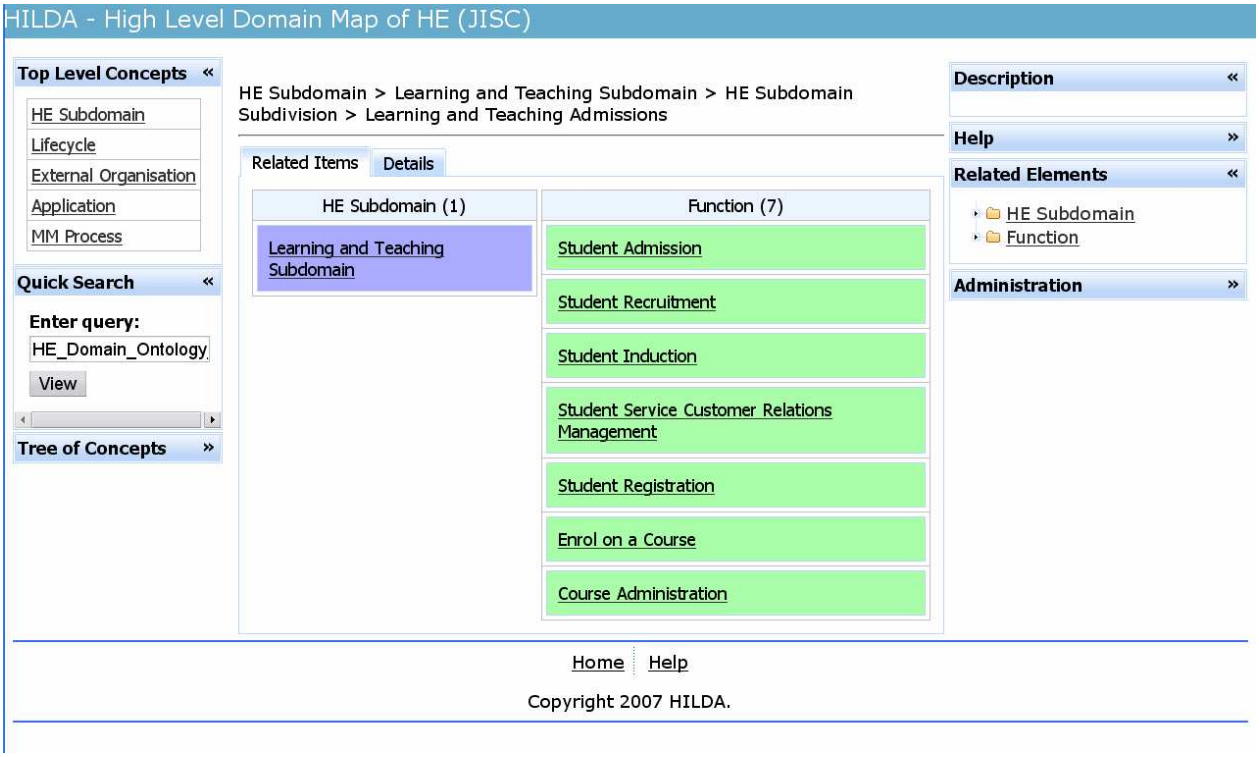

Figure 13: The admissions sub-area of the learning and teaching work area

From there she can drill down to the student recruitment function.

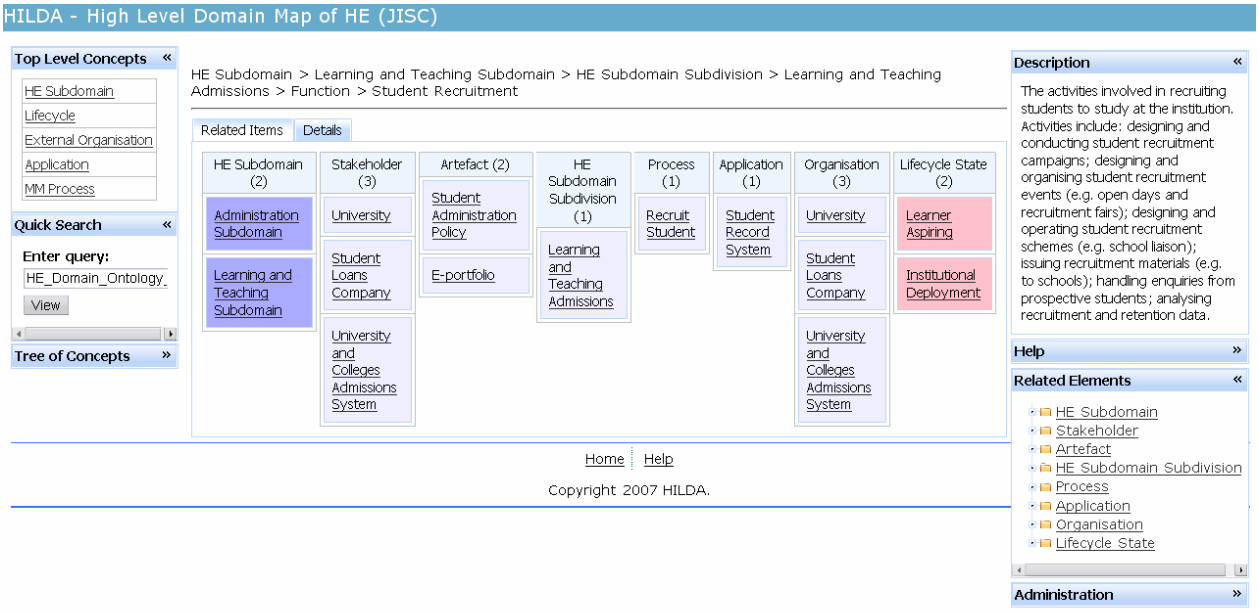

Figure 14: Student admission function

Michelle also looks at the e-portfolio application view

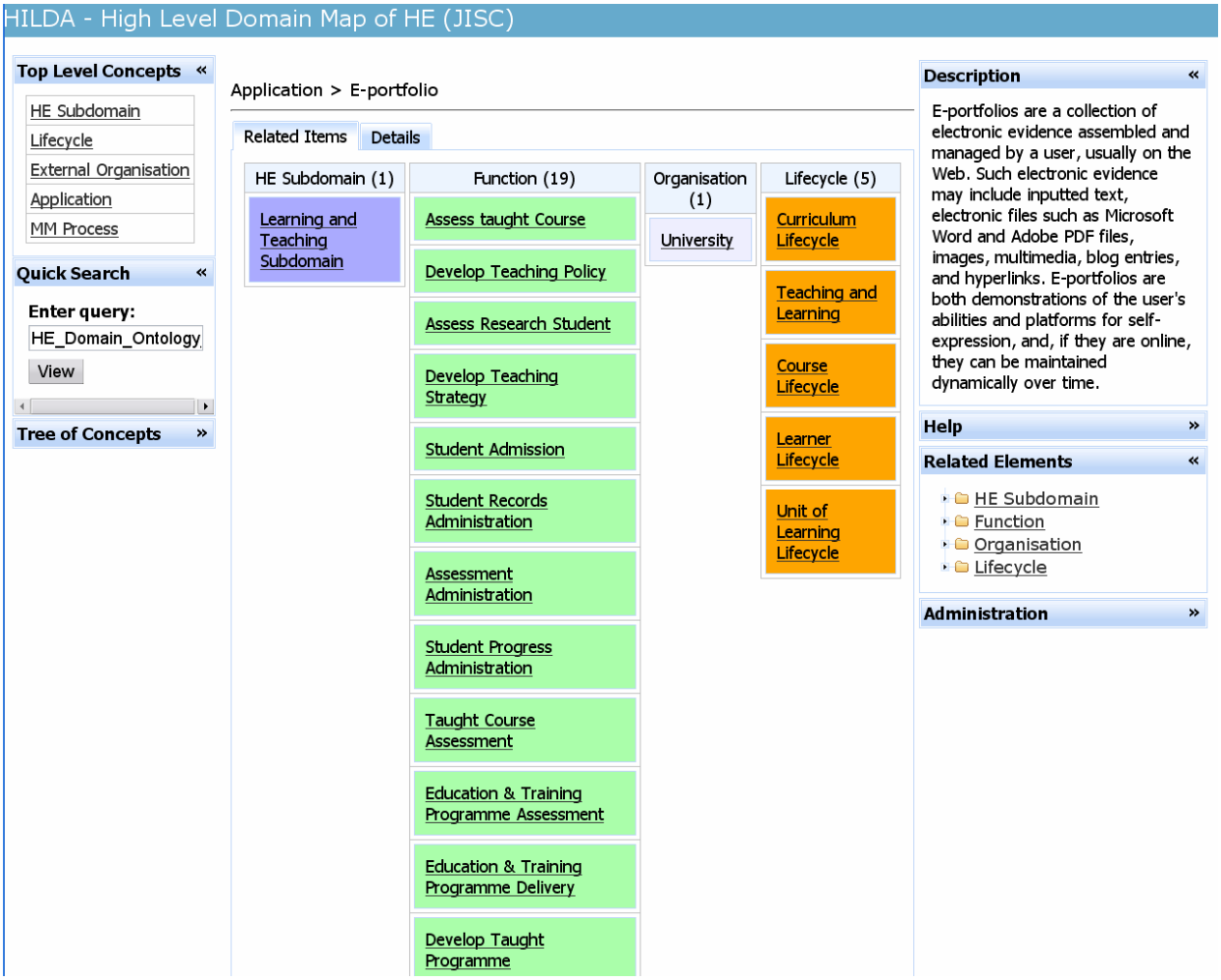

Figure 15: e-portfolio application showing work areas, functions and life-cycles

She discovers that many of the functions listed have not been worked out in detail and decides that one useful activity would be to develop a canonical model of the student admissions process, with particular reference to the use of e-portfolios.

She also notices that there are no service usage models for the evaluation of e-portfolios and therefore decides that the bulk of the money should be used to develop tools, and the supporting SUMs that can support the automation or semi-automation of the evaluation of e-portfolios.

Conclusion

These two scenarios have shown some of the ways in which a domain model can support work in universities, and the work of JISC, however we have identified a number of other stakeholders and some of the uses that they might make of the domain map which are shown in the table below:

Stakeholder	Uses
JISC stakeholders	
JISC Programme managers	• Enhancing their understanding of higher education • Understanding the e-framework • As shown in Scenario 2: Defining a JISC programme by identifying gaps, bottlenecks etc. • Monitoring and recording projects or programme activity • Promoting the work of JISC by increasing its visibility
JISC Committee members	• Understanding the e-framework • Understanding how proposed work relates to existing work. • Identifying gaps or bottlenecks
Project bidders	• Contextualising bids within the domain • Identifying work already done that they can build on • Identifying gaps that they wish to address
Project staff	• Enhancing their understanding of higher education • Contextualising the project within the domain • Locating existing work • Publicising / promoting their work
E-Framework project staff	• Enhancing their understanding of higher education • Enhancing their understanding of the e-framework • Providing better access to the e-framework • Providing a tool for promoting the e-framework • Relating the e-framework to other related work
Institutional Stakeholders	
Business analysts	• Enhancing their understanding of higher education • As shown in Scenario 1: A Business analyst - replacing the Student Record System support analysis within their institution • Support for discussions with stakeholders in a project • Provide a framework for analysis • Provide a framework for recording and analysis • Help locate work already done elsewhere
IT staff Systems Staff	• Enhancing their understanding of higher education • Enhance their understanding of the relationships between various applications • Support their understanding of functions and processes • Provide a means for locating suitable service implementations

Stakeholder	Uses
Staff Developers	• Enhancing their understanding of higher education • Provide a tool that can be used to help others understand the complexity of a university, and contextualise their work
Non Institutional Users	
Standards Bodies/Institutes	• Understand important data flows that might be better supported by standards • Ensure that standards being developed meet all appropriate needs
Open Source Developers	• Enhancing their understanding of higher education • Enhance their understanding of the relationships between various applications • Help them to locate existing work that they can build on
Commercial Vendors	
Software Developers	• Enhancing their understanding of higher education • Enhance their understanding of the relationships between various applications • Help them to locate existing work that they can build on
Enterprise Management Solution Providers	• Tool which they can map their system to in order to demonstrate the functionality provided
Sales People	• Tool for visualising functions that can be used to show the functionality that they offer • Tool for showing how they interoperate with relevant applications • Tool for showing how they interoperate with relevant external agents

Figure 16: Table of stakeholders and uses of the domain map

Having looked at some of the uses of the domain map we now turn to the data that we have included in the domain map before looking at the model that underlies the domain map and the ways in which it can be visualised.

The data in the domain map

To be useful a domain map needs to contain detailed information on the domain in question, in this case higher education. The model needs to contain a number of different types of information and show the relationships between them.

The key elements in the current version of the model are:

- **Function** - The function describes what the people or systems do to achieve their goals. The function will contain processes that show how value is obtained from that function for the business actors.
- **Processes and sub-processes -** 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. 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
- **Application** - Computer software that employs the capabilities of a computer directly on a task that the user wishes to perform.
- **Life-cycles and life-cycle states -** The description of the distinct phases through which an object passes during its life. This includes phases such as requirements definition, concept design, production, operation, maintenance, etc. It is a series of states, connected by allowable transitions.
- **External organisation** - Organisation outside the boundary of the university that interact with it. The interactions generally involve exchange of information. This information specification contribute to the domain information model.
- **Work areas (domains) -** In general, a domain is an area of control or a sphere of knowledge, identified by a name. It is an area that defines a set of common requirements, terminology and functionality..
- **Roles -** 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.
- **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.

A full list of the element and their definitions can be found at Appendix 2: The Domain map's model: Glossary, and a discussion of the model can be found at The model underlying the domain map and Appendix 2: The Domain map's model.

Having designed the model, it then needs to be populated with information from a variety of sources. The ITT listed about ten different potential sources, of which three proved particularly useful and these are discussed below. See Appendix 4: The use of data sources in the ITT for a discussion on why the other sources were found to be less useful.

JISC Infonet Business Classification Scheme

JISC infoNet have produced a Business Classification Scheme (BCS)[3] which provides a generic "map" of the functions and activities undertaken by HEIs which was designed to form the basis of the institution's file plan. As such it focuses on those processes which produce records that need to be archived, and relates strongly to their Records Retention Scheme.

[3] http://www.jiscinfonet.ac.uk/partnerships/records-retention-he

As the user guide for the BCS[4] puts it:

A Business Classification Scheme is a conceptual representation of an organisation's business. It describes an organisation's business functions and activities, and the relationships between them.

- **Functions** are the largest units of business activity. They are the major responsibilities that are managed by an organisation to fulfil its mission or mandate, and its responsibilities to its stakeholders.
- **Activities** are the tasks performed to accomplish each function.

The basic components of a Business Classification Scheme are:

- a hierarchical classification structure, with the top level containing the broadest categories of activity (i.e. functions) and the lower levels becoming increasingly specific (i.e. activities and their component parts);
- scope notes which define the scope of the categories.

A more detailed Scheme may also include:

- date ranges for functions and activities;
- 'For' references which clarify the relationships between functions and activities;
- definitions of terms used in the Scheme.

We have found the BCS an extremely useful starting point, but believe that it is lacking in a number of ways, which it may be worth listing here, but are discussed more fully in the section on proposed future work.

- Completeness of coverage - The BCS describes over 500 functions, in some areas going into great detail, whilst in others coverage is somewhat sketchy. In particular the BCS is very strong on the business processes, but comparatively weak on learning and teaching and research. Thus, learning and teaching accounts for just 18, and research 17 functions out of over 500 in the classification, compared to 84 for corporate management and 150 for corporate resources.
- Detail - the BCS only lists functions (and indicates a small number of processes - which it calls activities).
- Relationships between the functions are not recorded.
- It is simply a list with no way of visualising it.

The e-Learning Maturity Model

The complete set of the Process Areas, Processes and Practices were taken from version 2.3 of the e-Learning Maturity Model (eMM) framework and entered into the domain map. The eMM framework elements are related to other elements in the domain, allowing a practice view of teaching and learning, and the things that need to be in place for teaching and learning to be carried out. As a general guideline, an eMM practice is usually at a similar level of granularity as an HE domain map sub-process, the eMM process as process and the eMM Process Area as HE subdomain.

The JISC Reference model projects

The reference model development projects that were carried out as part of the early work on the e-Framework, provided an opportunity to test the ability of the HE domain map to 'go all the way down' from a high level business view of HE to a detailed design and coding of particular HE-

[4] http://www.jiscinfonet.ac.uk/partnerships/records-retention-he/hei-rrs-user-guide

supporting services. Two of the five models were taken as data sources at this stage: COVARM (Course Validation Reference Model) and FREMA (e-Framework Reference Model for Assessment). Both these models contained all the elements needed to go from descriptions of functions in their areas of concern down to specification of services and their aggregation into groups to support the functions, the Service Usage Models (SUMs) required by the e-Framework. The reference models provide an additional of view onto the domain map and a bridge to the e-Framework. Some examples of data from this aspect of the domain are given in Appendix 2.

Other sources

A number of other sources have been used because they were available and help to illustrate particular points. These include:

Embedding Excellence in Higher Education

Embedding Excellence in Higher Education brought together the learning gained from applying and embedding the principles of excellence in Higher Education in the Good Management Practice project, part funded by the Higher Education Funding Council for England (HEFCE), which looked at how the use of the European Framework for Quality Management (EFQM) Excellence Model could bring about improvements in organisational effectiveness in institutions.

Personal knowledge

In order to demonstrate how the domain map could work we have put in a small amount of information based on our own knowledge and experience of universities and the university system. This information is certainly not complete, and may not be completely correct. Taking the domain map further would require locating other sources of information and using them, and working with universities to develop the map further.

Areas that we have put data in from our knowledge include:

- defining a selection of the work areas and sub-areas.
- listing a selection of the major applications used in higher education.
- listing some of the external agencies and agency types that universities work with.
- classifying the business functions against life-cycles, work areas, applications and external agents.

As this the current domain map is intended as a proof-of-concept we have not been able to be completely systematic (and we are aware that there are currently large gaps), nor have we had time or resource to validate any of the data.

Further work

This project is primarily a proof of concept and production of an initial model and map of higher education, and as such we will not have captured a complete model within the project. There are a number of steps that will be needed to make the data in the model sufficient. These include:

- Identifying additional existing sources of information and incorporating them in the model. We would suggest working with the P-SPEX and ADoM projects as a starting point, and note that the P-SPEX project is already considering how it can use the domain map in its work.

- Connecting the model to the e-framework wherever data allows. This will provide a useful form of understanding the e-framework at a higher level and an additional form of navigation for users.
- Scoping out the creation of additional data where the model is incomplete and suitable sources do not exist, and then commissioning analyses of those areas of work in higher education that have not been sufficiently analysed to incorporate into the domain map.
- Enhancing the existing data. For instance, it may be helpful to annotate the relationships in the model.
- Work with the new Enterprise Architecture projects to be funded under the JISC Capital Call[5]
- Develop the relationships between the various entity types in the domain map. That is, many of the functions are not currently assigned to appropriate work areas, applications etc.
- Consider enriching the model to include, for instance, standards that can be used to support the exchange of data between applications.
- Build a detailed information model of the core entities identified as being required and produced by the core functions and processes; and those involved in the interaction of the HEI with external organisations.

Recommendation 1: Domain model projects, such as P-SPEX and ADoM, should consider using the domain map as way of making their results available in a common, widely usable form.

Recommendation 2: JISC fund work to identify additional sources of information that can be incorporated in the domain map, and add the information to it. These should address both (static) information elements and functional (behavioural) elements within HE's concerns.

Recommendation 3: Wherever possible the domain map should be connected to the e-framework, and in particular the e-framework editors should incorporate links to service usage models into the domain map as SUMs are added to the e-framework.

Recommendation 4: JISC should organise an expert workshop to validate the model underlying the domain map, and to recommend any appropriate changes to it before significant additional work is done to the domain map.

Recommendation 5: JISC should fund a project to work alongside the Enterprise Architecture projects to be funded under the JISC Capital Call in order to capture the information that they produce and link it to both the domain map and the e-Framework.

[5] Circular 02/07: Capital programme call for projects http://www.jisc.ac.uk/fundingopportunities/funding_calls/2007/07/circular0207.aspx

The model underlying the domain map

What Is A Domain Map?

In the early stages of the project the team debated at length the question of just what precisely is a Domain Map. This called for review of material produced both by JISC and JISC funded projects. Additionally we looked beyond JISC and the HE domain in order to develop our understanding of the Domain Map concept.

The project now has a working definition of a Domain Map with specific meaning in relation to a Domain Model.

Some Definitions

While the terms used here address concepts we found it useful to visit some basic definitions for the words we are using. These are (slightly abridged) from the OED:

Domain: *A sphere of activity or knowledge.*

Map: *A two dimensional diagram or collection of data showing the arrangement, distribution, or sequence of something.*

A representation in abridged form; a summary or condensed account of a state of things; an epitome, a summation.

Model: *1) A three-dimensional representation of a person or thing, typically on a smaller scale.*

2) Something used as an example.

3) A simplified mathematical description of a system or process, used to assist calculations and predictions.

With particular attention to Models, we are familiar with models such as a scale model used by an architect (def 1), or an economic model for forecasting (def 3). Likewise the concept of reference models (def 2) is used elsewhere in JISC[6].

We should also consider the concept of a Domain Model as used in Object Oriented Analysis and Design. For this we have a definition sourced from Martin Fowler[7]:

Domain Model: *An object model of the domain that incorporates both behaviour and data.*

This describes a specific use of the term “domain model” that has a degree of relevance to this project.

Domain Maps and Domain Models

Much of the project teams’ debate about what a Domain Map or a Domain Model could be focused on the commonality and differences between the concept of a Map versus a Model This debate was conducted within the terms of reference established by the work of JISC. A further

[6] http://www.elearning.ac.uk/features/refmodels2
[7] http://www.martinfowler.com/

dimension that provides a rich area for review is whether or not one predicates or negates the need for the other.

While it has to be stated that the project team remains partially divided about these questions, for the purposes of the project the following conclusions have been accepted:

- A Domain Model is a necessary foundation on which a Domain Map can be built.
- A Domain Model is sufficiently complex that that the Domain Map provides a gentler approach to accessing the Domain Model data at a sufficiently high level of abstraction that it can aid planning.
- A Domain Model is essentially a knowledge base
- A Domain Map is visualisation of that knowledge base

On this basis a Domain Map is predicated on the availability of a suitably rich Domain Model (knowledge base) along with the means to subsequently visualise it. Therefore the Domain Map does not negate the need for a Domain Model; rather it is built upon it.

The Domain Model can “stand on its own” for individuals who work directly with the knowledge base. In other words, a Domain Model does not of necessity require a Domain Map.

The Domain Map is a tool that helps raise the level of abstraction while reducing apparent complexity presented by the Domain Model and is primarily intended to broaden the potential audience and uses of the knowledge base.

Domain Model – Knowledge Base

The construction of the Domain Model has drawn heavily on object oriented analysis and design techniques to allow a rich, formal definition of entities and their relationships. In this sense the underlying model exhibits many characteristics that might be aligned to the definition above from Martin Fowler.

Domain Map – Navigation Aid

The Domain Map is a visualisation of the underlying model designed to at once:

- Simplify exploration of the model
- Show the knowledge contained in the model at a level of abstraction that facilitates planning.

Domain Maps not built on a Domain Model

This section has thus far presented the majority conclusions of the project team and is deemed appropriate for the project after ongoing consultation with JISC.

The debate regarding Map versus Model did raise other possibilities, though no firm proposals were produced. In particular there is a possible view that a Domain Map might not be built on top of a Domain Model. In this scenario rather than visualise a knowledge base the data is maintained as part of the map. There are several approaches that might be taken, these include a simple drawing of the topic areas within higher education which could be abstracted from either a structural or a process based perspective. Some examples of at least part of this have been produced, including the New Zealand Education Sector Standing Committee’s ICT Strategic Framework for Education and Education Sector Architecture Framework (see Figure

55 and Figure 56) and functional decompositions such as those produced by the Indiana University electronic records management strategy: revisited[8]

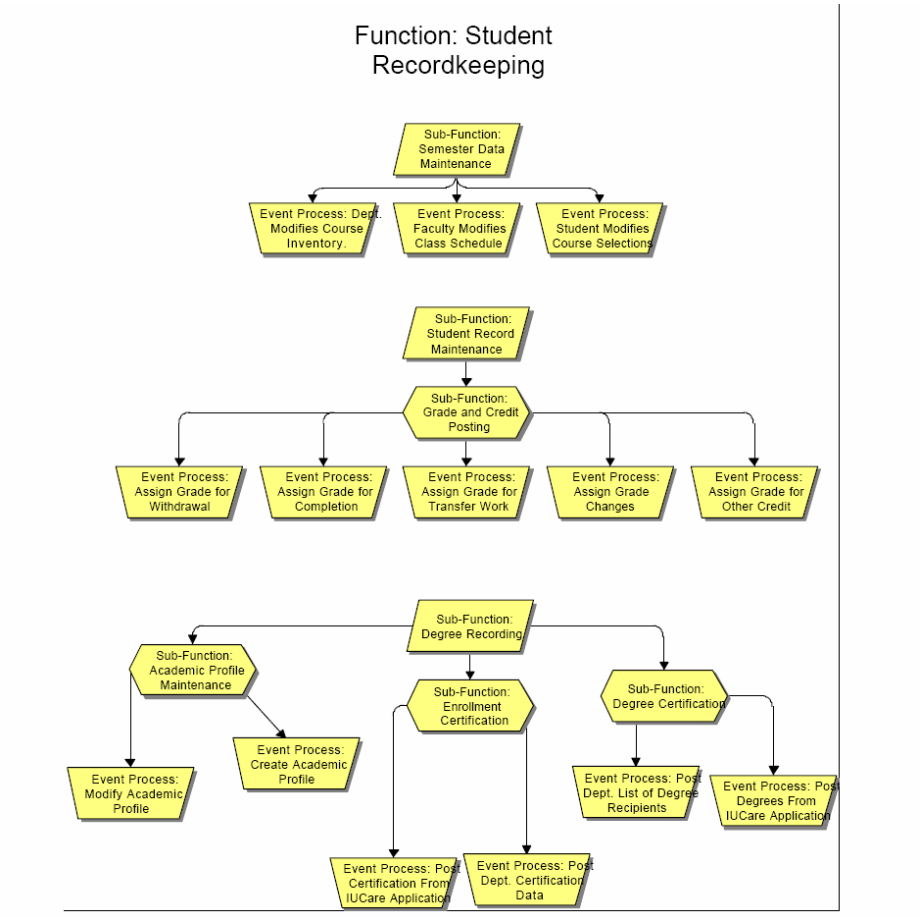

Figure 17: Functional decomposition of student record keeping

While this approach is believed to merit examination, it has not been possible to develop these ideas within the scope of this project.

The benefit of this approach could be a less complex entity underpinning the Map which could be made more targeted (against planning) and agile (in terms of not needing the domain model to function) solution that might be more easily used to explore the HE domain. However, the appeal to the majority of the project team of the Domain Model as Knowledge base, the lack of data to develop such an approach in the suggested sources and the lack of time to develop a compelling alternative, led to the dismissal of this approach to constructing a Domain Map. The conclusion reached was that should such an approach exist then it is something other than a Domain Map.

[8] http://www.indiana.edu/~libarch/ER/lettered6.pdf

Visualisation of the model

As has already been suggested, higher education is complex, and any model or map must reflect some of that complexity if it is to be useful. While the map is intended to be a simplification that is widely comprehensible it cannot hide all the complexity if it is to provide people with an understanding of the educational domain. The visualisation, therefore, cannot hide all the complexity; what it can do is to provide a way in which people can explore and understand the domain **more easily** than would be possible otherwise. This is a critical point. For users to gain anything from the map they are going to have to invest time and effort in understanding it, just as they would have to spend time and effort understanding what a piece of countryside is like from studying an ordnance survey map. We provide a more detailed discussion of visualising with maps, and other approaches to creating domain maps in Appendix 5: Visualisation and domain maps

Visualising the domain map

We believe that a map is a tool to support navigation and that a layered approach is needed, which can guide the user through the underlying model to enhance their understanding of the higher education system.

Given that the map is an aid to navigation around the model of higher education we have been looking at ways in which this can be supported. There are several aspects of visualisation that we need to discuss.

The purpose of visualisation is to enable the user to locate the information that they are seeking, and to contextualise it within the larger landscape. Thus, it needs to present the information in a manner that is sufficiently simple that users can easily grasp it, while at the same time being rich enough that they gain insight into the wider context.

We have developed four key ways of visualising the data; by work area (currently called domain in the screen shots), by life-cycle, by interactions with external agents and applications. We have also started to implement a view based on the maturity model discussed above. As we show below, they offer different opportunities for visualising and presenting the information to users.

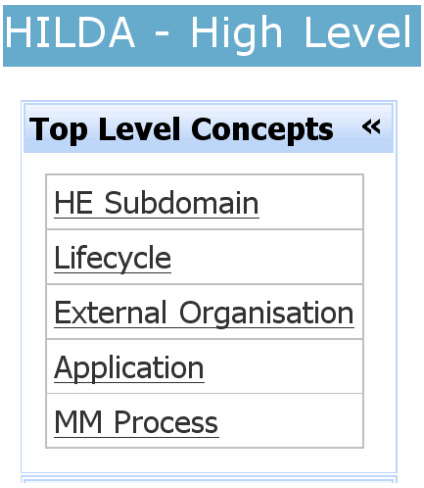

Figure 18: Five ways of visualising the domain map

Work areas (sub-domains)

The use of work areas (often referred to as domains or sub-domains, depending on the context) as a way of presenting the map was suggested in the invitation to tender and proposed in the consequent bid. While work areas are a 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 and visualisations since they do not easily decompose further into meaningful work areas sub-divisions that people will agree on. This is because they are ill-defined, with very strong the interdependencies between different work areas, that tend to be missed with this approach[9]. In other words, work areas and their decomposition into sub-divisions can be somewhat simplistic, and has the danger of encouraging "silo thinking". This is because decomposition does not allow us to capture the complexity and dependencies that exist between work areas.

Even the attempt of the e-Learning Framework's "brick wall"[10] to categorise components into layers as well as subdivide by area of concern, runs into issues of the 'size' of a brick and dependencies between its bricks. This approach has proved to have limited explanatory powers over the whole domain, and as more detail is added the picture becomes increasingly confused and difficult to explore.

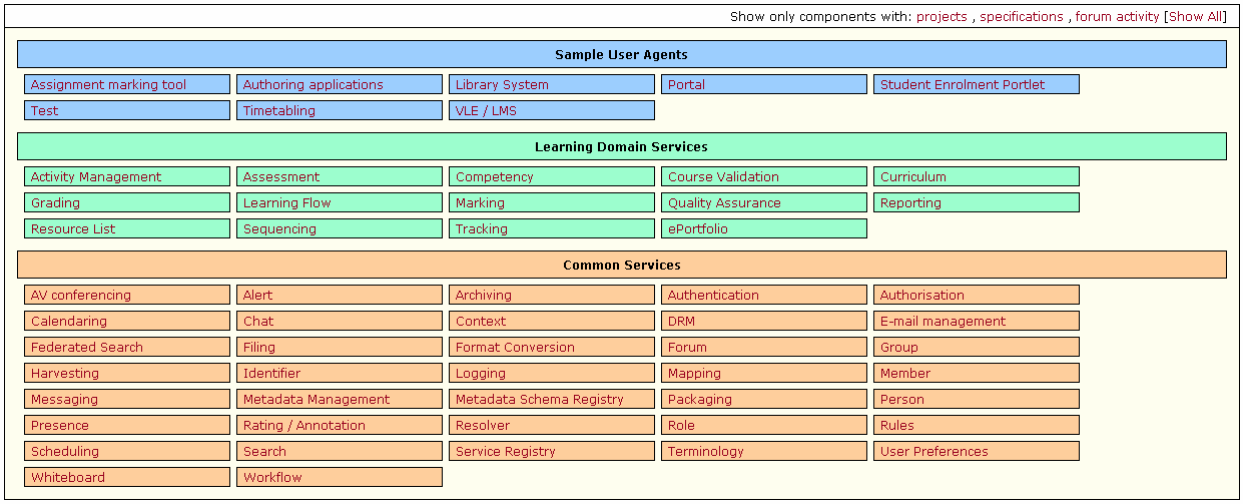

Figure 19: the e-learning framework

We have, in this project. decomposed higher education into ten overlapping domains:

- Administration
- Corporate management
- Exploitation
- Information technology
- Libraries
- Research
- Resource management

[9] We have had 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.

[10] http://www.elframework.org/framework

- Support services
- Teaching and learning
- Third stream

But many of the identified Functions will fit into several domains, for instance, research administration will fit into both research and administration and parts of it may also fit into resource management, information technology and libraries. A process such as the admission of a student into the university will involve administration and support services, but not teaching and learning.

At a simple level it is easy to conceptualise domain maps as a hierarchical form. In practice domain maps are likely to be much more complex and are likely to overlap. This overlapping can take multiple forms: Domain maps can share concepts, functions can cross domains, processes can go across domains. One danger of Domain Maps is that they revisit and possibly re-emphasise the vertical silo thinking of the early 1980s, a focus on process modelling may help avoid this pitfall.

However, it is worth attempting to create work area based views to discover how useful they might be, and Figure 20: the work areas in the domain map, shows the current work areas that we have included in the domain map, any one of which can be selected to see a more detailed view. We illustrate this with the learning and teaching work area, which amongst other things shows the work area sub-divisions that it can be decomposed into.

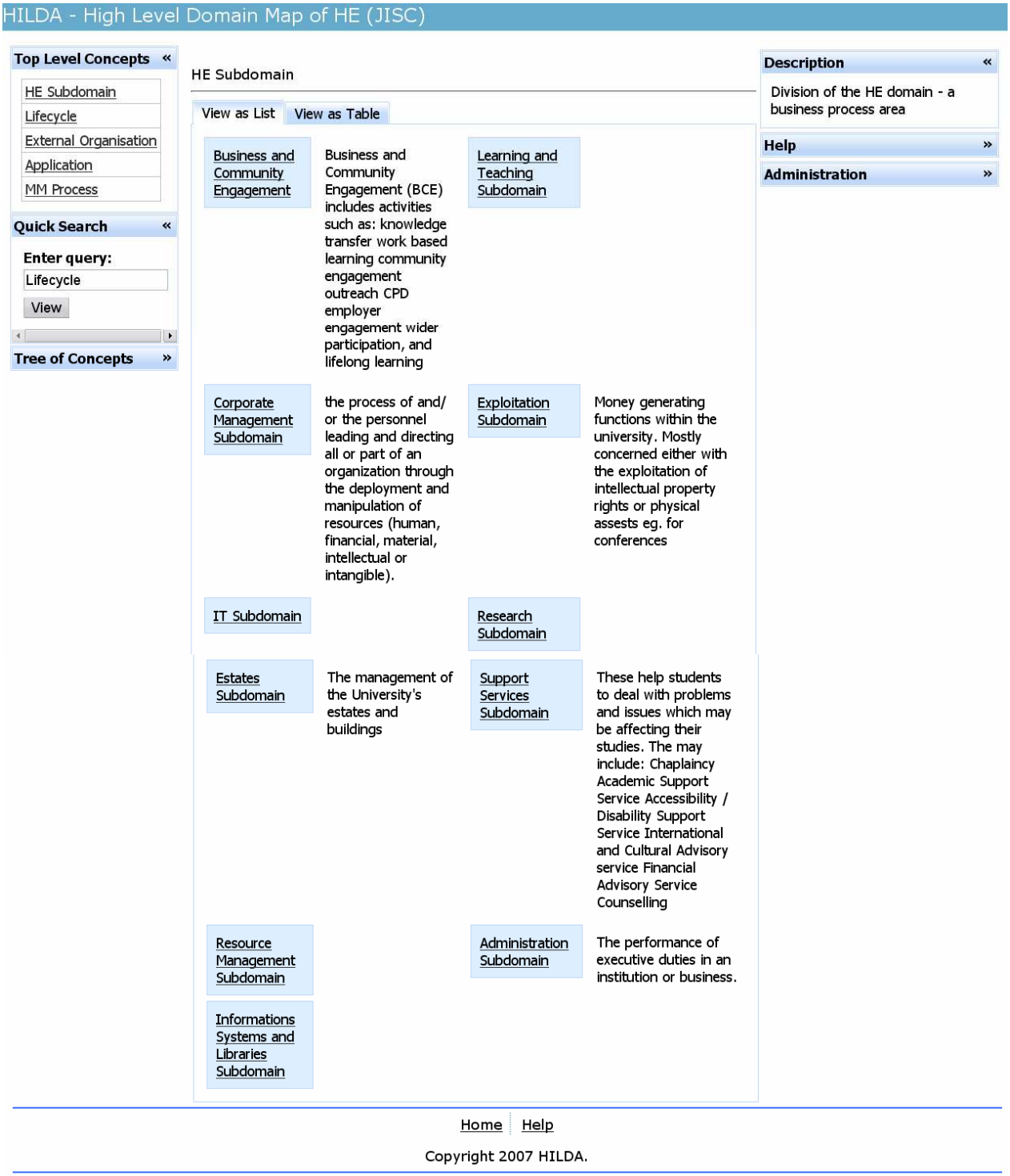

Figure 20: the work areas in the domain map

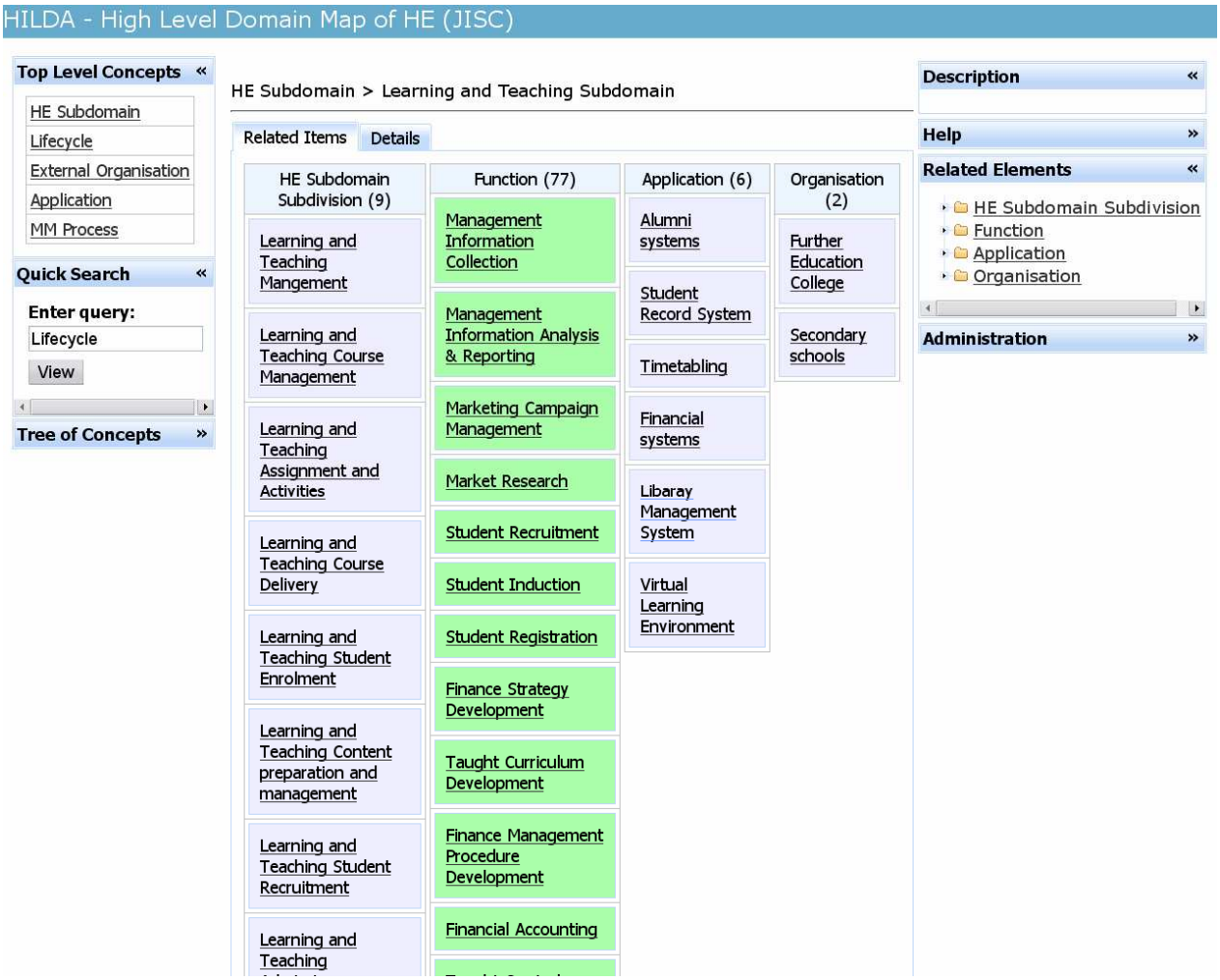

Figure 21: Learning and teaching work area - showing its sub-divisions and the functions within it, the applications that support it and he external organisations involved

We believe that the division of work areas into sub-divisions is problematic, as there are many different ways of approaching this depending on whether it is based on processes, roles or some other perspective. There is also the danger that one would end up with a map which defied easy comprehension, like some of those produced in the New Zealand Tertiary Architecture State Map. However, we have taken some of the work areas and tentatively broken them down into work area sub-divisions, as shown in Figure 23: The Course development area of the learning and teaching work area. We believe that considerably more work is needed here, in determining an appropriate set of work areas and sub-division of those areas and creating a consensus on the most appropriate ones.

Recommendation 6: JISC should determine whether work areas are a sensible and sustainable way of exploring the higher education domain, and if so should there be built a consensus around an appropriate set of work areas and their sub-divisions.

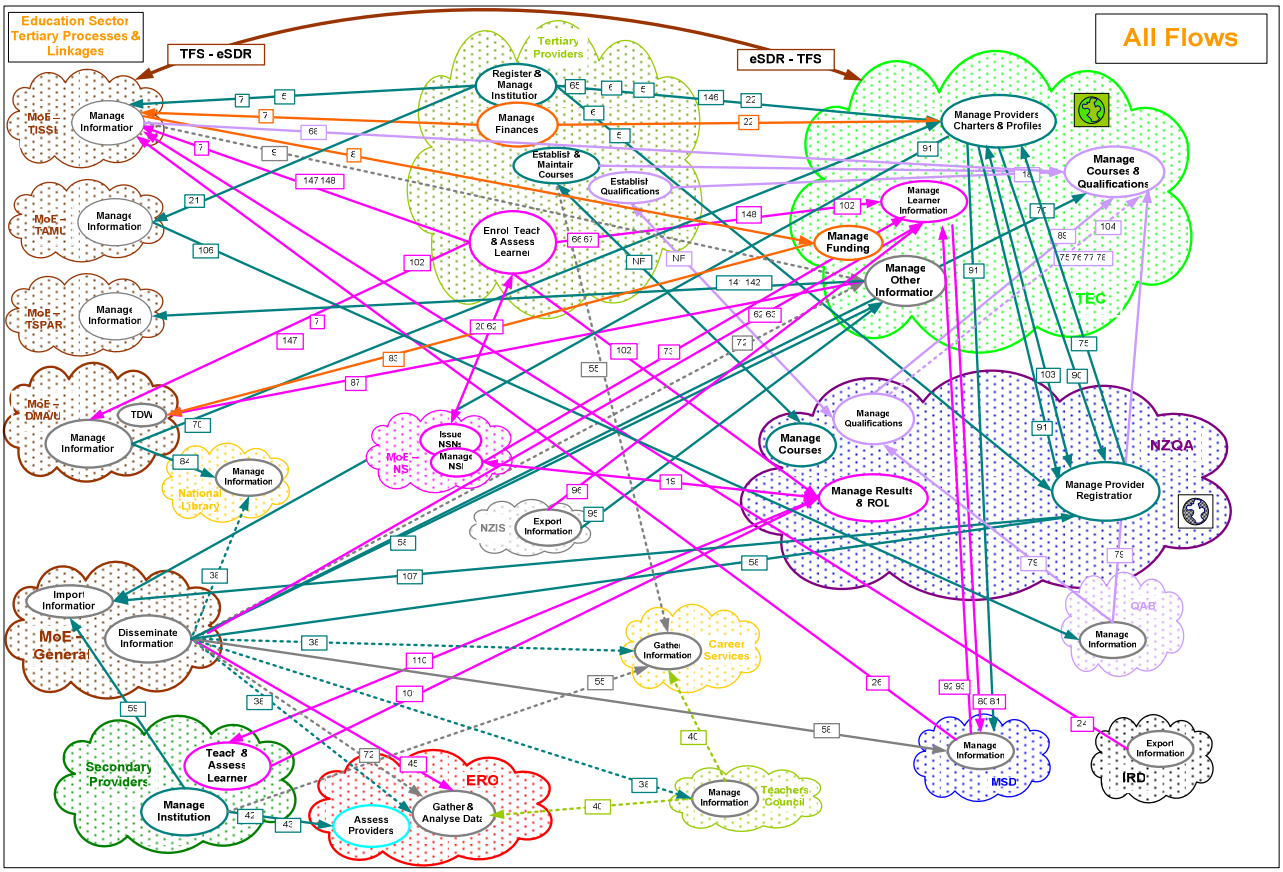

Figure 22: New Zealand Tertiary Architecture State Map

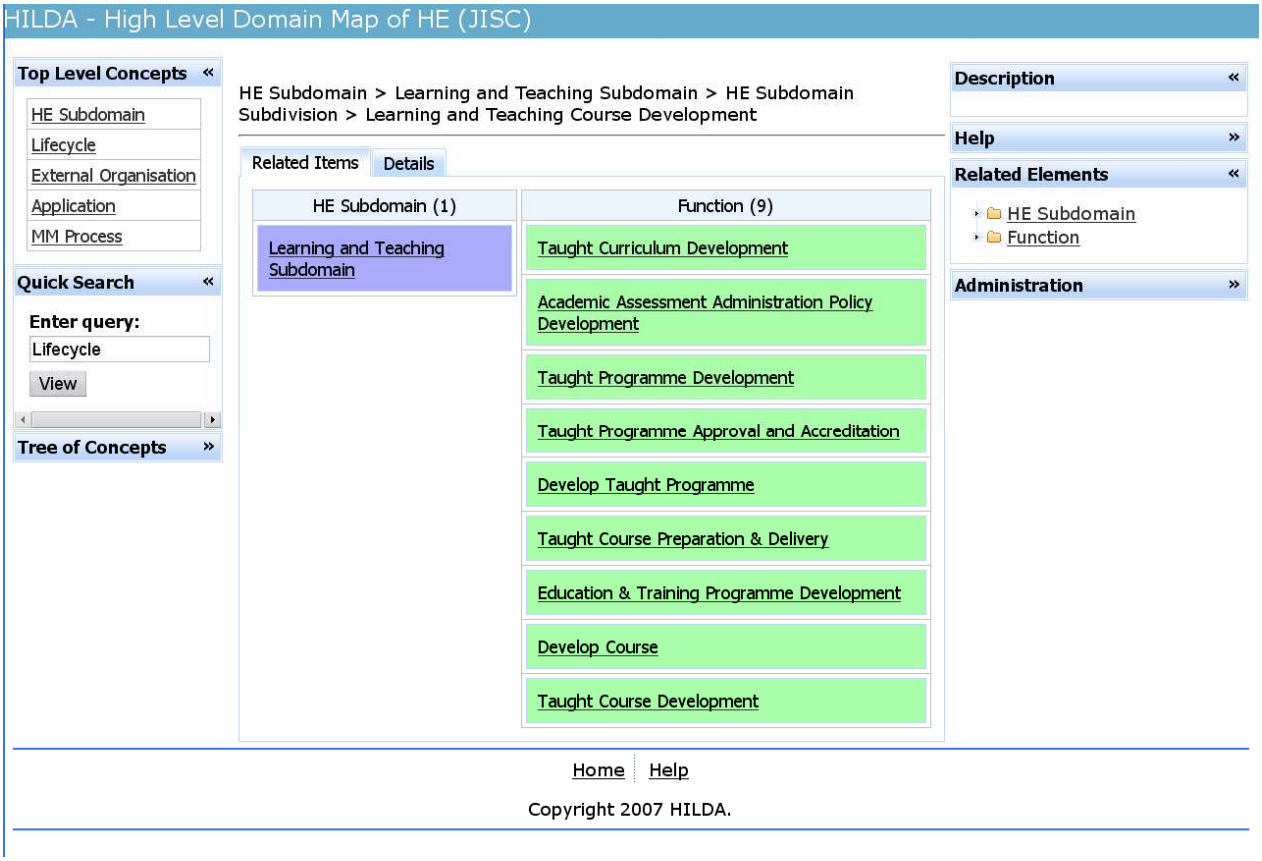

Figure 23: The Course development area of the learning and teaching work area

Life-cycles

A helpful way of thinking about the functions in any organisation, including universities, is in terms of life-cycles. While functions are self-contained, they do not stand in isolation, but are related to other functions within the university, and the use of life-cycles allows the user to quickly see the relationships, while not being overwhelmed with the complexity, in part this is because life-cycles can be naturally decomposed into a small number of life-cycle stages or states. Life-cycles come from the biosciences, and even quite complex ones like the malaria can quickly be understood with a little care. Further, this is an approach that has been taken by the JISC funded P-SPEX[11] domain map project, and therefore is likely to be productive in supporting visualisation of their work.

In higher education we have identified thirteen life-cycles so far:

- Assets
- Course
- Curriculum
- Estates
- Institutional
- Learner
- Learning resource
- Related companies
- Research
- Service
- Staff
- Teaching and learning
- Unit of learning

There may be some rationalisation of these (for instance course and unit of learning are likely to be collapsed together, as unit of learning encompasses course). Others may be discovered as we proceed. However it is possible to present these life-cycles in simple and meaningful ways to users, as demonstrated below. The following two diagrams illustrate how the life-cycles could be presented to the user, and then how the unit of learning life-cycle might look.

[11] http://pspex.tvu.ac.uk/wiki/index.php/Main_Page

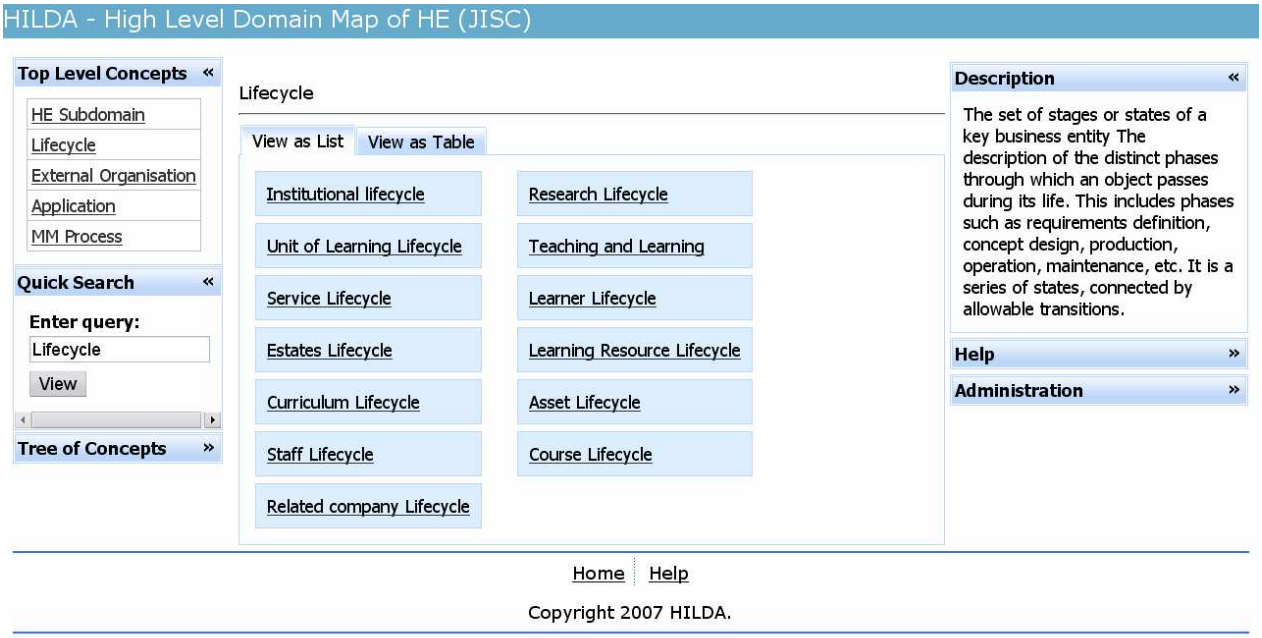

Figure 24: Life-cycles in higher education

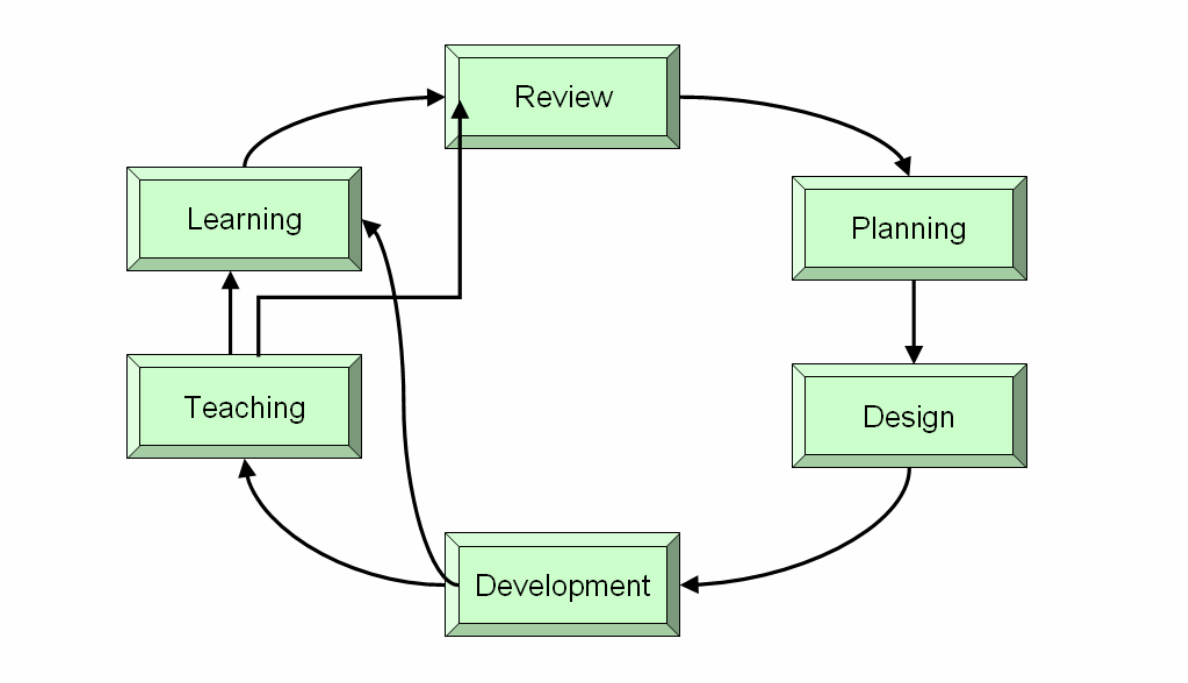

Figure 25: Diagram of the Unit of learning life-cycle

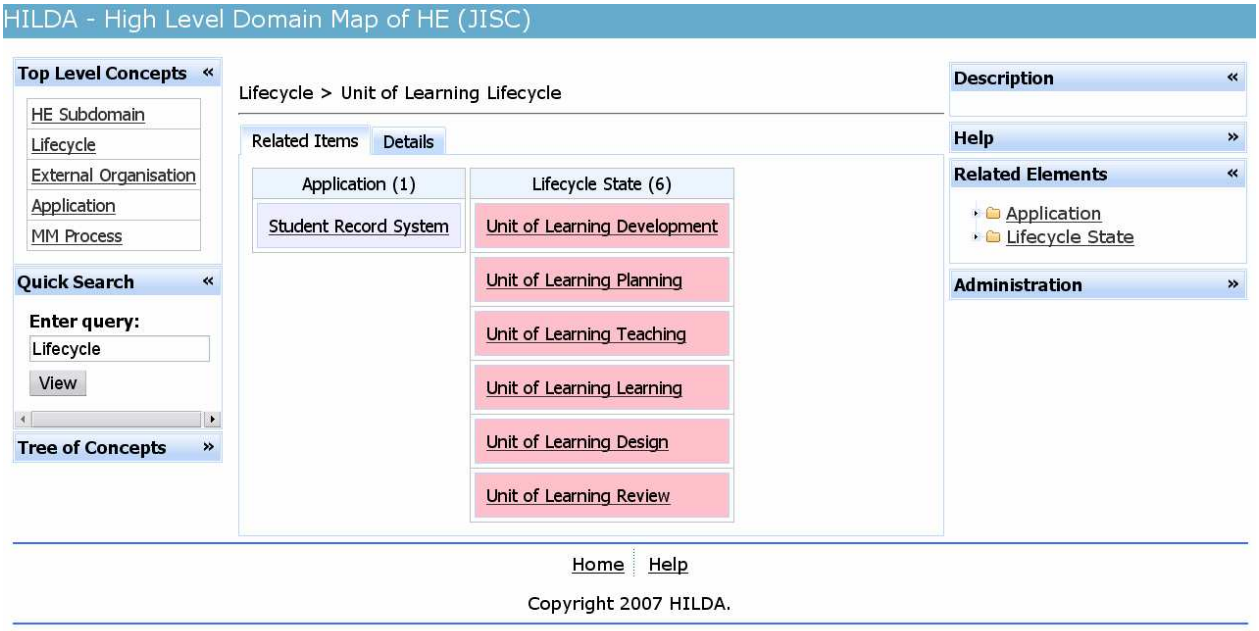

Figure 26: The Unit of Learning life-cycle

Some of the life-cycles are more complex, and we illustrate this with a UML diagram of the learner life cycle, and show how it is currently displayed in the domain map.

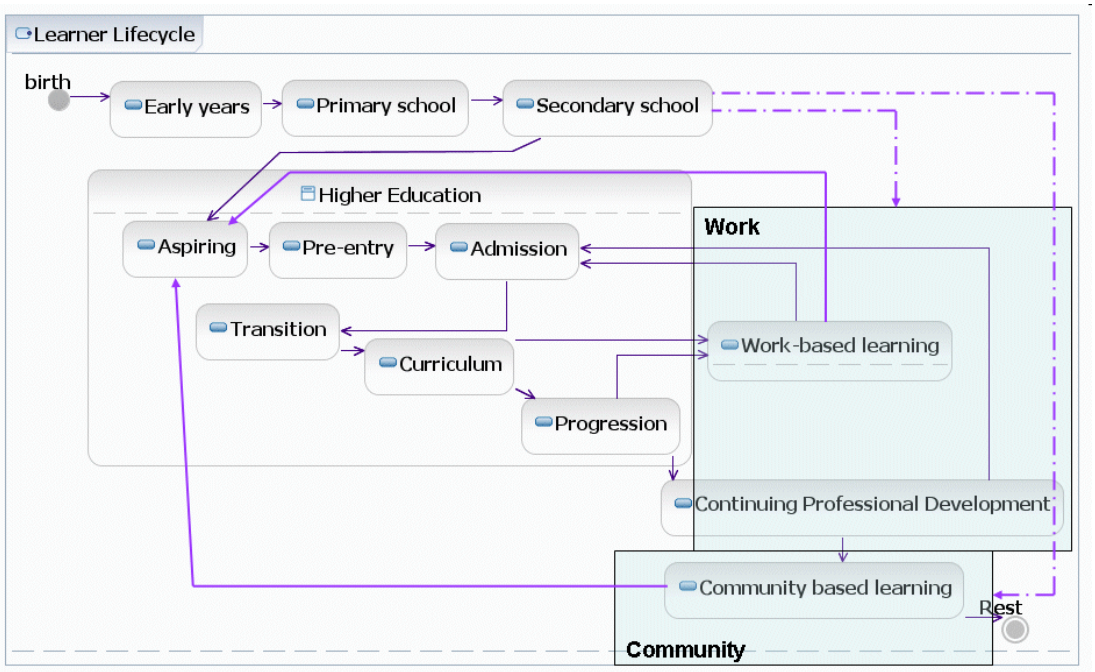

Figure 27: Diagram of the Learner life-cycle (UML)

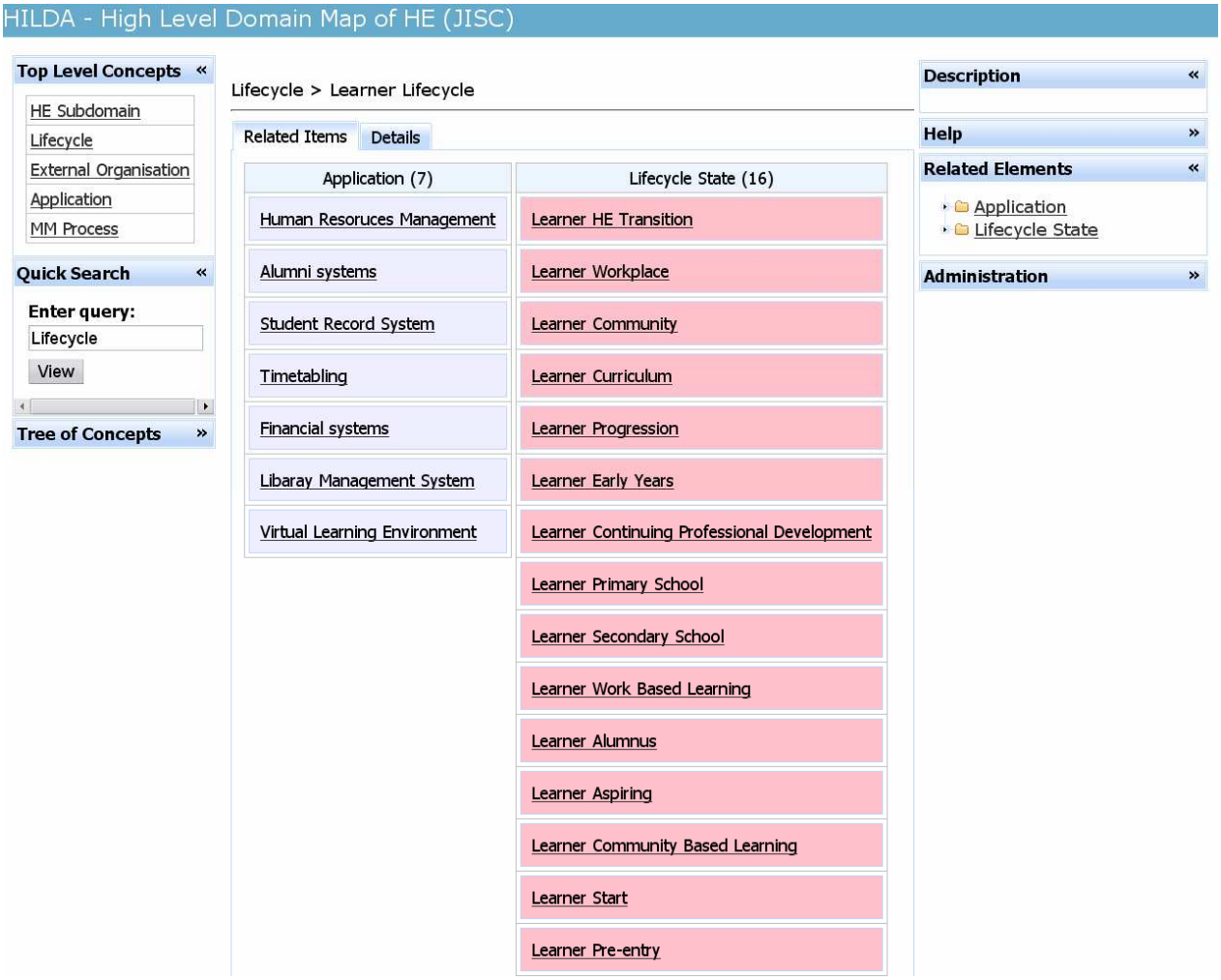

Figure 28: The Learner life-cycle

As can be seen, there are many ways in which the life cycles can be presented, with differing levels of complexity and information, but with appropriate design and supporting information (mouse over descriptions for instance) it should be possible to provide users with sufficient support to work with the life-cycles. The user can then use the life-cycle to select life-cycle states and explore in more detail what happens there:

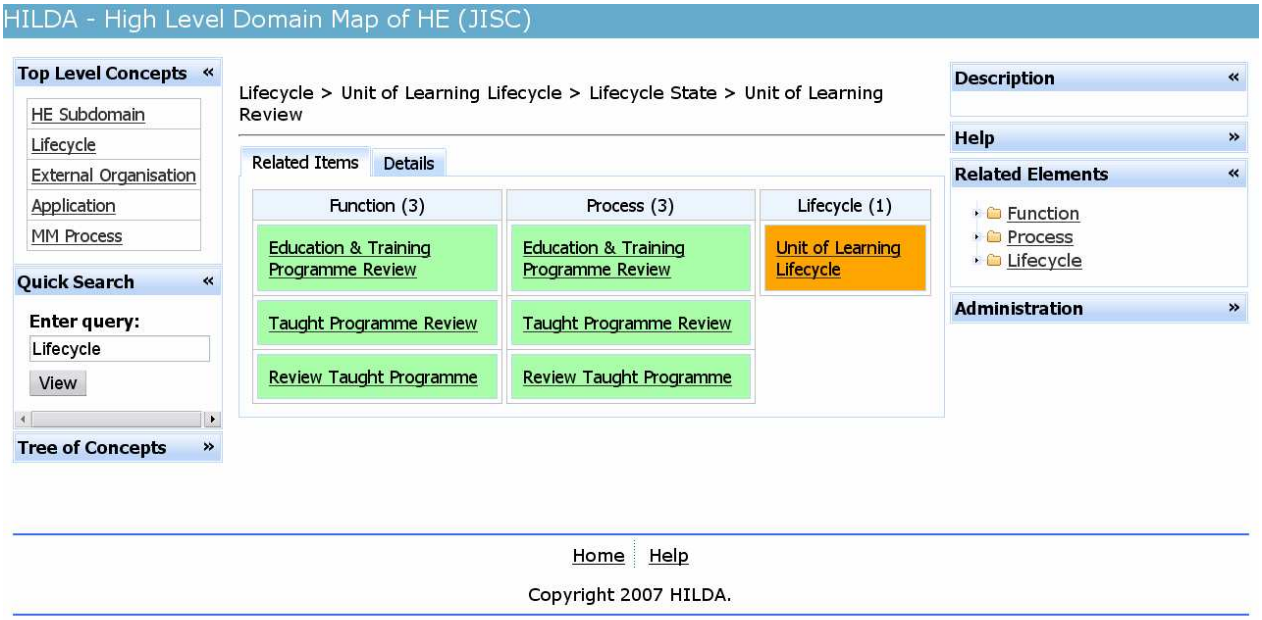

Figure 29: Course (unit of learning) review life-cycle state

As can be seen in Figure 29: Course (unit of learning) review life-cycle state, there are only a relatively small number of functions involved in a life-cycle state so that it is easy for the user to understand what is going on. The user can also use this to understand which external agents are involved, and therefore what information (and other) flows there are with them at this point.

From here it would clearly be possible to go down to the process level, and from there to service usage models (SUM), but this part of the model has yet to be completed.

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 external partners of various types, ranging from research collaborators to schools to funding councils to banks. So far we have identified twelve associated with learning and teaching, as shown below:

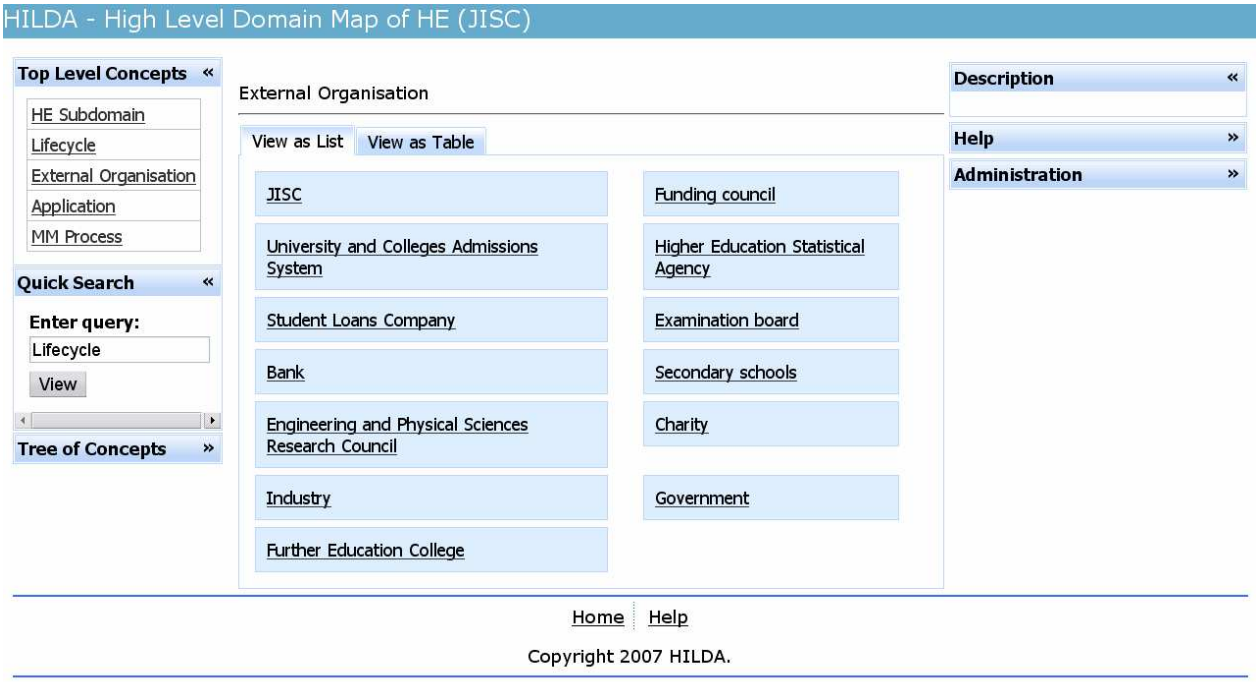

Figure 30: External agents that interact with higher education

While we have not put this information into the model yet, it would be possible to associate each of these organisations with the relevant work areas, life-cycles and life-cycle states and applications as shown in Figure 31. This can be a powerful way to help people to understand the functions, processes and relationships within an organisation, as it is often these external relationships that drive the processes and the way that they work. For instance, significant parts of the admissions process (one of the most important for universities) are driven by the requirements of UCAS, which controls the timings of the process and the information passed between applicants and university.

Since the interactions with external agents are 'owned' by functions, in cases in which there are fully detailed processes for executing the functions, it will be possible to follow the trail from the interaction, understanding the requirements for its support. The interfaces between the HEI and the external organisations need to be clearly defined and contain agreed information models for any transfers.

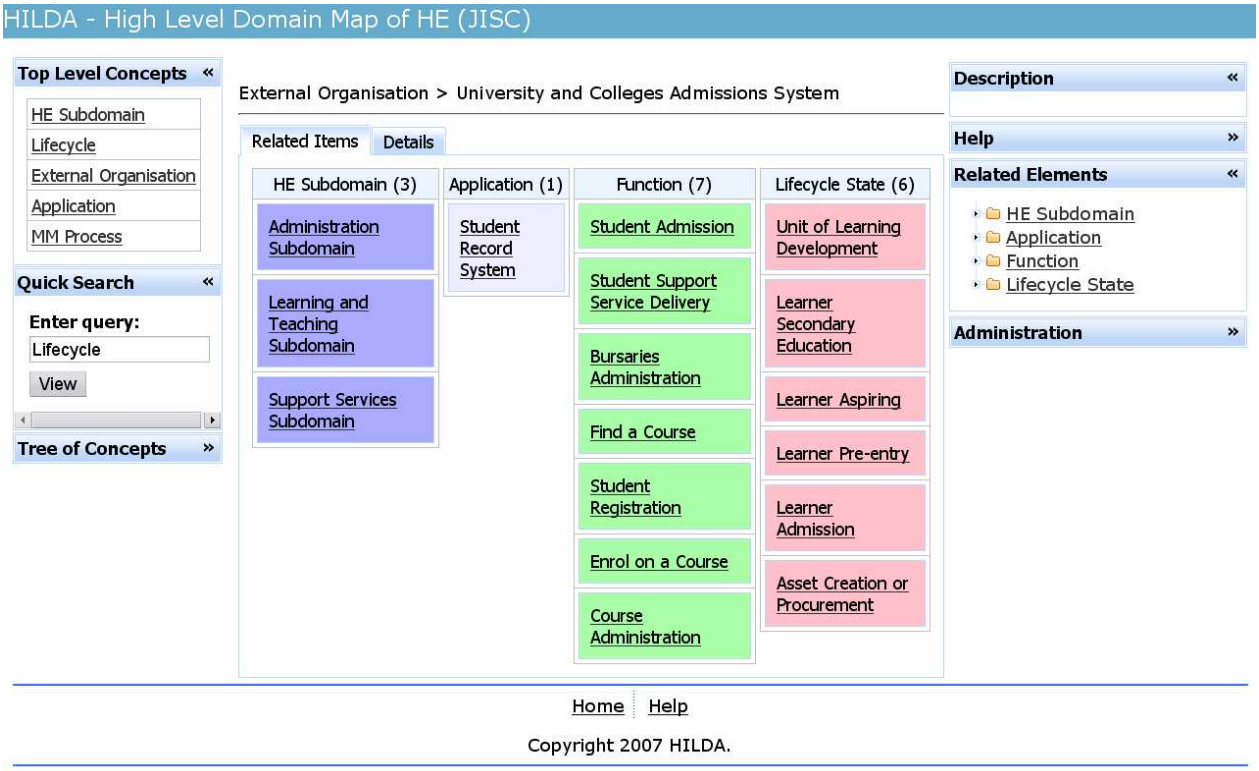

Figure 31: Relationships for an external agent

Applications

We have added applications to the model, because they 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. We believe, though, it will need testing to establish whether there is sufficient commonality in the scope of applications between universities that they can be a useful view or navigation route in a generic model. Applications would include:

- Student record system
- Finance
- Human Resources Management
- Virtual learning environment
- Library management
- Timetabling
- Research management
- Content management
- E-portfolio

Note that this is not intended as anything other than indicative at this stage, and there are concerns that this approach may lead to similar problems of "silo thinking" that we have identified as a danger of the work area approach..

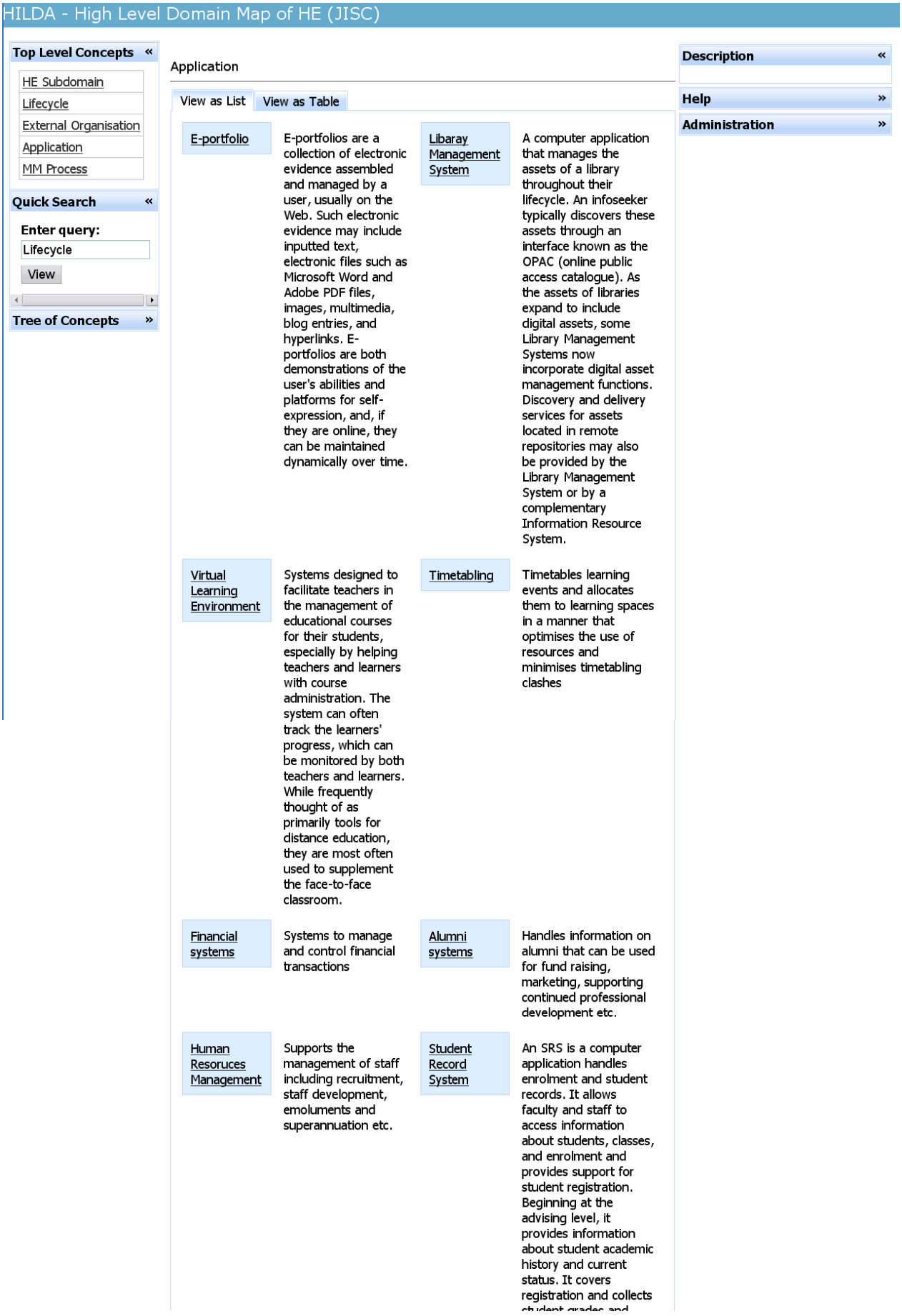

Figure 32: Applications in use in higher education

By selecting one of the applications the user would be able to see the work areas, life-cycles and external agents that are involved in the application.

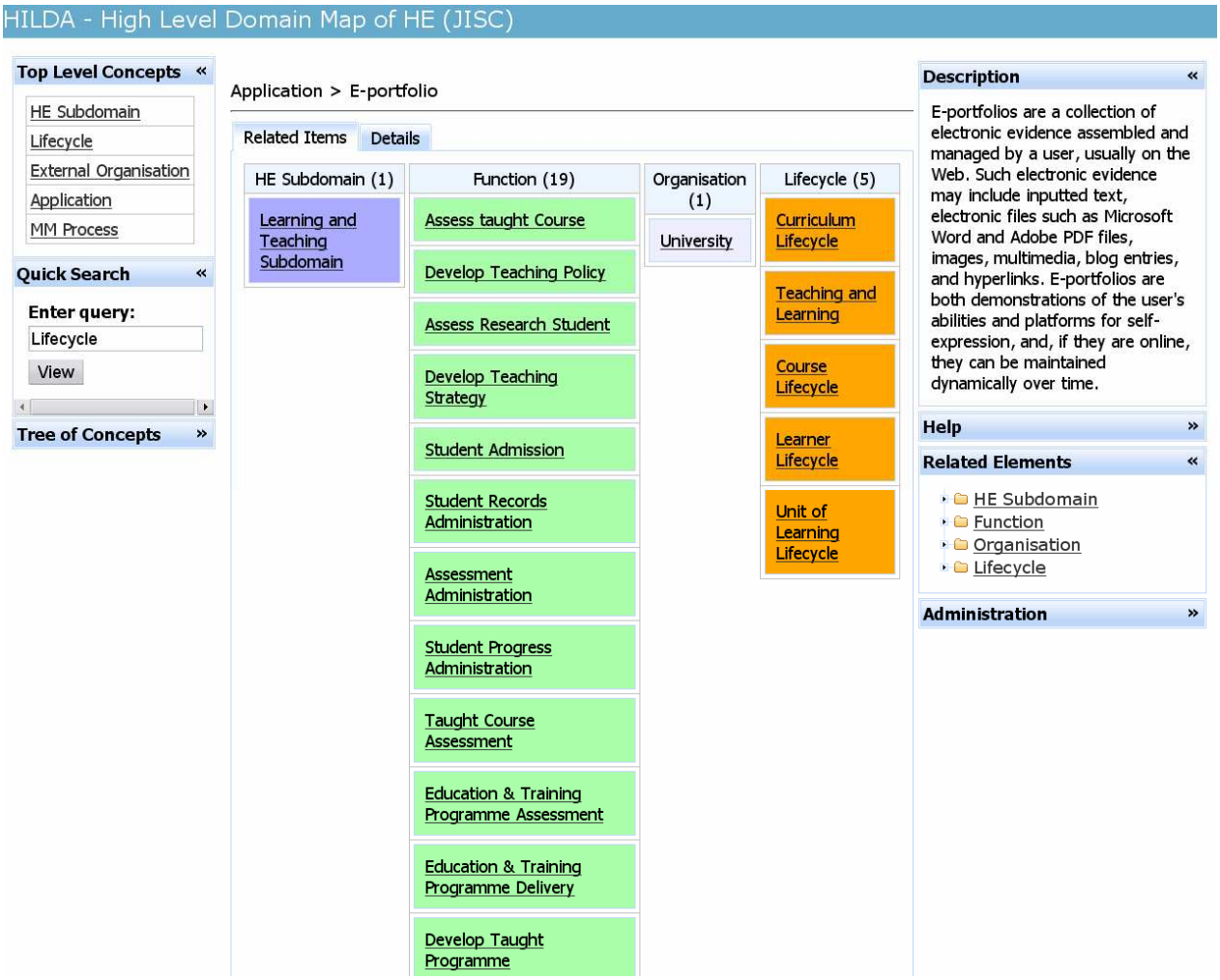

Figure 33: Details of the e-portfolio application

Beyond the project

The visualisation of the domain map needs to be significantly enhanced. For instance:

- It should be possible to see all the details of the items on the screen using "mouse overs" or "pop-ups" or some similar technique.
- The visualisation tool should be extended to support data entry as well as display so that users do not need to download and learn Protégé in order to put their results back into the domain map.
- Print versions of pages should be developed which could be richer than the screens and be suitable for discussions.
- Methods for linking to the e-framework should be developed.

Recommendation 7: The user interface to the domain map should be significantly enhanced, including the ability to show more information on screen and greater detail for printing.

Recommendation 8: The user interface should be further developed to enable users to input information to the domain map.

Applicability of the model

We have made a very generic model that we believe covers nearly all higher education institutions, including collegiate and federated universities. We believe that the model will apply to all funding council funded universities, including the following:

- Pre-1992 universities
- Post-1992 universities
- Collegiate universities (such as Oxford and Cambridge)
- Federal universities (such as Wales and London)
- Distance universities (The Open University)

We note the following institutions that are not covered by the current model and consequent map:

- Colleges of higher education (though these are likely to be able to be covered with small modifications to areas such as course approval processes)
- Further education colleges which offer higher education.
- Higher education institutions which encompass further education - in this case only the higher education part of the institution is covered.
- The University of Buckingham, as a private university outside the normal set of external agencies and controls may only partially be modelled.
- Overseas universities operating in the UK.
- Overseas universities operating elsewhere.

There are likely to be functions being carried out in universities that are not be covered by the model, as it is designed to be archetypical. However, it is likely that the underlying metamodel of the domain map will hold for all these variations on higher education providers and that the differences lie only in some of the data instances of that model.

Evaluation

The project put in place a methodology that incorporated a relatively robust framework for reviewing and analysing the key data available in the source documents identified in the original call. This framework utilised a so-called “modelling configuration” which provided a meta description of concepts and relationships that must exist in domain map for higher education. This meta description provided a useful and rigorous check list for evaluating the source documents. By encoding the modelling configuration as UML model (concepts and relationships), the structure also served as a specification model which later evolved into an implementation model as the team explored the use of the ontology tool Protégé.

A second aspect of the methodology was the use of lifecycles of key concepts as an approach to understanding the complexity of the domain and the interactions and dependencies between sub-domains. Lifecycle models are an established modelling approach and are particularly well supported in many IS methodologies and notations including UML. The use of lifecycles as part of the methodology has encouraged a useful synergy between this project and the current ongoing project – P SPEX which is using lifecycles of curriculum objects to develop the domain map for Programme Specifications.

The High Level Domain Map project is a small and tightly focused project and this has played an important role in determining the shape of the project. The team’s decision to use two distinct scenarios to instantiate sample domain map knowledge using the Protégé ontology application has served to illustrate the benefits of using the methodology it has. The modelling configuration and accompanying UML model originally served as a specification model, the Protégé tool requirements and the need to show a number of viewpoints allowed the team to construct an implementation model of the modelling configuration for use in the Protégé toolset. This relatively lightweight interpretation of model driven architecture concepts provides some useful evidence to JISC community in using such techniques.

While the scope of the project has perhaps limited the focus of domain map (underlying knowledge structures and navigation mechanisms) to the use of a lifecycle viewpoint, the team recognises that there are other viewpoints that also allow a full exploration of the complexity of a domain for example, a business process provides a horizontal cross-cutting concern across the whole domain. Similarly a viewpoint that allows focus on a structural view may also be beneficial.

One notable outcome that has emerged is the need to interpret domain maps as mechanisms for viewing and navigating the knowledge and structures that are inherent in the more formal model based view of a domain. While the project has begun the process of visualisation and navigation there is clearly much further work to be done in this area. This outcome is being mirrored in the P-SPEX project which is similarly exploring the use of visualisation of domain maps as a means of engaging different communities with a domain. It is likely that the P-SPEX team will be exploring the outcomes from the High Level Domain Map project and in particular the use of the implementation approach using Protégé to develop the (sub) domain map for Programme Specifications.

Appendices

Appendix 1: Usage scenarios

Normally a project such as this one would be driven by a clear set of user requirements, and a system would be built that could address as many of these as possible given the constraints. However, there is currently little understanding of what a domain map is, or how it differs from a domain model, and no clear guidance on what the requirements might be. Within a ten week project we have not been able to set aside the time to work with JISC and develop a set of user requirements. Instead, we have developed, from the information in the bid and discussions with JISC staff, a set of scenarios relating to what the domain map might be used for. We can then show how the domain map, as we are developing it, addresses these scenarios, and this can be used to discuss how to refine the maps and underlying models to better meet JISC's needs. Should JISC decide to further develop the domain map these could be used as part of the discussion to define the user requirements.

However, in developing scenarios JISC activities can be categorised as

- New activities
- Ongoing activities
- Reacting to external events, policy changes etc
- Responding to new initiatives, funding etc

For each category we can identify a number of questions that might be asked:

Activity	Questions
New activities	Have we already got one of these? What have we got? Is it suitable? Can we reuse existing elements? Who has already done this type of work? Who are the experts? Who are the users? What do the users need? How difficult is it? How much will it cost? How long will it take? Who should do it?
Ongoing activities	What are the priorities? Do we still need it? Who is using it? Does it still do the job? Is there something better?
Reacting to external events, policy changes etc	What impact will it have? What do we need to do? How do we respond?
Responding to new initiatives, funding etc	What are the priorities? How shall we spend it? What new programmes do we want to support?

In order to illustrate in more depth the nature of the planning process and the possible use of the tool set provided from this study, five scenarios are described below. They may be somewhat

unrealistic but they illustrate the approach and mindset for the use of the tool set in the planning processes.

Use case 1: JISC programme manager developing an ITT

JISC produces ITTs to address issues that are not being well addressed by other means including the development of services and demonstrators to, amongst other things, prove the e-framework. To date, the work has not been systematic, with the first call simply asking for reference models without making clear exactly what a reference model might be. This resulted in an eclectic group of projects working in different domains, in different ways, producing different artefacts at differing levels of abstraction.

For this use case I am going to suppose that Sam has been asked to draft an ITT for their committee (JISC E-Framework Committee or JEF) that will have the greatest impact on getting the e-framework taken up by universities.

Sam realises that to determine where the greatest impact can be had he needs to remind himself of what they have already got (either through JISC or international funding) and look for some area(s) that are likely to be valuable to decision makers in universities, and particularly to IT directors.

Consequently, Sam goes to the domain map and begins to explore the various domains in it in a fairly haphazard way, looking at the domains and life-cycles for inspiration and looking at what services have been developed and rolled out. For this Sam finds being able to move freely around the map moving between the different domains and life-cycles and drill down to see what services have been implemented very useful.

After a while, and a strong cup of coffee, Sam decides that e-administration is most likely to grab the attention of IT directors. Sam goes back to the domain map and goes to the e-administration domain, and then to the asset life-cycle on the grounds that all managers have some interest in the assets in their domain. Sam looks at the life-cycle and sees that there are already services that implement large parts of the life-cycle including acquisition, management, maintenance and disposal. Sam realises that there are no services that support project management for major acquisition projects (such as major computer installations or buildings). Sam looks at the reference models in the area, which are reasonably complete and uses these as the basis for defining a set of services that the JISC could fund. As the domain map only shows completed work Sam emails DEST, SURF and New Zealand to ask if they are working in the area.

Use case 2: JEF member reviewing draft ITT

Sam submits his draft ITT, which contains a number of links into the domain map and it is sent out in the JEF committee papers. Mo is fairly new to the committee and consequently does not have a very good grasp of JISC's work and reads the committee papers when received rather than on the train to the meeting. Not fully understanding the e-framework or where the suggested work fits in, Mo follows the first link which is to the asset life-cycle. Seeing the full life-cycle and the ability to explore parts of it in more detail Mo looks at each step in the life-cycle in turn and finds that useful in making explicit the steps in handling assets, which Mo had never thought through in detail. As Mo is currently specifying the acquisition of a large network storage array Mo bears that example in mind while going through the life-cycle. Mo looks at services involved in project management and sees that a number of them are already developed, but that as the ITT suggests there are a number of gaping holes in the area that make it impossible to implement project management processes. Using the project life-cycle Mo explores some of the existing services and realises that some of them will not support project management properly in the way that they are described in the e-framework. Mo rings Sam and asks about this, with the result that they come to the meeting with a proposal to extend the ITT to include services in that area.

Use Case 3: Writing a bid

Ed is responsible for a team of project managers at the University of Neasden and has been looking for something to support the project management life-cycle. The commercial products that Ed has looked at are either too expensive, too inflexible or cannot easily be integrated into other systems at the University. Ed is therefore interested in using the e-framework to support the project management life-cycle and in particular for some major new projects that are to start detailed planning in about 12 months.

Ed has not worked with the e-framework before, and therefore wants to get a general understanding of the e-framework. Ed goes to the domain map site and sees the various domains, but decides that life-cycles fit better with her way of thinking and looks at the asset management life-cycle. Looking at the model Ed can see what has already been implemented, and what is needed to get a working system that would address her needs. She looks at the existing service definitions and decides that what is there already will not meet her needs, and that therefore working on the e-framework would be a distraction from what she needs to do. She therefore decides not to bid, but to watch the development and perhaps pick up on it later.

Next steps

Validate the scenarios in discussion with people within JISC, and if necessary rewrite or develop new ones to demonstrate the type of processes that the map is expected to support.

Appendix 2: The Domain map's model

The Domain map's model

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 (Wikipedia). The system under consideration here is the Higher Education Institution.

Background to the modelling approach

The HEI is considered as a system which exists in a social/ geographical/ economic/ political context. A system may be defined simply as a collection of components organized to accomplish a specific function or set of functions[12] and always exists in a context, its external environment from which it is bounded[13]. This forms the basis for establishing an approach to mapping the HE domain which is taken to be the HEI system and its interactions across its boundary with its environment.

One way to gain an understanding of how the HEI system works is to model the system and iteratively test and refine the models. The selection of type of system models to be constructed for this project has its roots in Bunge's work[14] [15] which provides us with a mathematical approach to describing the world and the things in it, and underpins today's Object-Oriented Analysis Methodology for understanding systems and the way they function.

The chosen modelling method and language must be able to deal with system complexity and permit sufficient precision to make the models useful for the domain map users. The specified uses of the domain map determine which properties, or features, of the system should be captured. One approach to capturing a specific set of properties of a system is to use a visual modelling language, for example, the Unified Modelling Language (UML) that enables description and explanation both the structure of a system and what is happening in a system. For this project it was decided to use UML to create a conceptual model of the domain and an ontology tool to instantiate and validate the conceptual model[16]. Ontology "studies the most pervasive features of reality, such as real existence, change, time, causation, chance, life, mind, and society"[17]. This appeared to be a good starting point for a deliverable that could be evaluated by its stakeholders.

Correctly structured models enable the modeller to focus on particular aspects without losing the coherent whole. The modelling approach needs to support models at any level of abstraction and allow the modeller to go from a sketch of a concept all the way down to a precise detailed design for planning, management and operation of the system. The models of this domain are of the people, processes and technology with particular regard for the things that need to be put

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[12] IEEE STD 610.12 www.ichnet.org/glossary.htm

[13] Fowler 1998 Fowler, A. (1998) Operations management and systemic modelling as frameworks for BPR, International Journal of Operations & Production Management, Vol. 18 No. 9/10, 1998, pp. 1028-1056

[14] Bunge 2004a, 2004b Bunge, M. (2004a) How Does It Work? The Search for Explanatory Mechanisms, Philosophy of the Social Sciences, Vol. 34 No. 2, 182-210,

[15] Bunge, M. (2004b) Clarifying Some Misunderstandings about Social Systems and Their Mechanisms, Philosophy of the Social Sciences, Vol. 34 No. 3, 371-381

[16] Using ontology to validate conceptual models, G Shanks, E Tansley, R Weber - Communications of the ACM, 2003 - portal.acm.org

[17] Bunge, M. Philosophical Dictionary, Enlarged. ed., Amherst, New York 2003

in place to facilitate the teaching and learning processes, the core business of an HEI, including whatever social and technological interactions are deemed appropriate. The modelling team needs to empirically test its ideas about how the HEI system works. The models that it constructs are testable by others because it constrains the effort to the use of an accepted industry standard visual modelling language.

The ontology tool enables construction of a knowledgebase according to the conceptual model created in the visual modelling language. This knowledgebase can be visualised and accessed in a number of different ways in order to meet the user requirements.

When analysing a system, different analysts will usually produce different models. Different analysts will apply different internal rules of generalisation and expression of the rules and constraints that govern peoples' work. However, the models are open and accessible to the people concerned, the system stakeholders. These stakeholders may examine, validate and critique the models against their own views and experience. An iterative process of modelling and model refinement permits continuous improvement and responsiveness to change.

On this basis the following set of open source tools and languages was selected:

1. Conceptual modelling in UML (tool: StarUML)
2. Ontology construction in Frames (Protégé)
3. Knowledgebase instantiation in Frames (Protégé)
4. Knowledgebase browsing and navigation (ontology_browser_webApp[18])
5. Visualisation in Frames (Protégé plug-in TGViz)

The conceptual model of the domain (modelling configuration)

Taking a domain map to be a high level domain model with navigation routes for views of interest to its different stakeholders, we can define the HE domain model to be a model of things in the world of HE provision. The domain map metamodel is then 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 following is a set of statements about the HEI in its context. This is the starting point for the conceptual model which provides the modelling elements and can therefore be considered to be the domain map metamodel or its modelling configuration.

HE Domain Map Metamodel (Modelling Configuration):

An **HEI** is an **organisation** which generally has a **vision** for itself as an enterprise and it has **stakeholders** who have an interest in the success of the organisation. Its vision is expressed in its **mission** statement which is realised in its strategy as a set of **goals** (or aims and objectives) that are attained through **operational plan**s which meet policy.

An **HEI** exists in a context of interactions with other **external organisations**. In these interactions it both requests information and responds to requests for information i.e. the **interactions** have **interaction content data**. These requests and responses belong to **functions** (requesting function and responding function) i.e. they do not happen in isolation.

An **HEI** can exist as a member of a federation of HEIs in which case some of its functions become the responsibility of the **Federation-holding Organisation**. The organisation comprises a collection of **organisational units** with defined responsibilities and concerns.

[18] Prototype developed for the HILDA project http://130.88.2.245:8088/hilda/

The **HEI operational plan** (tacit or explicit) is carried out by its **functions** (Business Use Case in UML). A **function** has a primary **actor** (fulfilling a **role)** and may also have collaborating **actors/roles**. **Functions** have **flow(s) of events. Function**s can reflect either the system 'as is' or requirements for future systems.

A function's **flow of events** is a **process** and comprises **activities**, **business events**, **process controls** (transitions and decision points) and **artefacts**. **Artefacts** are either **resources** for activities or **deliverables** of activities. **Process Controls** use **rules**.

Guidance may be available for an **activity** to assist its execution and its use is determined by a contextual **guidance usage principle** which explains how the guidance should be used in the particular process context.

The system has a number of key business objects whose lifecycles are managed by the core functions. An **object lifecycle** is the set of **states** held by that object over its whole life. The **state** is the set of attribute values for the object and determines what the object in question may do. There are **state transitions,** triggered by **events** between states (events may be time, periodic or external intervention). An object may flow through a **process** with state changes being brought about by activities in that process. **State transitions** are controlled by **rules**.

A **process** may be divided into **sub-processes** which comprise **activities** that may be further broken down into **steps**. A **sub-process** takes place in an object's **lifecycle state**. When a **sub process** runs it is a runtime **sub-process run context** that is characterised (given attribute values) i.e. the state attribute values and possibly additional information about the runtime environment

Actors/**Roles** may be **organisational units**. A **role** defines a set of related skills, competencies, and responsibilities. An **actor** is the person or component that fulfils that **role.**

A **function's flow of events (process)** is executed (operationally supported) by an orchestrated/ choreographed set of **services**. Not all services are software based, some are people based (offline).

The support of **processes** by **services** may be mapped in a **service usage model** to facilitate **application** development planning. The services and their usage models may be managed in a **service framework**.

An organisation's **applications** support its **functions** and the technologies and standards used are managed in an **enterprise architecture**.

Metamodel in UML

The set of statements, above, was used to construct a visual model of the identified elements and their interrelationships in a UML Class Diagram. This is the metamodel for the HE Domain Map and the set of elements was entered as classes and relationships in Frames using the Protégé ontology tool. The ontology was then populated with instances of the classes from the set of source documents, creating a knowledgebase for the HE domain.

The elements in the UML Class Diagram have been grouped into five areas and coloured accordingly, to facilitate reading of the visual model (Figure 34). The colour key for areas within the metamodel is: **Organisation; Function; Service; Practice; View.**

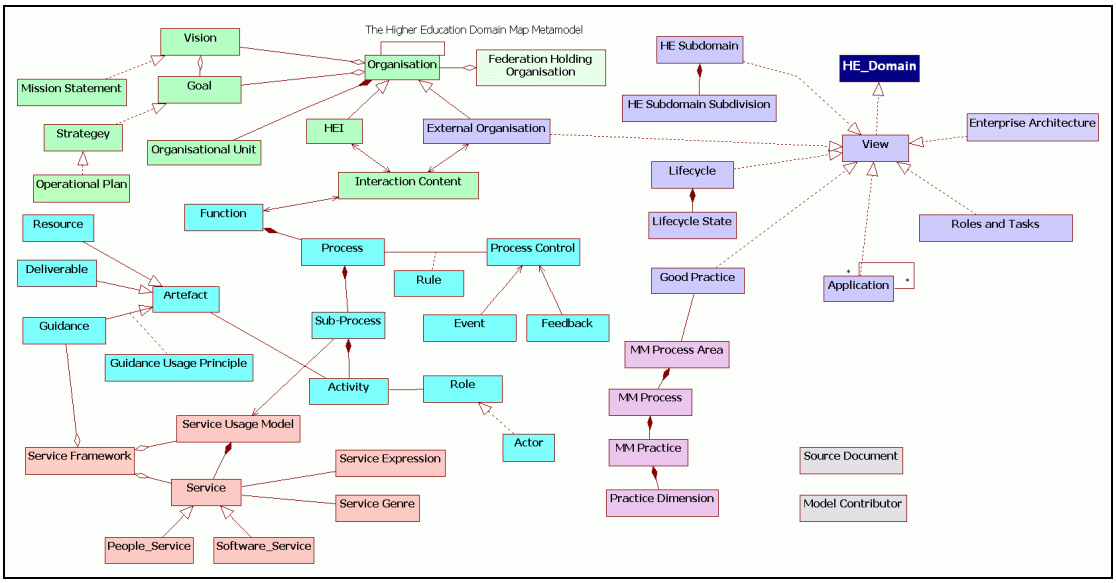

Figure 34 : The Higher Education Domain Map Metamodel

The domain map metamodel includes elements of the HE world and the elements required for the different navigation routes proposed. In order to be able to use the knowledgebase for the various views, further connections are required between the elements than those identified in the simple description of the domain. These additional connections are shown in Figure 35: The Higher Education Domain Map Metamodel Knowledgebase Relationships

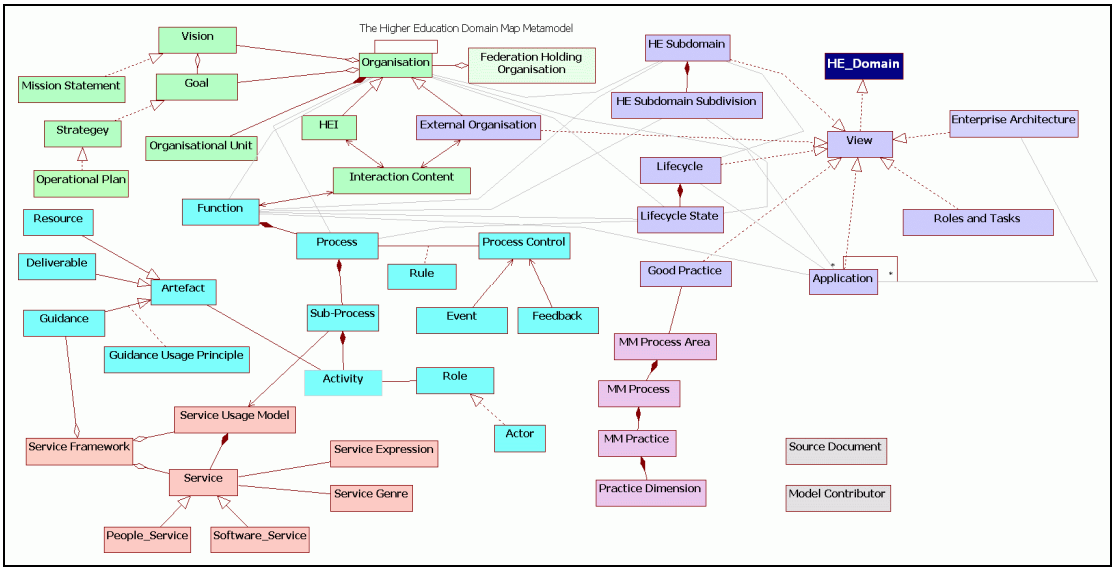

Figure 35: The Higher Education Domain Map Metamodel Knowledgebase Relationships

The following are views of sections of the metamodel, required for the eight viewpoints that we have considered:

1. Lifecycle State
2. Sub domain
3. Application
4. Good Practice
5. Roles and Responsibilities (for future development)

6. External Interactions
7. Enterprise Architecture (for future development).
8. Reference Models

Lifecycle State View

Core entities in the HE domain have lifecycles. A lifecycle is the set of distinct stages or states through which an entity passes during its life/existence. In the case of Assets, such as a piece of equipment or infrastructure, the lifecycle includes states such as planning and requirements, creation or procurement, operation, performance management, maintenance, decommissioning and disposal. In the case of the Staff lifecycle, the states include Applicant, Employed, ex-employee, on Holiday, Maternity Paternity leave, Retired, Secondment, Sick, Suspended, Training, Unpaid leave etc.

The lifecycle is an ordered series of states, connected by allowable transitions. In a given state, the entity can perform, or be subject to, certain activities. The state determines which activities are allowed, or appropriate. Certain activities or events bring about a change in state, thus allowing a different range of activities. By connecting functions and their processes to lifecycle states it is possible to find, for example, all the things that can happen to an entity at a particular stage in its lifecycle. Conversely, it is possible to see where the impact of particular activities will be, in terms of the core entities in HE.

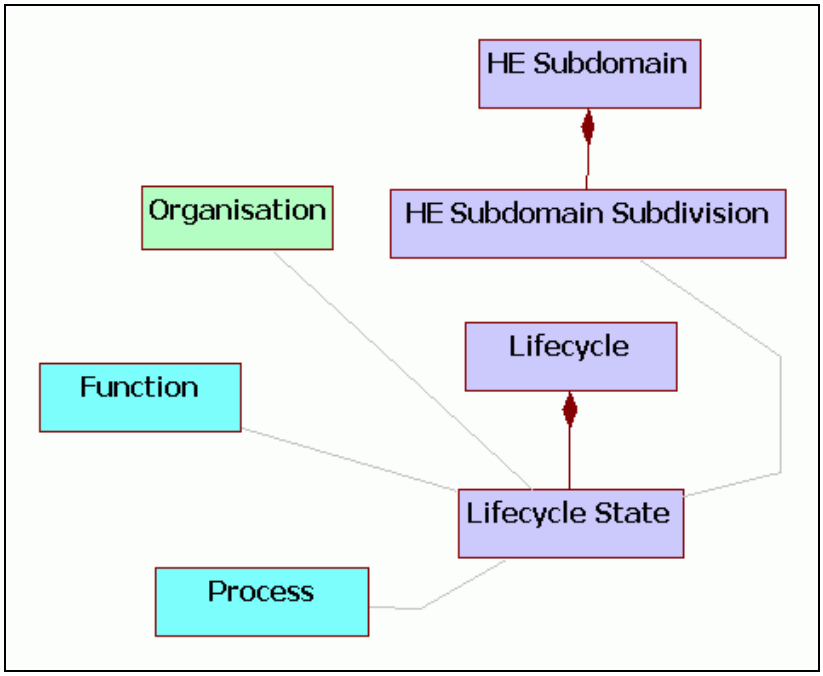

Figure 36: The Lifecycle View Section of the Metamodel

Figure 37: An example from the HE Domain Knowledgebase through the Lifecycle View shows an example from the knowledgebase of the Lifecycle view; in this case, the Learner Lifecycle in the HE Transition state. The links to functions, processes and organisations from this state are shown in the central part of the screen.

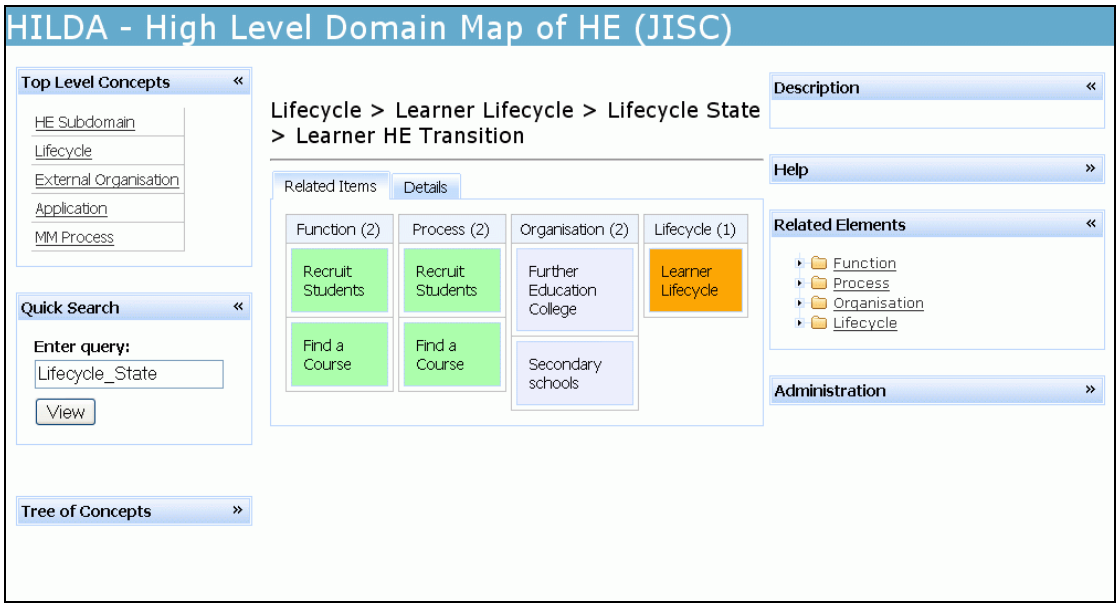

Figure 37: An example from the HE Domain Knowledgebase through the Lifecycle View

Subdomain View

For the domain map, the HE Domain has been divided up into subdomains, based on JISC guidelines and the source documents, and these further divided into subdivisions. Figure 38: The Subdomain View Section of the Metamodel shows the elements related to the subdomains.

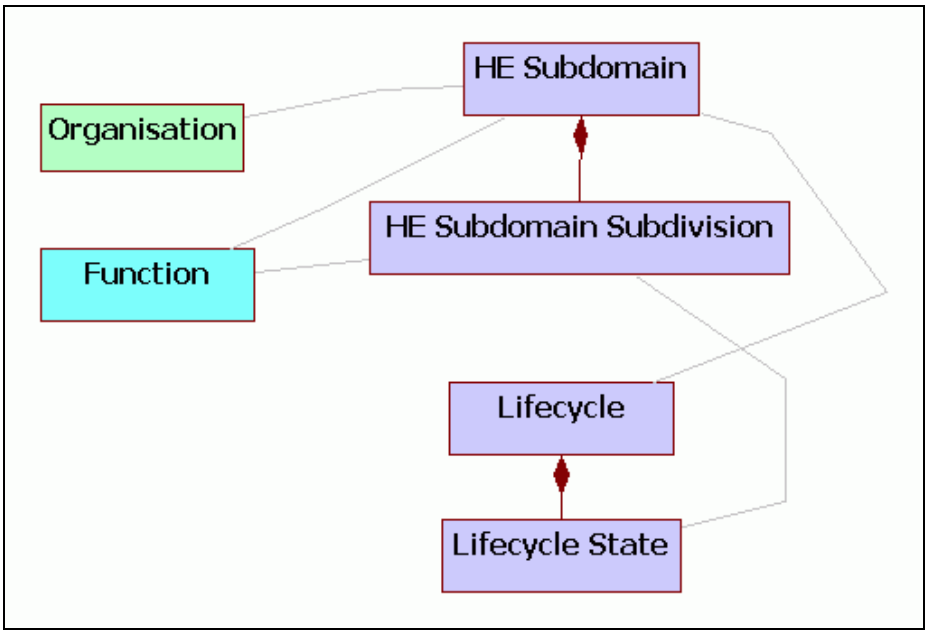

Figure 38: The Subdomain View Section of the Metamodel

The initial set of subdomains used in the knowledgebase is: Business and Community Engagement, Learning and Teaching, Corporate Management, Exploitation, IT, Research, Estates, Support Services, Resource Management, Administration, Information Systems and Libraries. Figure 39: An example from the HE Domain Knowledgebase through the Subdomain View shows an example of the Administration subdomain and its connections to functions, applications and organisations.

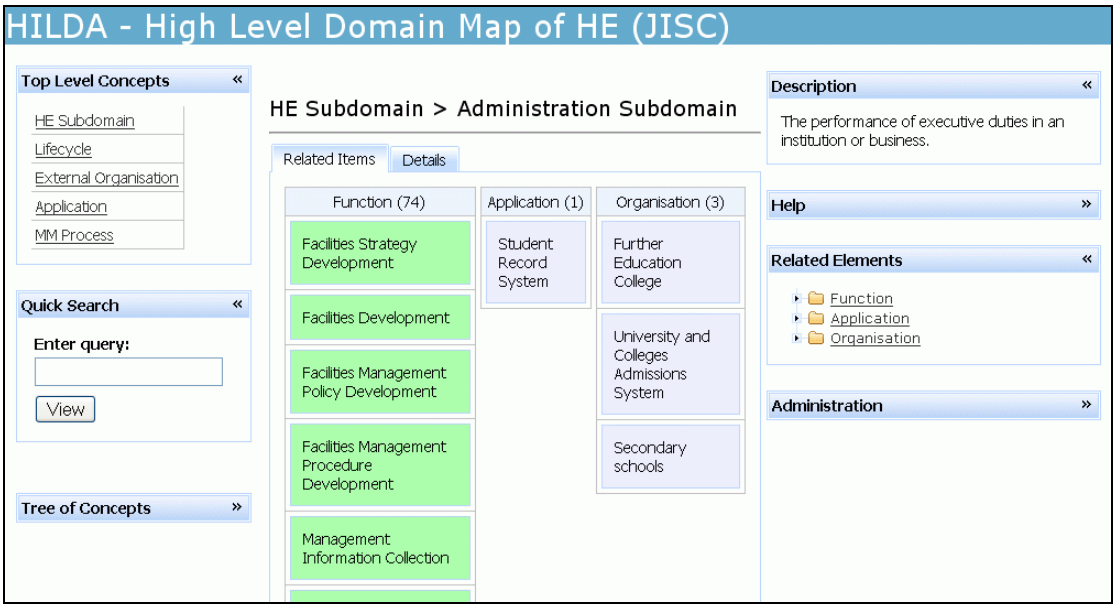

Figure 39: An example from the HE Domain Knowledgebase through the Subdomain View

Application View

An HEI's software applications support parts of its functions, so that mapping their interdependencies and connections to functions and lifecycles has the potential to support IT portfolio planning decisions and to aid understanding of the impact of software application changes. These connections are shown in Figure 40: The Application View Section of the Metamodel. In addition, the domain map application view can support an HEI that is planning a migration to service oriented architecture and/or using a service layer for application integration.

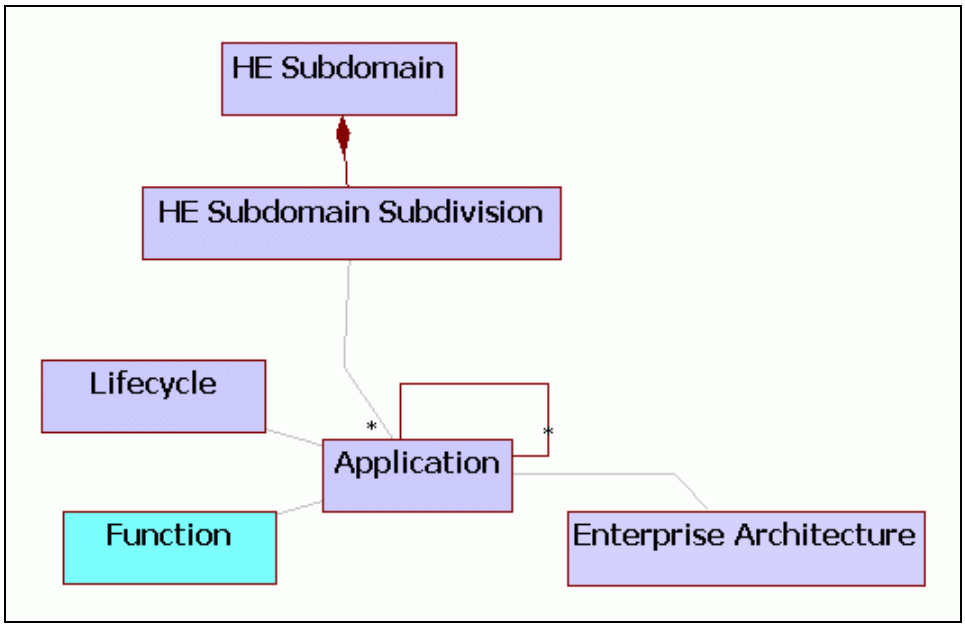

Figure 40: The Application View Section of the Metamodel

The connections of an e-portfolio application to subdomains, functions and lifecycles are shown in Figure 41: An example from the HE Domain Knowledgebase through the Application View. The description pane on the right hand side of the screen gives an overview of the functionality of the e-portfolio application.

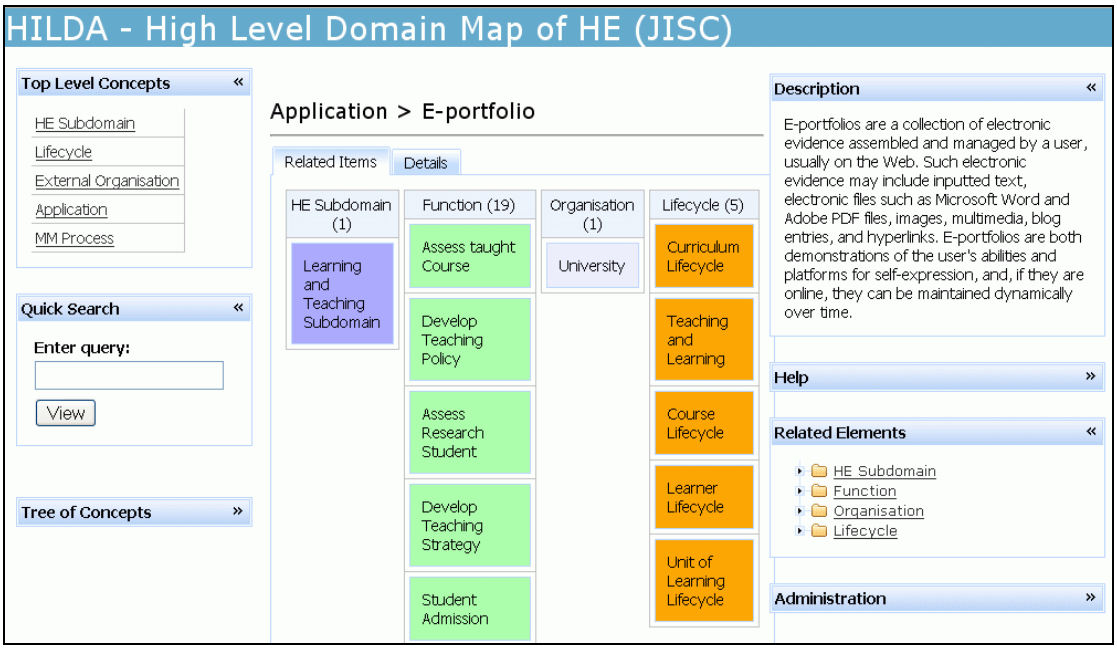

Figure 41: An example from the HE Domain Knowledgebase through the Application View

Good Practice View

One of the source documents supplied to this project was the e-learning Maturity Model (eMM) which is a framework for quality improvement[19]. The e-Learning Maturity Model offers a framework to identify the set of processes and their underlying practices that comprise the whole provision lifecycle. eMM is designed to be used as a benchmarking tool that can examine different organisational levels with a view to prioritising areas of work for improvement. Following assessment, changes can be proposed for specific known practices, and their impact understood. It is used to highlight specific areas of activity within an organisation in a way that can be associated with existing and desired dimensions of practice maturity. Combined with other methods for working towards change in specific cases, including process and transition modelling, individual areas of work can be guided towards improvement by encouraging discrete measurable adaptations appropriate to their circumstances. There is an underpinning knowledgebase of practice in this framework and a structure which indicates how practices support process goals. The eMM processes and practices collection and the framework structure thus provide a view of HE provision that can be linked to other elements in the domain map. One advantage of the eMM view is that it is expressed in practitioners' language and may therefore offer a more accessible route through domain issues for practitioners. Figure 42 shows the elements of the domain map metamodel covering the eMM view and its links to processes and lifecycles in the HE domain.

[19] Marshall, S.J. and Mitchell, G. (2004), "Applying SPICE to e-Learning: An ELearning Maturity Model?" in Proceedings of the Sixth Australasian Computing Education Conference (ACE2004), Dunedin. Conferences in Research and Practice in Information Technology, Vol. 30. R. Lister and A. Young, Eds.

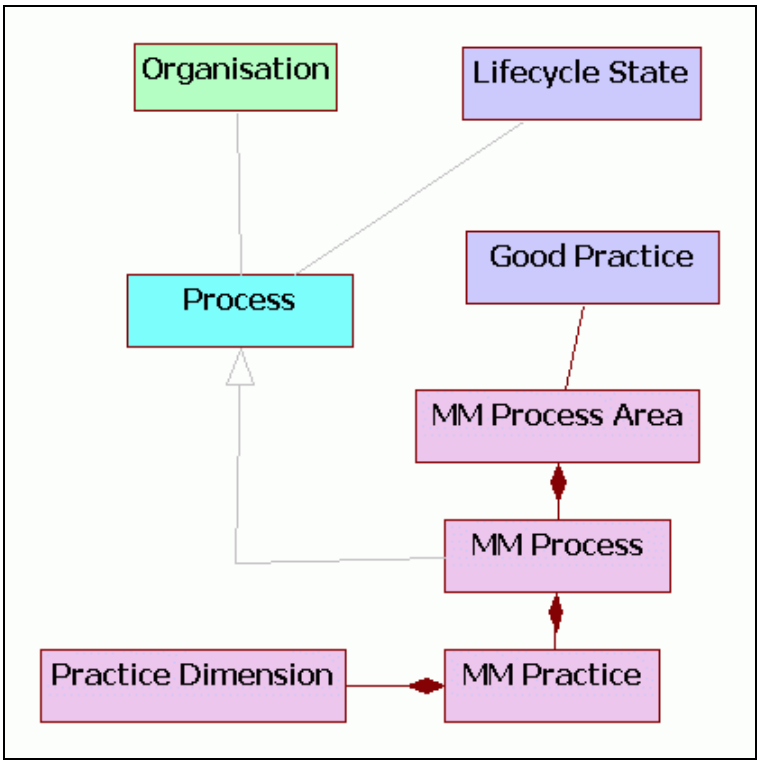

Figure 42: An example from the HE Domain Knowledgebase through the Good Practice View

A small sample of practices is shown in the central pane in Figure 43. These are from the quality improvement framework process that deals with designing and managing e-learning resources to maximise reuse. Process capability and maturity can be assessed with the eMM framework, using five dimensions of maturity and seeking evidence of the practices within each dimension. It is also possible to view each practice supporting a particular process as a set of cues for activities that should be carried out to meet process goals. These can then be used to design or redesign processes.

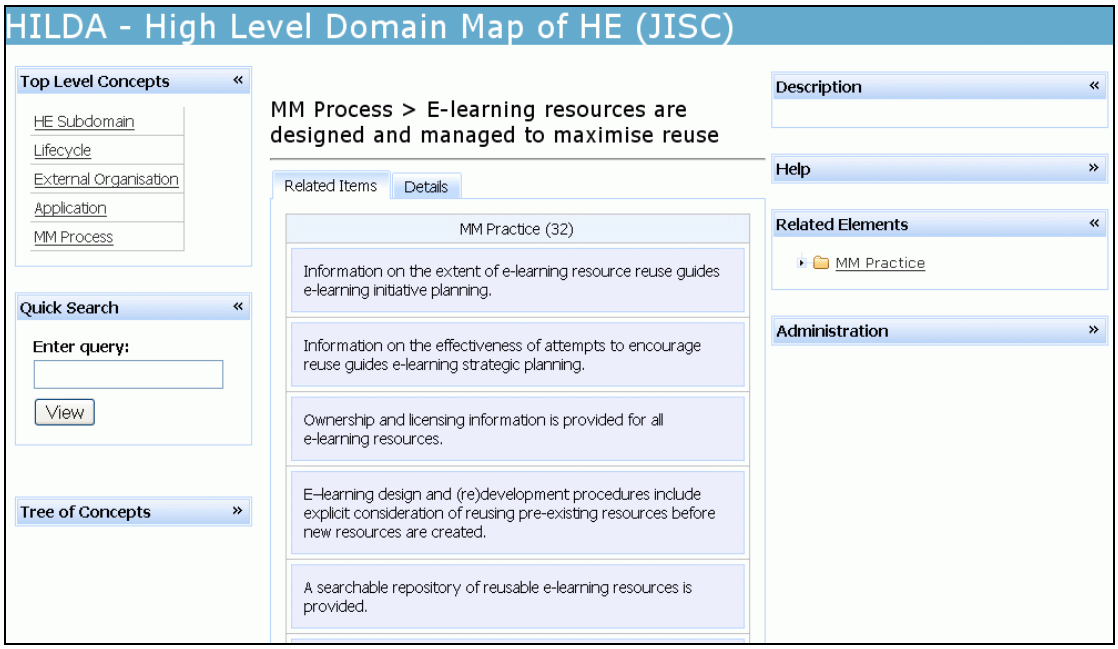

Figure 43: Example from the HE Domain Knowledgebase through the maturity model View

Roles and Activities View

An analysis of roles and responsibilities in HE should lead to a useful view of the domain. This analysis was not possible in the timeframe of the current project. Figure 44 shows the elements in the domain map metamodel that are required for this view. This is a key approach to understanding the HE domain as a system, covering the 'who', 'what', 'how' and 'when' of HE provision.

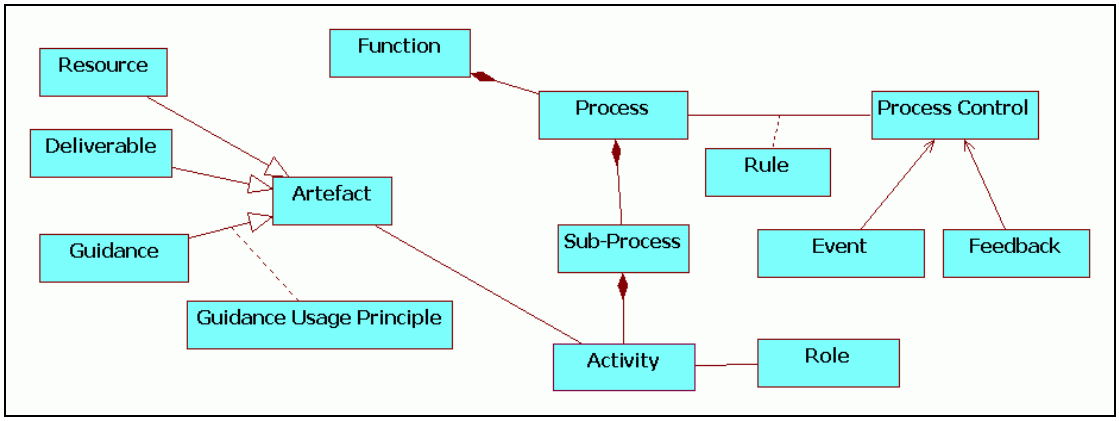

Figure 44: The Roles and Activities View Section of the Metamodel

The knowledgebase has not yet been populated with instances to demonstrate this view.

External Interactions View

An HEI exists in a context of interactions with other organisations. In these interactions it both requests information and responds to requests for information i.e. the interactions have interaction content data. These requests and responses belong to functions (requesting function and responding function) i.e. they do not happen in isolation. This view follows the interactions to the functions supporting them.

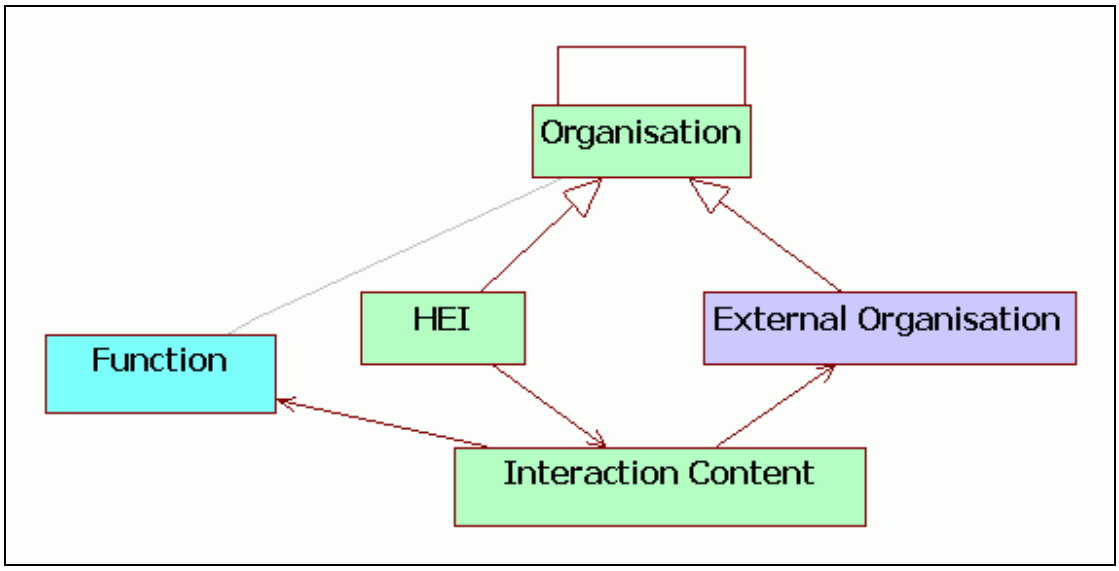

Figure 45: The External Interactions View Section of the Metamodel

Figure 46 shows the interaction between the HEI and UCAS and the connections to the subdomain, applications, functions and lifecycle states that relate to this interaction. An example from the knowledgebase, shown in Figure 46, show the instances of subdomain, application, function and lifecycle state that relate to this interaction.

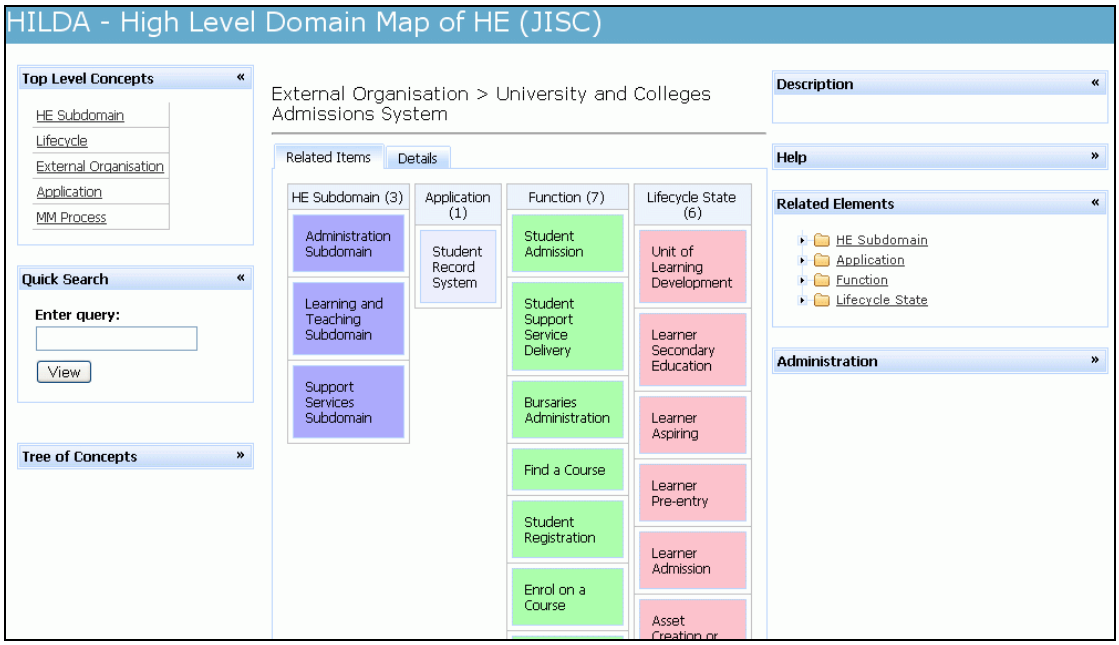

Figure 46: Example from the HE Domain Knowledgebase through the External Interactions View

Reference Model View

Reference models for service frameworks provide 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. Figure 48 shows the elements required to form this bridge between the domain map and the e-Framework.

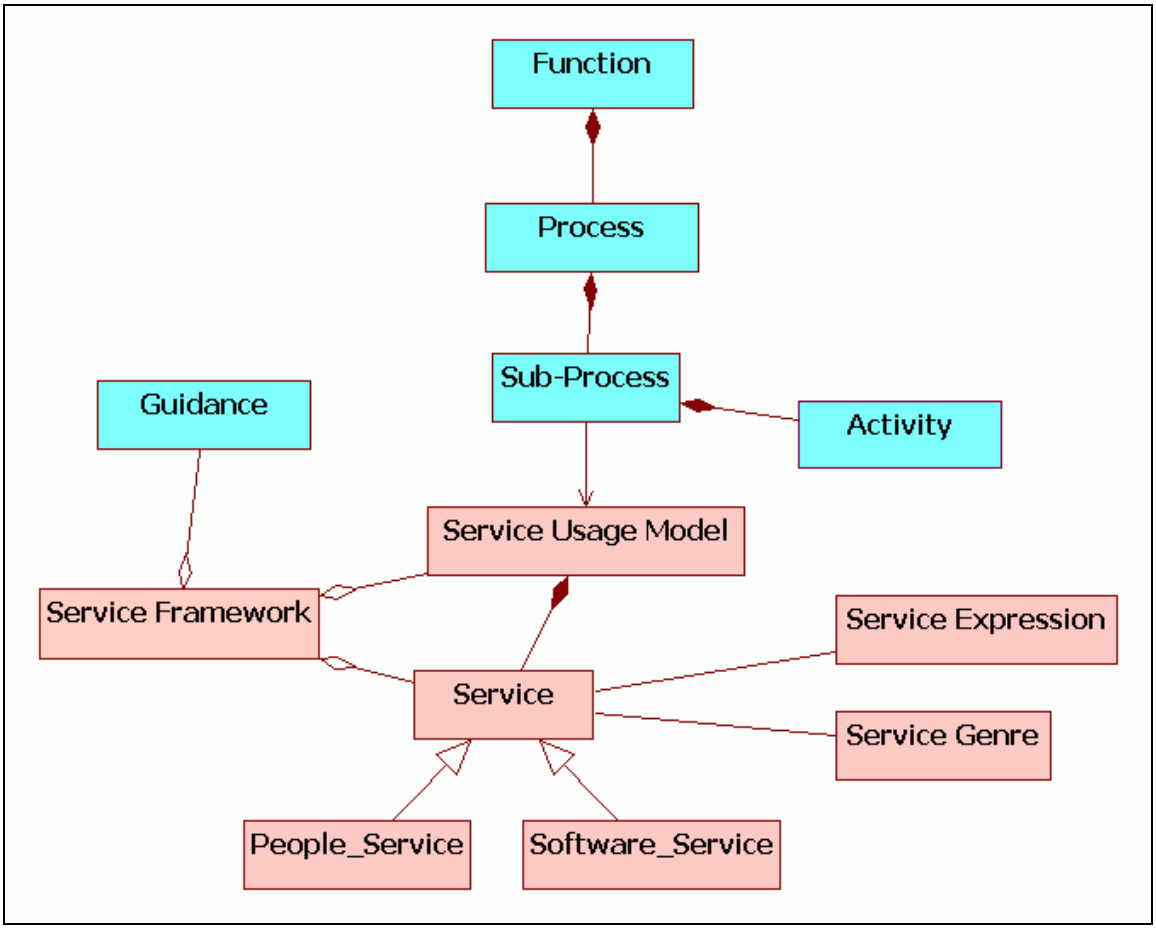

Figure 47 The Reference Model View Section of the Metamodel

Two reference models were taken for sample data, COVARM (Course Validation canonical business process) and FREMA (Assessment). The screenshots below (Figure 48, Figure 49) show the SUMs links to services and the external documentation of the reference models. The links to the e-Framework can be maintained through the external documentation link.

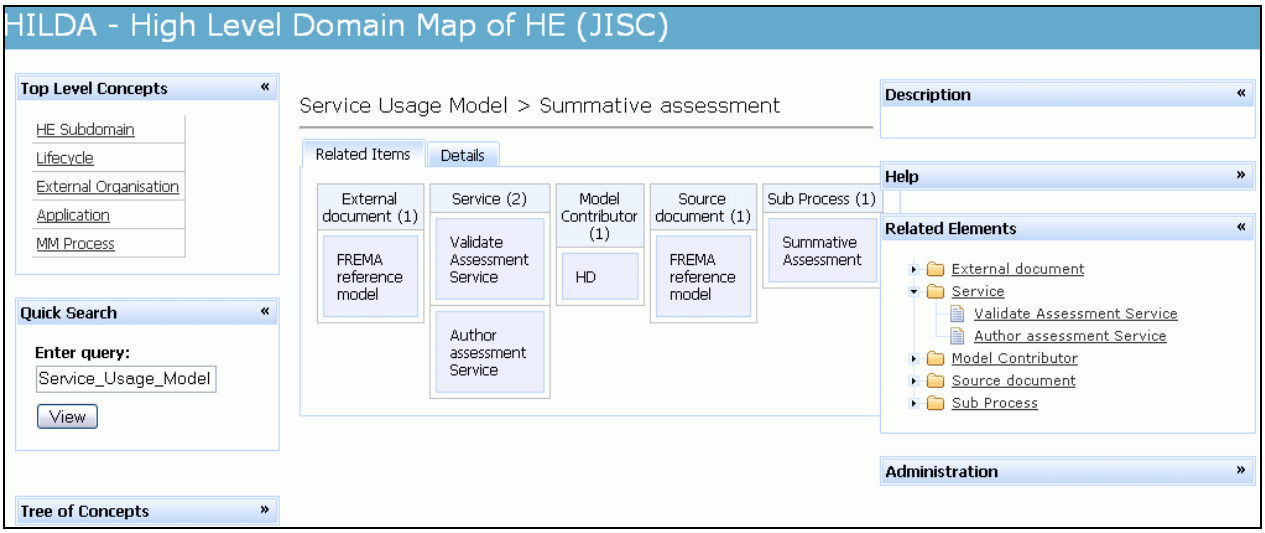

Figure 48: SUM from the HE Domain Knowledgebase of FREMA reference model

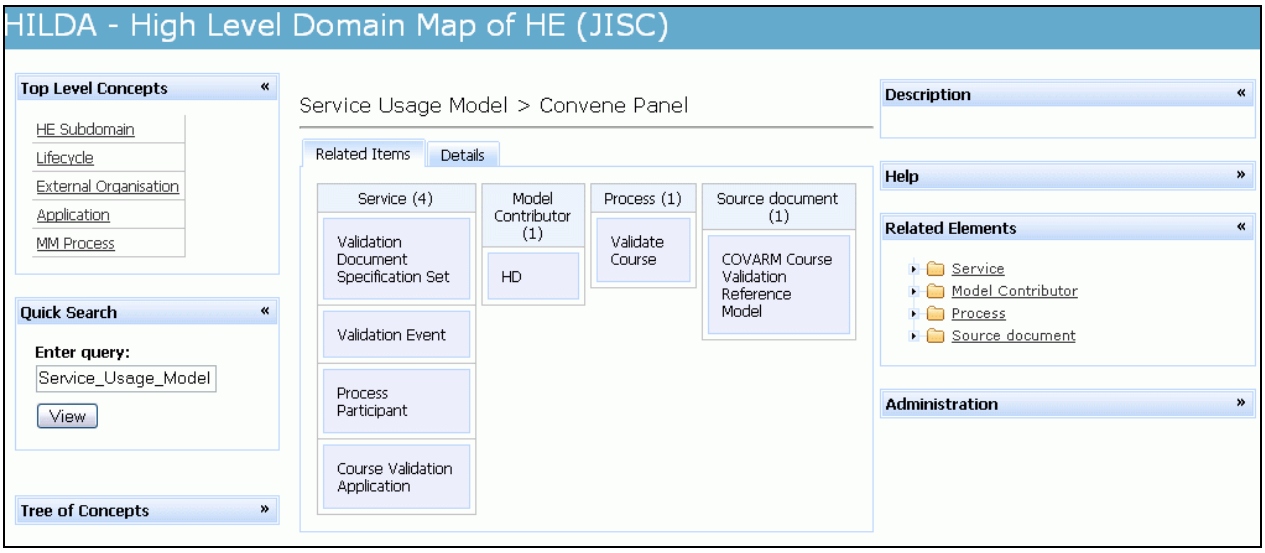

Figure 49: SUM from the HE Domain Knowledgebase COVARM reference model

Glossary

The metamodel elements were given definitions which were discussed and agreed by all the team members. This forms a glossary for the domain map. These definitions are entered as documentation of the elements in the ontology tool for the knowledgebase.

Term	Definition
Activity	discrete action, executed by a role, within the flow of events (process) of a function
Actor	Person or system component fulfilling the responsibilities of a Role. A primary actor is generally identified for a function.
Application	Computer software that employs the capabilities of a computer directly to a task that the user wishes to perform.

Term	Definition
Artefact	Activities 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.
Business Event	An occurrence of something to which the system must respond. Business Events are used to trigger Business Use Cases, to signal changes of state of the business, and to pass information between Business Use Cases.
Deliverable (is an Artefact)	Roles produce artefacts in the course of performing activities
Enterprise Architecture	The practice of applying a comprehensive and rigorous method for describing a current and/or future structure and behavior for an organization's processes, information systems, personnel and organizational sub-units, so that they align with the organization's core goals and strategic direction. Although often associated strictly with information technology, it relates more broadly to the practice of business optimization in that it addresses business architecture, performance management, organizational structure and process architecture as well. (Wikipedia)
Event	An occurrence of a stimulus that can trigger a state transition. Events may include signal events, call events, the passing of time, or a change in state.
External Organisation	Organisation outside the boundary of the HEI that interacts with the HEI.
Federation-holding Organisation	A management organisation for a group of member organisations. The degree of autonomy of the federated organisations varies.
Function	The function describes what the business 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 business actor(s).
Goal	A goal is a desired state of affairs of a system. Goals provide general purpose and direction. They are the end result of ultimate accomplishment toward which an effort is directed. They generally should reflect perceived present and future need. They must be capable of being effectively pursued.
Guidance (is an Artefact)	Additional information related to roles, tasks (activities), and work products (deliverables). Examples of guidance are: Guideline, Template, Checklist, Tool Mentor ,Supporting Material ,Report ,Concept ,Practice, Reusable Asset, Term Definition, White Paper, Example

Term	Definition
Guidance Usage Principle	The way in which a knowledge (guidance) artefact for an activity is used in a particular process context
HE_Subdomain	Also called **work area**. An area of control or a sphere of knowledge, identified by a name, within the HE domain sphere of knowledge.
HEI	Higher Education Institution. Organisation that provides learning products, primarily for higher education.
Interaction Content	The information provided in response to a request from another organisation or information received from another organisation. This information specification contributes to the domain information model.
Lifecycle	The description of the distinct phases through which an object passes during its life. This includes phases such as requirements definition, concept design, production, operation, maintenance, etc. It is a series of states, connected by allowable transitions.
Lifecycle State	A state is a condition of an object in which it performs some activity or waits for an event. An object may remain in a state for a finite amount of time.
Mission Statement	A mission statement defines the core purpose of the organisation
MM Practice[20]	Maturity Model Practices support the goals of an MM Process. Practices are organised according to which dimension of a process they support
MM Process	Maturity Model Process is a description of the goal of a set of activities, each of which will be the responsibility of some role(s) and carry constraints concerning the timing and manner of their execution.
MM Process Area	Maturity Model Process Area from the eMM divides the capability of institutions to sustain and deliver into five major categories or process areas
Operational Plan	Deals with the internal operations and equipment necessary to produce the organisation's products and services.
Organisation	A company, corporation, firm, enterprise or institution, or part thereof (whether incorporated or not, public or private) that has its own function(s) and administration, that supplies products or services
Organisation Interaction	A transaction between two organisations (touch point) in which there is a request for services and/or information and a response to that request.

[20] eMM Quality Improvement Framework
http://artemis.utdc.vuw.ac.nz:8000/pebble/2007/06/26/1182827934197.html

Term	Definition
Organisational Unit	Named subdivision of an organisation with defined responsibilities.
Process	The flow of events of a function describes what needs to be done by the system to provide value to an actor. It consists of a sequence of activities that together produce something for the actor. The flow of events consists of a basic flow, and one or more alternative flows.
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.
Process Control	A decision point in a specific location in a business use case activity diagram where the workflow may branch based upon guard conditions. A decision point with a set of possible outcomes.
Resource (is an Artefact)	Roles use resource artefacts to perform activities
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.
Rule	Rules define specific constraints that must be satisfied. Rules may apply always (in which case they are called invariants) or only under a specific condition. If the condition occurs, the rule becomes valid, and must therefore be complied with.
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 Framework	The systematic format and technical structure that supports metadata, concepts, contents and controlled vocabularies for managing the provision of services.
Service Usage Model	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.
Software Component	“the software implementation of a business concept or business process. It consists of all of the software artefacts necessary to represent, implement, and deploy a given business concept as an autonomous, reusable element of a larger distributed information

Term	Definition
	system." (Herzum & Sims).
Stakeholder	An individual or group with an interest in the success of an organisation in delivering intended results and maintaining the viability of the organisation's products and services.
State Transition	A transition is a relationship between two states indicating that an object in the first state will perform certain actions and enter a second state when a specified event occurs and specified conditions are satisfied. On such a change of state, the transition is said to 'fire'. Until the transition fires, the object is said to be in the 'source' state; after it fires, it is said to be in the 'target' state.
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.
Sub-Process Run Context	A description of the run-time execution of a sub-process.
Vision	A shared mental framework - direction and aspirations of the organisation

Appendix 3: Terms of Reference

The Terms of Reference in the ITT posed a number of questions that this study was asked to consider. Here we show where the topics have been covered in the main report, or, if appropriate address them here instead.

What can be learned from developing a domain map of the UK HE sector?

Where the value is (and to whom) in developing a map / maps, listing key stakeholders and summarising potential benefits. This should also include an appraisal of where and when such a domain map is or is not an appropriate tool through which to develop an understanding of functions / processes, or articulate relationships / data flows, etc.

Much of the report addresses this issue, but especially the section on Scenarios.

However, it is worth briefly listing some of the groups that a domain map is useful for and why. This cannot hope to be exhaustive either for the groups or the reasons.

Stakeholder	**uses**
JISC Potential stakeholders	
JISC Programme managers	• Enhancing their understanding of higher education • Understanding the e-framework • As shown in Scenario 2: Defining a JISC programme by identifying gaps, bottlenecks etc. • Monitoring and recording projects or programme activity • Promoting the work of JISC by increasing its visibility
JISC Committee members	• Understanding the e-framework • Understanding how proposed work relates to existing work. • Identifying gaps or bottlenecks
Project bidders	• Contextualising bids within the domain • Identifying work already done that they can build on • Identifying gaps that they wish to address
Project staff	• Enhancing their understanding of higher education • Contextualising the project within the domain • Locating existing work • Publicising / promoting their work
E-Framework project staff	• Enhancing their understanding of higher education • Enhancing their understanding of the e-framework • Providing better access to the e-framework • Providing a tool for promoting the e-framework • Relating the e-framework to other related work

Institutional Stakeholders	
Business analysts	• Enhancing their understanding of higher education • As shown in Scenario 1: A Business analyst - replacing the Student Record System support analysis within their institution • Support for discussions with stakeholders in a project • Provide a framework for analysis • Provide a framework for recording and analysis • Help locate work already done elsewhere
IT staff Systems Staff	• Enhancing their understanding of higher education • Enhance their understanding of the relationships between various applications • Support their understanding of functions and processes • Provide a means for locating suitable service implementations
Staff Developers	• Enhancing their understanding of higher education • Provide a tool that can be used to help others understand the complexity of a university, and contextualise their work
Non Institutional Users	
Standards Bodies/Institutes	• Understand important data flows that might be better supported by standards • Ensure that standards being developed meet all appropriate needs
Open Source Developers	• Enhancing their understanding of higher education • Enhance their understanding of the relationships between various applications • Help them to locate existing work that they can build on
Commercial Vendors	
Software Developers	• Enhancing their understanding of higher education • Enhance their understanding of the relationships between various applications • Help them to locate existing work that they can build on
Enterprise Management Solution Providers	• Tool which they can map their system to in order to demonstrate the functionality provided
Sales People	• Tool for visualising functions that can be used to show the functionality that they offer • Tool for showing how they interoperate with relevant applications • Tool for showing how they interoperate with relevant external agents

Whether current evidence suggests that a single high level domain map is an achievable goal

(and if so, at how high a level of abstraction would the map need to be in order to be of value to the JISC and to the stakeholders in the sector); whether, for example, there are sufficient differences across the home nations, and/or across old and new universities to require separate domain maps; whether some degree of fragmentation and clustering would need to be applied in order to align a manageably small number of different models to 'types' of institution; or whether commonality can be established at some appropriate level of abstraction and a 'reference' domain map can be created which is not exactly instantiated by any single institution but represents sufficient commonality to enable actual differences to be easily identified.

We have demonstrated that a single domain map can provide views at a level of abstraction that allows it cover virtually all universities in the United Kingdom (exceptions being those universities that are also further education colleges and private universities (ie the university of Buckingham)).

There may well be some functions that some universities do not undertake, and the relative effort and importance will vary, but the functions are common across universities. Indeed, many of them are either laid down by law (health and safety, financial audit) or external bodies that they have to work with (funding bodies, UCAS, HESA).

There will be local differences, especially at the lower level (processes). However, we believe that universities that wish to work with the domain map in significant detail (eg. to support business analysis) will take a local instance of the domain map and customise it with local information, for instance relating job titles (which vary considerably) to roles (which vary much less).

Whether the landscape is so complex that it should be broken down into component areas

such as internal – institutional functions and operations, and the relationships between them; and external – across institutions, eg Funding Council data returns, HESA statistics, research data, etc., or by other means (to be determined by the study) through which to maintain focus and increase the opportunity for representing generic functions;

The domain map that we have partially implemented demonstrates that a single map is a sound and effective solution, so long as a number of different ways of viewing it are provided. This is partially addressed in the section Visualisation of the model.

We have shown that a single domain map can support views based on:

- Relationships with external organisations (agents) such as HESA and UCAS.
- Work areas (domains) such as learning and teaching, research or management.
- Applications (such as virtual learning environment, e-portfolios and human resources management).
- Life-cycles (such as learner, unit of learning and asset).
- Good practice (as laid out in the eMM Quality Improvement Framework)

While we have not had the resources to address it, the domain map is also capable of supporting role and enterprise architecture based views.

Production of canonical models

The way in which functions are implemented as processes can be expected to differ across institutions and to remain open to future improvement and innovation. However they may be close enough for it to be possible to abstract a common or canonical model, as was done in the COVARM project (referred to above). If other such work can be identified it would be useful to highlight it.

We believe that many of the functions in the domain map could be described using canonical models in the way that COVARM has. This is likely to be especially true where there are external factors driving the way that work is done. Thus, examples might include:

- **(Undergraduate) admissions.** This is significantly determined by UCAS and the A level examination boards. While there are some differences (some universities interview candidates, and other do not, some subjects require the submission of portfolios and others do not etc.) It would be reasonable to develop a model which allowed for this variation in practice

- **Research Assessment Exercise -** (or its replacement). This is likely to be significantly determined by the externally required metrics so that all universities will require similar functions and processes to support the work.

- **Bidding to the research councils -** The research councils' requirements are the same wherever the bid comes from, canonical models might therefore be developed. There may have to be several covering the difference research councils, and possibly even their programmes.

There are other areas where common practices have grown up, and there may be sufficient similarity that a canonical description would cover the majority, if not all, universities.

- **Archive management -** those universities that have archival material use similar processes

We also believe that many of the business functions that are common across all businesses (financial audit, purchasing, payroll, human resources management) would be amenable to the development of canonical models. We would expect these to build on work that has been undertaken in industry and the public sector.

Some that are less likely to be amenable to a standard approach may include:

- **Teaching** - where practices vary between subjects and institutions and even levels within a subject

- **Assessment** - like teaching this varies across subjects and levels

- **Student fees** - as the basis for reduced fees appears to vary considerably from institution to institution

There is also some scope for identifying instances of processes that are sufficiently more effective and/or efficient implementations of a function which can identified as examples of good practice.

While this is undoubtedly true we have not had access to appropriate data during the project to comment on this. In order to determine whether specific implementations are examples of good practice would require significant analysis (or use the results of such analysis undertaken elsewhere).

Generic themes and issues which can be pulled out of the work done to date, which may suggest areas of commonality between different process models

It has not been possible to go to the level of detail required for this type of analysis, as it would require a full analysis of each model to be compared. However, we have created the structures which can be used to support this type of work.

Recurring areas of profound difference between models, and between case studies within models,

These may suggest areas that cannot be effectively abstracted up to a common view (and instead may sit outside of any generic map of the educational domains);

In the works and models that we have analysed we have not found any profound differences. However, we have been unable to undertake a detailed analysis of the New Zealand work due to the nature of the artefacts available to us. Though, on the evidence available we do not believe that there are profound differences. Of course, there will be functions that are specific to schools and to New Zealand, but that would not pose problems for the model. The underlying model does not prescribe structure, function or process and would therefore fit all HE organisation types that the authors have encountered.

Vocabularies and taxonomies which have grown up through particular modelling exercises, and how these might be harmonised

Harmonisation of vocabularies is a social, not a technological exercise, and is beyond the scope of this project. However, we do note that is possible to provide role (which is closely related to community) based views on the domain model which could accommodate different vocabularies.

We offer no recommendations on how different communities can be persuaded to harmonise their vocabularies. However, we have established a glossary from the domain map metamodel which can provide a useful starting point for such discussions. The ontology tool that we have used allows for synonyms and the browsing tool permits user preference of the fields displayed, allowing localised views of a common set of elements.

Recommendations for methods by which a more detailed map (or maps) of HE (and potentially FE) functions / processes may be identified, articulated and developed

Based on the synthesis of current knowledge produced by this study. This study should make recommendations which could be fed into the planning of future work;

The current domain map allows maps to be visualised at different levels of detail, from work area (domain) all the way to sub-processes and SUMs (which reside outside the domain map, in the e-framework).

The current domain map allows maps to be visualised at different levels of detail, from work area (domain) all the way to sub-processes and SUMs, whose specification and component services reside outside the domain map, in the e-framework.

This work has put a framework in place for future projects to continue to populate a living evolving knowledgebase of the HE domain. A process should be put in place that would allow

knowledge element authoring and contribution to the knowledgebase. The knowledgebase can be developed by individual HEIs or by the sector.

Recommendation 9: It is recommended that JISC put in place a process that would enable projects, analysts and others in the community to contribute to the domain map.

The set of source document used in this proof of concept work has led to an uneven distribution of elements in the knowledgebase, with a greater emphasis on support and infrastructure elements than on the key functions of higher education, and in particular we would recommend an exploration of:

- Learning and teaching
- Research
- Libraries and information management

Recommendation 10: JISC should consider funding further population of the domain map, with an emphasis on the areas of Learning and Teaching, Research and Libraries and Information Management

Another area that it would be appropriate to consider is enterprise architectures, and their relationships to the domain map. This could be done in conjunction with the planned projects to carry out enterprise architecture endeavours using TOGAF[21]. The domain map could be extended, in a straightforward way, to capture the elements of enterprise architecture, as specified in TOGAF, and provide support for the TOGAF approach. Since the enterprise architecture projects are tasked with providing elements to the e-Framework, the domain map could be used to provide smooth integration between the functions and processes, applications, infrastructure and the service specifications for the e-Framework.

As already stated in Recommendation 5: JISC should fund a project to work alongside the Enterprise Architecture projects to be funded under the JISC Capital Call in order to capture the information that they produce and link it to both the domain map and the e-Framework.

It may also be used to provide the integration of the enterprise architecture findings with the domain functions and processes that it is to support, and with the service usage models that are required for planning the development of service oriented architecture.

Any other issues raised during this synthesis process which should be considered as part of any future work in the area.

In addition to populating the knowledgebase and developing a robust ontology browser based on the proof-of-concept application, two other areas of work have been identified as worth considering.

A Decision Support tool based on the eMM framework and the domain map

The e-Learning Maturity Model (eMM) model was developed in New Zealand based on two complementary models, the Capability Maturity Model (CMM) from the Software Engineering Institute[22] and SPICE (Software Process Improvement and Capability dEtermination)[23]. The Capability Maturity Model for Software characterises a mature, capable software process and

[21] JISC Circular 02/07: Capital programme call for projects http://www.jisc.ac.uk/fundingopportunities/funding_calls/2007/07/circular0207.aspx

[22] Software Engineering Institute (2002) CMMISM for Systems Engineering and Software Engineering (CMMI-SE/SW, V1.1). Staged Representation, CCMI Product Team. www.sei.cmu.edu/cmmi

[23] El Emam, K. Drouin, J-N. and Melo, W. (1998) SPICE: The Theory and Practice of Software Process Improvement and Capability Determination. IEEE Computer Society, California, USA

the progression from an immature, ad hoc software process to a mature, well-managed software process. This model is currently applied to a number of industry sectors[24]. SPICE, which is a joint effort by the International Standards Organisation (ISO) and International Electrotechnical Commission (IEC) to create an international standard for software process assessment adds the approach for organising the e-learning provision practices and processes into process areas.

The CMM has five levels of maturity, ranging from 'initial' to 'optimised'. Each level of maturity in the CMM has a corresponding set of key practices. The practice descriptions are an elaboration of what is meant by maturity at each level of the CMM. From the first phase of his work in New Zealand, Marshall has come to a more holistic view of process maturity in which there are five dimensions of maturity. There is not necessarily a linear progression of capability from one to the next. That is, it is not necessary to reach full capability in one dimension before progressing to the next. It is possible for organisations to develop different patterns of capability across the five dimensions that are to some extent independent (Marshall 2006).

The combination of CMM with SPICE as a basis for eMM provides a means for an institution to appraise their ability to perform their key business processes, such as those required for e-learning provision. It also provides the mechanism for giving guidance to improve process capability. The eMM also offers the means to create the underlying reference model for measuring process maturity from multiple aspects and assessing capability within each aspect. Implementing the CMM determines the state of an organisation's current software process, the high-priority software process-related issues facing an organisation, and obtains the organisational support for software process improvement. Implementing the eMM should similarly create a picture of the current teaching and learning provision processes across the institution and highlight issues facing the HEI.

The complete set of the Process Areas, Processes and Practices were taken from version 2.3 of the eMM framework and entered into the domain map. The eMM framework elements are related to other elements in the domain, allowing a practice view of teaching and learning, and the things that need to be in place for teaching and learning to be carried out. As a general guideline, an eMM practice is usually at a similar level of granularity as an HE domain map sub-process, the eMM process as process and the eMM Process Area as HE subdomain.

In an eMM-based change management project (Pathfinder at the University of Manchester, funded by the HE Academy), a knowledgebase was created to capture relevant elements from a series of practice change cases. The collection of cases has provided an understanding of some of the issues facing an HEI implementing a change strategy and of the value that could be gained from the analysis of the change process. However, in order for this analysis to realise its benefits, it needs to be accessible and easily useable by those with responsibility for implementing change strategies.

Currently, there is a knowledgebase of activities, practices and other elements of the change process. However, this knowledgebase, though information-rich, does not have a user application layer that will allow it to be applied easily to a variety of new change scenarios. We therefore propose development of a decision support tool aimed at managers responsible for implementing change.

To achieve this, the change management knowledgebase could be merged with the HE Domain knowledgebase and the knowledgebase browser tool extended to address decision support requirements.

It will address the needs of managers being tasked with devising and implementing new teaching and learning support structures, with minimal disruption to provision, that can support the demands of the HEI's vision for the future. A decision support tool has application in helping

[24] Griffiths, A. (2005), Capability model mature–or is it?, IT Now, Oxford Journals, http://itnow.oxfordjournals.org/cgi/content/abstract/47/5/18 last accessed 11.5.2006

managers at all levels determine change strategies, providing those institutions that have a need to change and improve their teaching and learning processes, with a practical tool to support the work. The tool could be used in strategy development, to support change in practices or processes or to establish the current status processes in a particular domain.

The tool would utilise the practices from the eMM framework and the empirical evidence gained through the pathfinder project activities to facilitate managers and other leaders in making decisions regarding the establishment and development of processes and practices. It is envisaged that the tool will enable a manager to choose from a number of topics or themes in which they wish to make improvements. For example, they may wish to improve student support or develop staff competences. Having chosen the topic, the tool will provide a 'sub-domain map' of the relevant lifecycle for this particular topic.

This builds on the concept that eMM can be 'sliced' in various ways to produce a 'sub-domain eMM' focused on a particular aspect. This idea for focussed use of a maturity model is supported by the Business Process Maturity Models (BPMM), a well-accepted foundation approach in other sectors, in which domain maps have been used to focus on building capacity in specific areas of the business. The sub-domain map will indicate the appropriate practices from the framework for that particular area and show their linkages to the relevant lifecycle. This will help the user identify potential areas of development in their own organisation. To aid the decision process, the tool will have additional layers which can be viewed for particular domains or sets of practices.

Recommendation 11: It is recommended that the e-learning maturity model be incorporated into the domain map in order to provide additional ways of understanding the higher education domain and to make the e-learning maturity model more widely available.

A process driven knowledgebase for SOA development

The domain map metamodel contains the elements required to address provision of process context sensitive guidance. Each instance of an activity in the model may have guidance attached in the form of checklists, templates, white papers, examples, good practice guides and similar. The processes link the activities and these may be visualised through the ontology browser. The knowledgebase thus has the potential to provide ongoing, at-elbow support for people executing processes of any kind, including development of services for a service oriented architecture. An example of this process with its guidance is provided in the COVARM reference model and this could be imported into the HE domain map.

Recommendation 12: A process driven knowledgebase for Service Oriented Architecture (SOA) be developed, as an extension of the HE domain map, to support developers in producing elements for the e-Framework and for SOA in their own institutions.

Appendix 4: The use of data sources in the ITT

The Original Invitation to Tender (ITT) included a list of suggested sources that we could make use of in building the domain map. It is worth explaining what we have done with each of these.

The sources are:

JISC e-Learning Framework reference model projects[25]

The COVARM[26] (Course Validation Reference Model) project has had some of its elements mapped into the domain model, and it would not be problematic to incorporate more of it.

Some elements of FREMA[27] (E-learning Framework Reference model for Assessment) have been mapped into the domain model, and again it would not be problematic to incorporate more.

While this project has not had the resources to investigate the other four projects

- eP4LL: (ePortfolio for Lifelong Learning)[28]
- LADIE (LADIE: Learning Activity Design in Education)[29]
- XCRI: (eXchanging Course-Related Information)[30]
- Personal Learning Environments[31]

Another JISC funded project is synthesising these projects, and is intending to use the domain map as one of the methods of making the information more accessible to users. Initial investigations by that project suggest that the model should support most of the appropriate information, with other information belonging to the e-framework.

JISC infoNet's Business Classification Scheme[32]

This provides a generic 'map' of the many of the functions and activities undertaken by HEIs; As already suggested, it has a strong focus on the administrative and managerial functions with considerably less work on the functions and processes which actually comprise learning and teaching or research.

Notwithstanding this focus the JISC infoNet's Business Classification Scheme (BCS) forms the basis for the information currently in the domain map.

The BCS Functions need to be more fully related to applications, work areas and life-cycles than there has been time for in the project.

[25] http://www.elframework.org/refmodels/
[26] http://covarm.tvu.ac.uk/covarm/
[27] http://www.frema.ecs.soton.ac.uk/
[28] http://www.nottingham.ac.uk/epreferencemodel/
[29] http://www.elframework.org/refmodels/ladie
[30] http://www.elframework.org/projects/xcri
[31] http://www.cetis.ac.uk/members/ple/
[32] http://www.jiscinfonet.ac.uk/partnerships/records-retention-he

New Zealand Education Sector Standing Committee's ICT Strategic Framework for Education[33] and Education Sector Architecture Framework[34]

The information that we have received on the New Zealand Education Sector Standing Committee's ICT Strategic Framework does not provide sufficient information as it stands to be of much use. We have extracted all the information that we could. However it is not clear what many of the items are, and, as discussed previously relationships are often unclear and the form of the map causes problems with representing the knowledge.

However, if there is a more detailed model underlying the representations that we have seen then this may form a useful input.

Lessons from and recommendations of the Management and Administrative Computing (MAC) initiative[35] 1988-1995

Lessons from the MAC Initiative contain no information on any of the models or data used. The information is about the lessons that could be learnt from the approach taken. It is not impossible that there is data from the MAC initiative that could be used at a later date.

JISC infoNet's Managed Learning Environment (MLE) InfoKit[36]

The MLE Infokit considered the steps in building an MLE rather than the business processes it supports. Whilst a useful reference material many of the ideas have been superseded by practical implementations of MLE's using SOA principles. More relevant data may be collected by reviewing some of these projects.

Leadership Foundation organisational development group[37]

Leadership Foundation organisational development group has some potentially useful information on roles, but at this stage we are not modelling roles. It would be useful to include roles, and have a role based view onto the domain map. However, the information available from the Leadership Foundation organisational development group is at a very high level and considerable work would be needed to expand on the information available.

HEA e-Learning Benchmarking exercise[38]

With the exception of the e-learning maturity model (see below) the HEA e-learning Benchmarking exercise and has not been considered to date.

The e-Learning maturity models

The information from the e-learning maturity model has been incorporated into the domain map in its entirety.

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[33] http://www.minedu.govt.nz/web/downloadable/dl11734_v1/supporting-document-for-ict-strategic-framework-co.pdf and www.minedu.govt.nz/goto/ictframework
[34] http://www.middleware.edu.au/docs/forum/Leach_Forum_Aug06.pdf
[35] http://www.ucisa.ac.uk/events/1999/conference/price_files/TextOnly/index.html
[36] http://www.jiscinfonet.ac.uk/InfoKits/creating-an-mle/one-more-time/index_html
[37] http://www.lfhe.ac.uk/networks/od/odgroup.html
[38] http://www.heacademy.ac.uk/benchmarking.htm

European Framework for Quality Management (EFQM) Excellence Model - Higher Education Version, based on the EFQM excellence model[39].

The European Framework for Quality Management contains no information that we could identify that is visible to non-members and that is relevant to the model. The EFQM project talked about quality at quite a high level. For business processes this would translate to Key Performance Indicators (KPI's) which could be measured. Examples of these may be technical such as number of registrations in a day to more business focused such as number of student graduating in each award classification. The initial review of EFQM did not find data to this level of detail.

[39] http://www.efqm.org/Default.aspx?tabid=35 and http://www.shu.ac.uk/research/integralexcellence/docs/embracing_excellence.pdf

Appendix 5: Visualisation and domain maps

As discussed briefly in Visualisation of the model we consider a map to be a tool that supports navigating or exploring, in this case a domain map is a tool that can support exploration of a domain model.

Here, we look at some of the issues associated with visualisation, and some of the approaches to creating domain maps that have been used elsewhere.

Visualising with maps

Take the following maps of Italy:

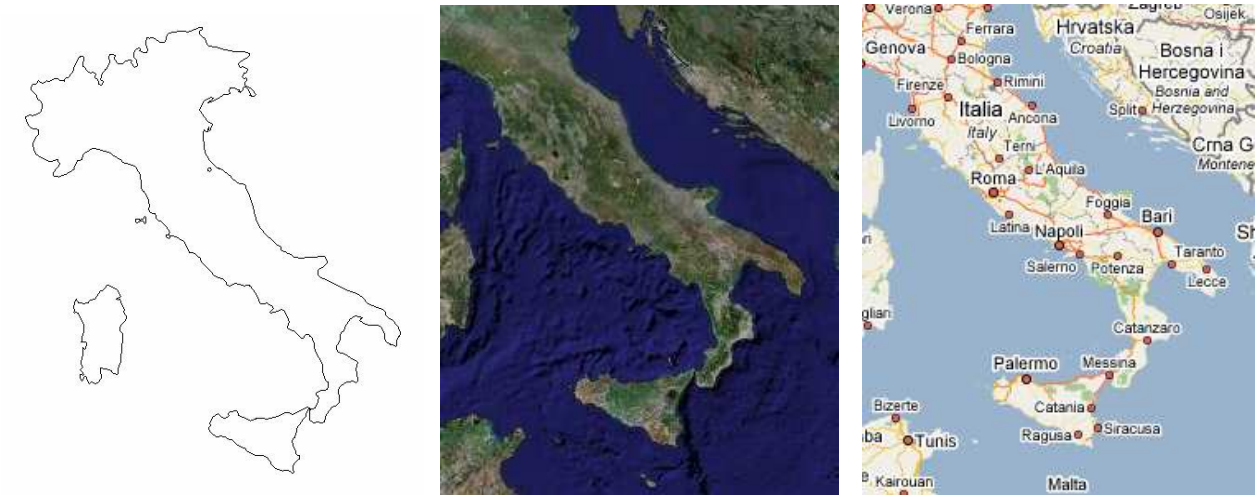

Figure 50: Three maps of Italy[40]

The first is the easiest to understand, but contains very little information, while the other two take some effort to understand, and as the detail becomes greater more effort is required.

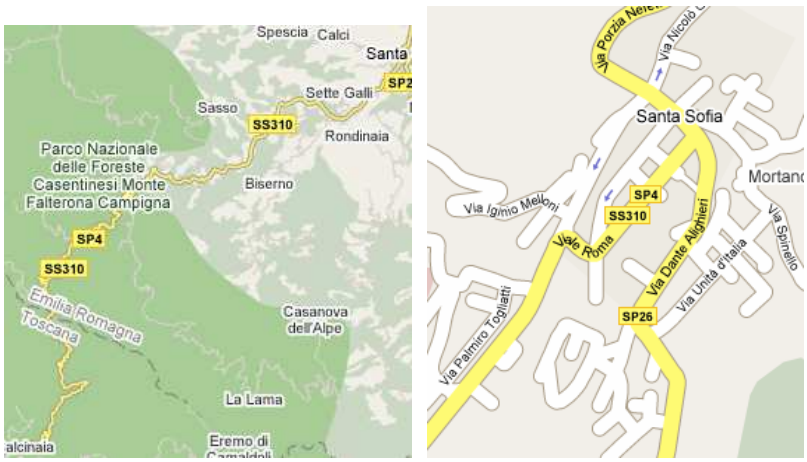

Figure 51: details from Italy[41]

[40] http://geography.about.com/ library/blank/blxitaly.htm and Google maps
[41] All from Google maps

As one increases the level of detail (as shown in Figure 51: details from Italy) one looses much of the context, so that it is difficult to understand which part of Italy they are from. Thus, it becomes increasingly important to help the user with the broader context, which in this case might take the form of showing where on the larger scale maps the detail comes from. It may also be important to provide support on the choice of view (topographical, schematic, geological etc.). We have grown up with geographic maps and have a good understanding of what they are trying to achieve and how they work, this means that the support that the user requires is likely to be relatively low (perhaps a key and an indication on a smaller scale map of what the current map covers).

Visualising domain maps

We can find no examples of domain maps that relate to what we are trying to do here. There are a number of things that call themselves domain maps, but these are either very simple or complex and incomplete. See Figure 52: Systems Integration Domain Map, Figure 53: The JISC e-Learning Framework - Common services or Figure 54: XCRI domain map for examples that claim to be domain maps, though the last is perhaps tongue-in-cheek. There are a number of problems with these approaches, including that they are not scalable and that they have very little explanatory power.

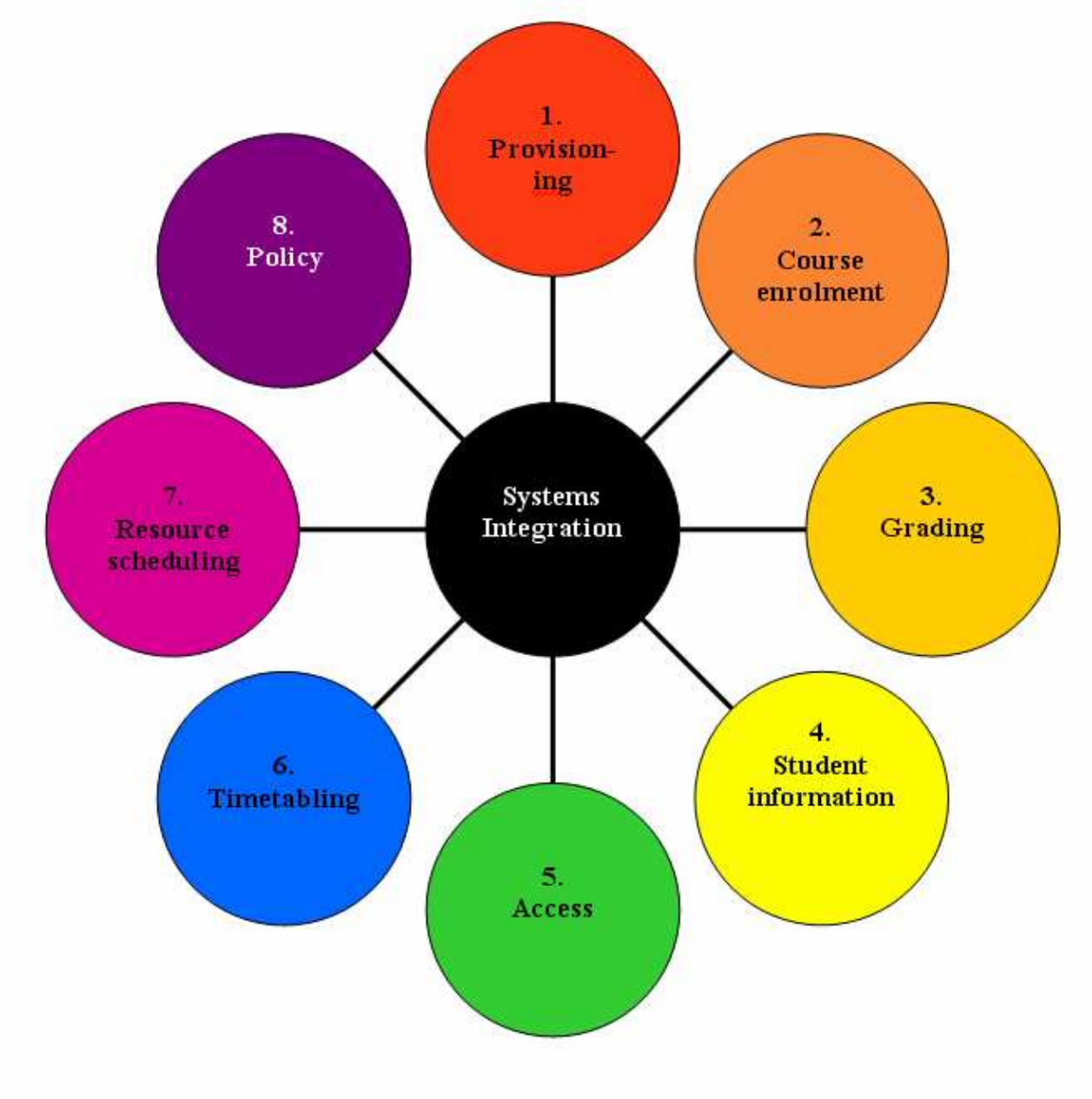

Figure 52: Systems Integration Domain Map[42]

[42] http://www.elearning.ac.uk/resources/Systems%20Integration%20Map.doc/download

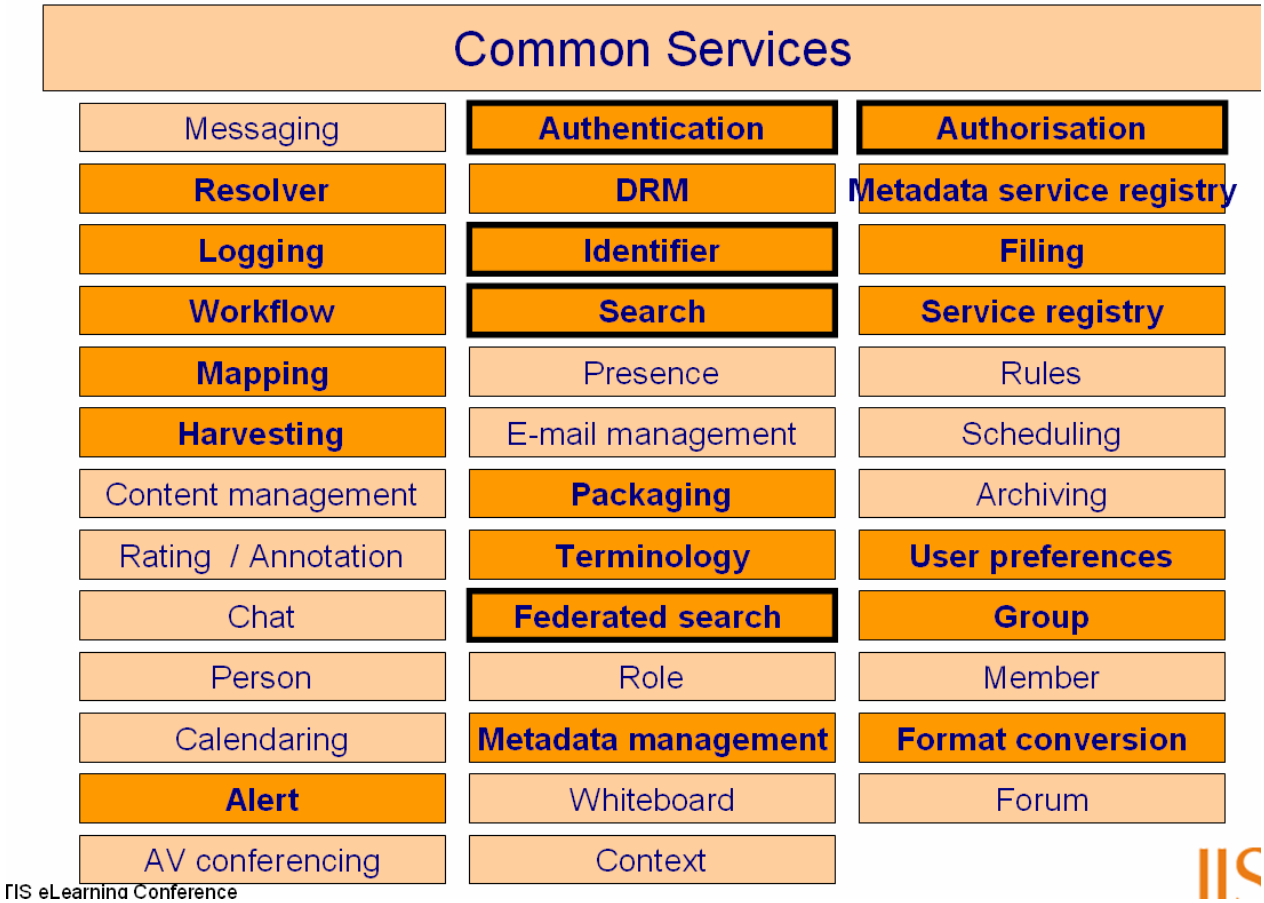

Figure 53: The JISC e-Learning Framework - Common services [43]

[43] ibid

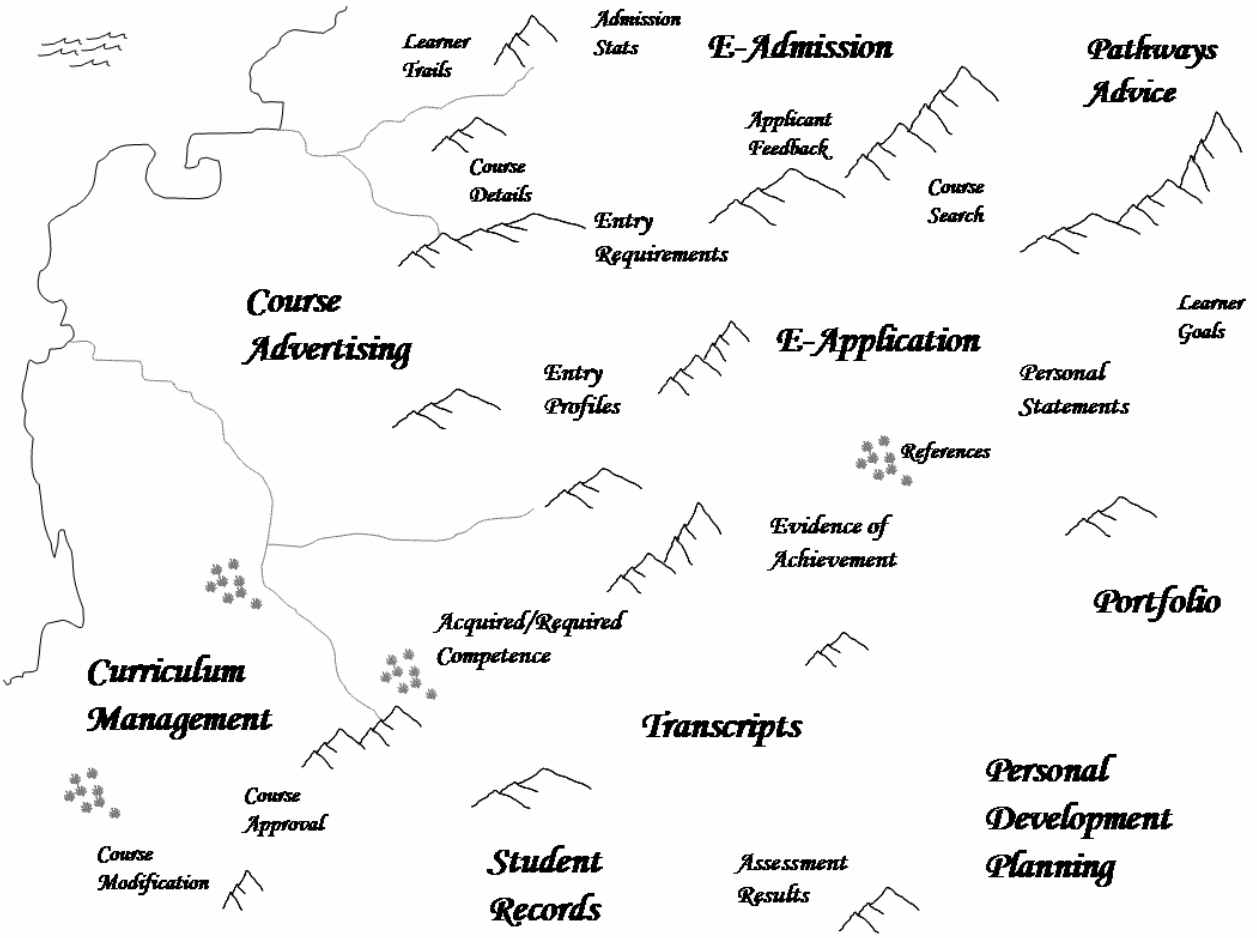

Figure 54: XCRI domain map[44]

On the other hand, the New Zealand Ministry of Education has developed a set of diagrams, or maps, of schools comprising a business component framework and a schools' architecture framework (See Figure 55: New Zealand schools - Business Component Framework, Figure 56: New Zealand schools - Schools Architecture Framework, Figure 57: New Zealand schools - Target State Implementation and Figure 58: New Zealand schools - Business Element Model). These are significantly more detailed than the previous maps, but from our perspective they are insufficient. Firstly there is nothing other than the labels by way of concrete information. For instance, few people are likely to know what OSH management is. Secondly, it is not clear what any of the boxes or relationships mean. This could be alleviated with a key but that still would not tell you the relationships between the business services and the functions and processes in the Business Component Framework. Thirdly, it is difficult to know how to use the diagram, and in particular how to start reading it. Fourthly, because it is being portrayed as a two dimensional artefact it necessarily has to over simplify in order to achieve legibility. As a single example, "Teacher payroll" appears as part of staff management and resource management, but not as part of financial management, and other staff in the school do not appear to be paid at all!

[44] http://www.elframework.org/projects/xcri/xcri_domain_map.gif/download

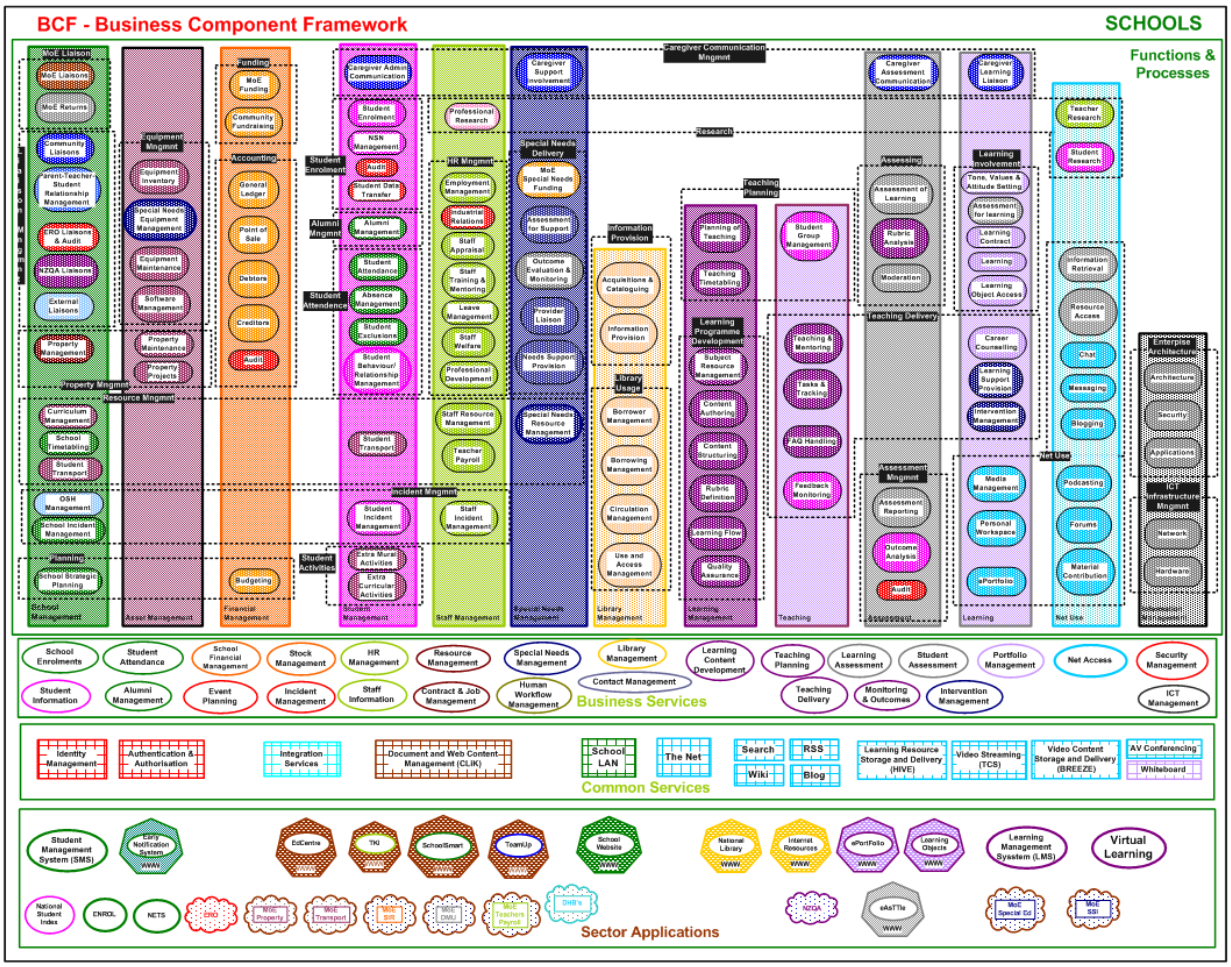

Figure 55: New Zealand schools - Business Component Framework

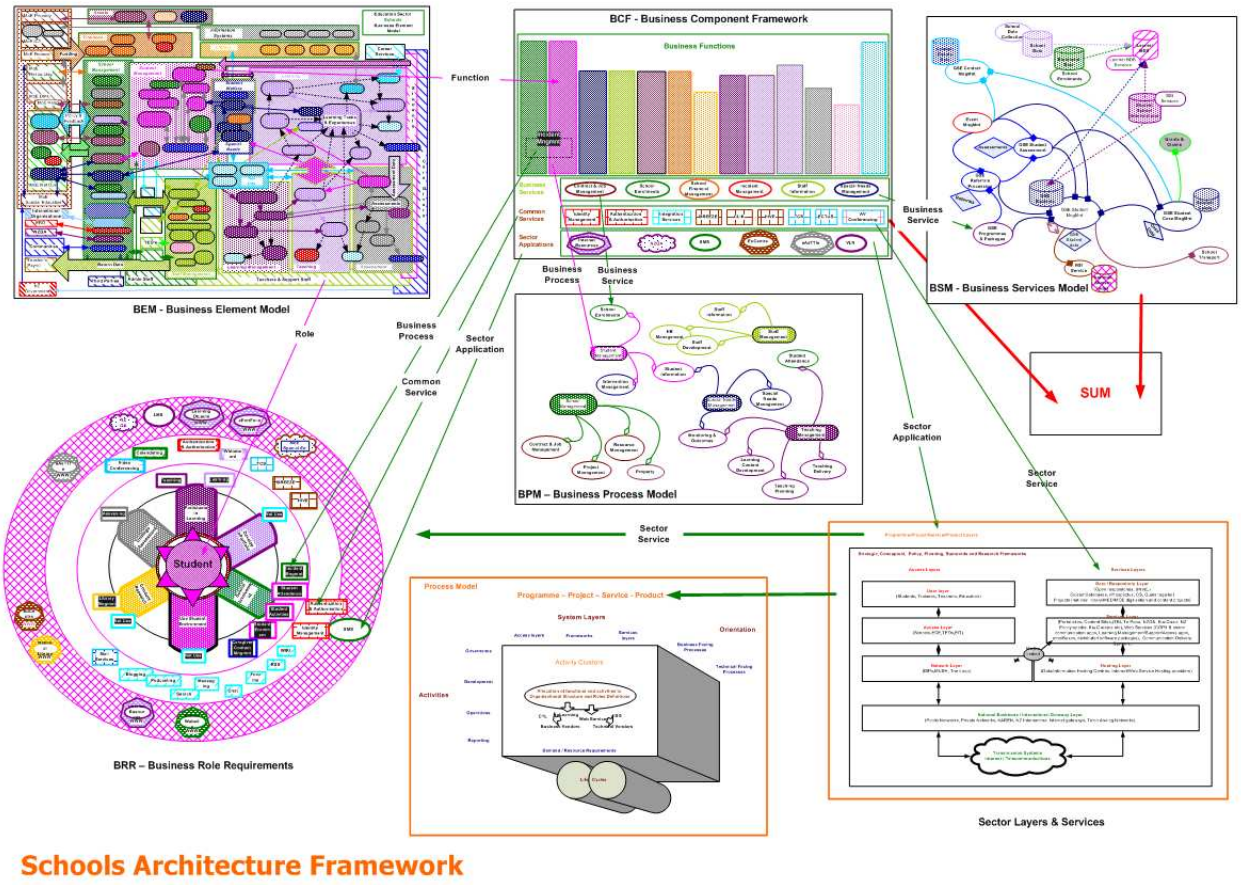

Figure 56: New Zealand schools - Schools Architecture Framework

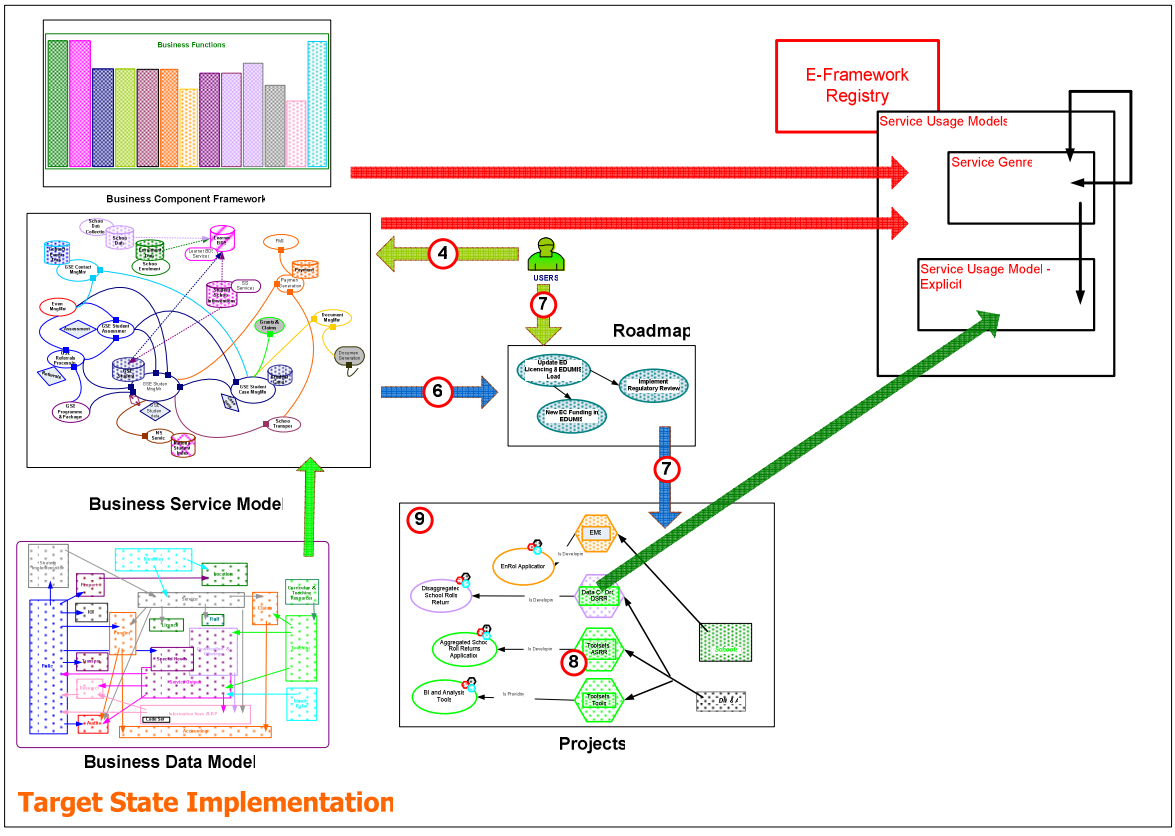

Figure 57: New Zealand schools - Target State Implementation

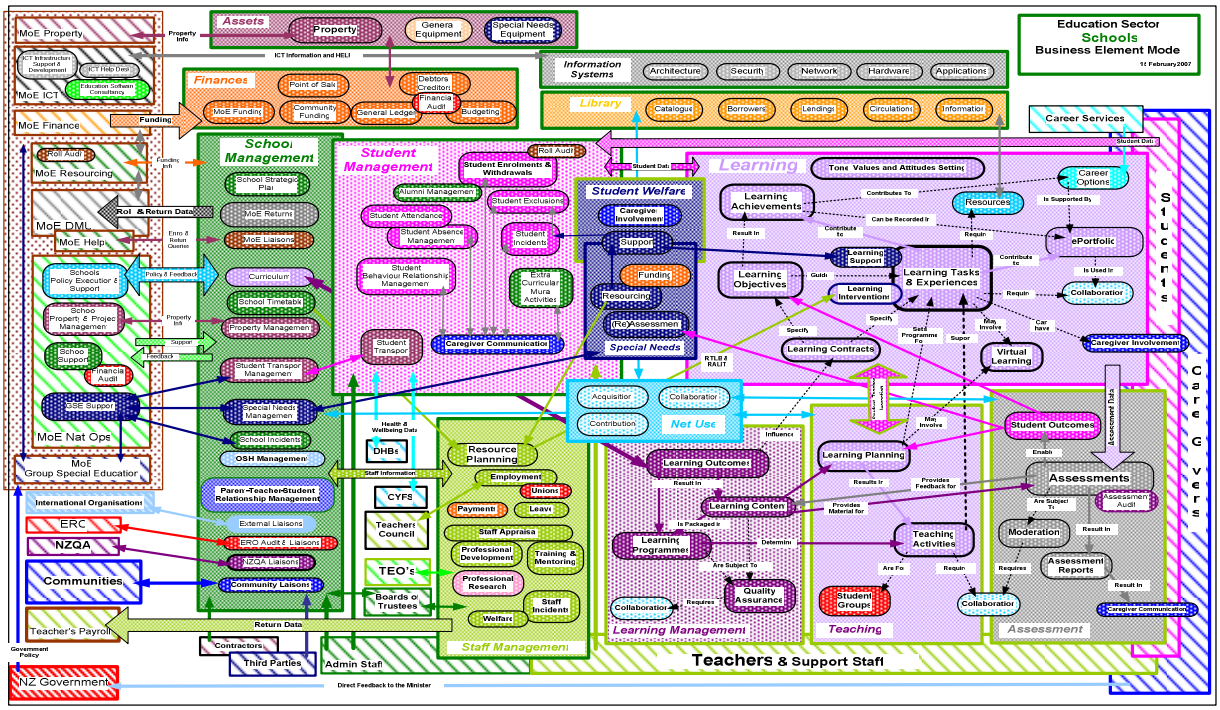

Figure 58: New Zealand schools - Business Element Model