

Reference models - the next important step

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One of the key steps in moving towards the implementation of a service oriented approach is the development of reference models. This article is an attempt to understand what reference models are, the role they might play, and to contribute to the discussion that is taking place about what these might constitute - at a general and non-technical level.

Background

In the Non-technical guides to technical frameworks [1] I explored the move that is taking place in the IT world away from monolithic systems to service oriented approaches, particularly in the context of education. The JISC e-Learning Programme has been developing a technical framework based on web services to support this approach. A key paper The e-Framework for Education and Research: an Overview [2] outlines the present thinking about the role of these approaches and particularly the role of reference models, and is recommended reading for interested readers.

Introduction

Ten years ago we could create a simple web page using an html editor, then add a newsgroup, and it seemed as if moving into online learning could be a relatively painless and exciting adventure [3]. Now the internet has become ubiquitous and technically extremely complex.

If we are presently involved in online learning in an educational institution we will be grappling with integrating our student record system with the library system and the virtual learning environment (VLE) we have implemented to support e-learning. We will also be thinking about how we share information between institutions because many courses are beginning to be taught collaboratively, and we need to be in a position to support lifelong learning.

And now we are being confronted with developments in service oriented approaches to technical infrastructure which, if the hype is to be believed, will solve all our problems and enable us to move towards a more flexible and responsive model. This approach will also allow us to use the legacy systems we already have in place, and yet take advantage of a wide range of tools, so we can build a system which will suit our needs.

If we are teachers, this may sound like a great vision, but it may now feel as if the whole thing has become so technical and impenetrable that it is difficult for us to engage in thinking

about which might be the best tools for us to use, even though we may already be feeling constrained by what's available. Yet at the same time, we may be happily using the internet in all sorts of ways at home for online shopping, travelling, entertainment, digital photography, email and so on.

Part of this dissonance will be arising from the fact that the technical speed of development of the internet far outstrips the speed at which institutions and large organisations can respond. However, service oriented approaches to system development are offering a way forward. A component based approach which enables organisations to 'mix and match' tools, or 'services', means that they can design and construct systems to suit their own needs, and include their existing 'legacy' systems as well, thus allowing for a far more flexible and economic approach. [4]

One of the advantages to this approach is that systems can be developed that support the way users actually want to do things, but one of the costs is that these users will have to think seriously about what it is they want to do, and how they want to do it, in order to find out what tools would be best for them. Whilst developers are used to engaging in 'user requirements gathering' and 'systems analysis' to help them design systems that they can then implement in code, teachers are not generally used to having to be deeply analytical and precise about what they do, or to engaging in grappling with the range of technical tools available and selecting what might be best for them. This article is looking at how the development of 'reference models' may help to provide a way forward.

The e-Learning Framework and reference models

The e-Learning Programme is concerned with the development of a service oriented approach to technical infrastructure for education through the e-Learning Framework (ELF), and at the same time with developing a deep understanding of the pedagogical implications of e-learning to ensure that these inform the design of technical systems.

Recently, an important development has taken place, the scope of the ELF has widened and become part of The e-Framework for Education and Research, a collaboration between JISC and the Australian Department of Education, Science and Training (DEST). [5]. Whilst I will continue to refer to ELF for the rest of this article, this change will be reflected in a change of name at some point in the near future.

Reference models - the next important step

The ELF provides a 'factoring' of all the possible functions we might expect an ideal e-learning system to provide and describes these as services, however it does not yet show how these might be combined in a real situation. Whilst an integrated system such as a VLE provides a structured suite of tools which determines how they should be used, anyone wishing to use a service oriented approach will have to think far more carefully about what they wish to be able to do in order to select the set of tools they need.

One of the next steps, therefore, involves identifying a particular area of interest, say assessment or PDP, and considering those services that will be relevant to that domain and how these could be selected and combined.

In order to move into this next phase we need to go through several stages –

- firstly we need to define the domain or problem we are interested in (for example assessment)
- we need to understand what people actually do and/or want to be able to do in the context of assessment (and we need to be able to describe this in both natural language and in a formal and abstract way)
- we need to consider what services in the ELF can support these activities, and if there are gaps in the e-Framework, identify what these might be
- then we need to consider how these tools might work together at a technical level, and how the activities we have analysed can be sequenced

The outcome of this exercise is a *reference model*

A reference model shows which services will be needed to solve a particular problem and how they can be put together, the relevant standards that apply, and how they might be used. However this will still be at a general level, so it can be referred to from a variety of educational contexts. They articulate needs, requirements, workflows and processes in a number of domains, checked against a wide number of users and stakeholders in each domain, together with a mapping of each process to underlying technical services [6]

In order to move from this stage to produce an implementation in a real situation, the next step would be to create a design based on one or more reference models, and the final step would be for a programmer to implement this design. Reference models are therefore of key importance in the process of moving from a technical framework which can seem very abstract, to implementing this approach in the real world.

The development of a reference model involves gaining a good understanding of the area of interest and of what people actually do (ie the human context), and of what technology is available and should be involved (ie the machine context). It therefore helps in the process of building the 'all-important bridge

between the user and the technology' [7]

The role of reference models in a service oriented approach

In their paper on Service Oriented Approaches [8], Wilson, Blinco and Rehak explain the process of moving from a framework to a working implementation by defining four stages or 'key concepts' –

- A Framework provides a "broad vocabulary" consisting of all the possible 'services' for a domain such as e-learning (see the ELF)
- A Reference Model selects some of these services for a common learning or teaching requirement and shows how these services can be used to meet this need
- Designs can now be developed which implement the reference model
- An Artifact is then produced from one of these designs. It may be 'a piece of software, a workflow or process, a combination of software components, a piece of content or anything else that can realise a design'

Whilst metaphors always have limitations, the following two may help in understanding the role of reference models –

A dinner party

Dinner parties take a wide variety of forms from informal gatherings with close friends to highly formal and structured events. They all involve the selection and combination of dishes, wines etc from a 'framework' of possible dishes and wines, and the use of certain types of tools and objects such as cutlery, table decorations etc, and perhaps a dress code.

The hosts of a dinner party need to firstly decide what this event is about (relaxing? impressing someone? a wedding? etc) and a 'reference model' for this particular type of dinner party would then suggest certain suitable combinations of dishes and wines, the sequence in which these would appear, perhaps the types of acceptable clothing etc.

However, it would not say what these dishes or clothes should actually be, or what technology in the way of cookers, food processors etc should be used. The specific choice of recipes etc would be described in the 'design' of the particular event, and the actual result in terms of the meal itself would be the 'artifact'.

Manufacturing a car

A car manufacturer will construct cars from a wide range of possible components (a 'framework'), many of these may be purchased from a third party supplier. The manufacturer will develop a 'reference model' which defines a) what a car in general terms is, such as its behaviour and the components that make it up b) certain key characteristics for the components they need to construct a car (eg bolt sizes, dimensions, strengths of material etc) - these will enable the supplier to design the component as they wish as long as they comply with these constraints, and it will allow this component to be combined with others purchased from other sources.

Some of these components may be used in several different models of car, but in order to produce a unique model a 'design' will be produced, and the factory will then be able to produce a car based on this design - an 'artifact' using the terms above.

In both these cases, it is necessary to understand in general terms the nature of the activity, (eg a dinner party is not the same as, say, breakfast, and a car is not the same as a tractor), and to move from this position to a situation when a particular event can occur in the real world.

A more precise and technical description of what a Reference model should provide is offered in the paper *The e-Framework for Education and Research: An Overview* [9]

A Reference model should provide -

- An abstract task model of what has to be accomplished to meet the needs addressed, described in a way that is independent of how it is accomplished
- The description of the chosen means of implementing this model, including:
- The roles and activities that humans and computer systems are respectively to play in accomplishing this task.
- The workflow or processes involved.
- The use cases involved at one or more points in the process that form part of the computer system requirements at each point.

From the use cases are derived:

- a specification of the service or services called on, together with links to the specifications and bindings used; and

- a specification of how the various services are co-ordinated in those cases where they have to work together.

Reference Models and any accompanying reference implementations provide idealised exemplars that help with deployment and can be modified or adapted to fit particular institutional circumstances. More importantly, they help ensure that development is driven by human and organisational needs rather than by technology.

Techniques and tools

Whilst we have therefore seen that reference models can provide a way of 'bridging' the world of users and technologies, there are some real challenges involved. In order to write the code that underpins a piece of software, developers need the task they are addressing to be described with great precision. However, it is very unlikely that practitioners such as teachers, will be able to (or wish to?) describe what they do in such precise ways.

It is not the purpose of this article to explore the techniques and tools available for developing reference models in any depth as this will happen elsewhere, but it is important to note that there are many tools available to help articulate and model what people actually do, and as importantly, what they want to be able to do, for example UML [10] for the development of use cases, models of workflow [11], and tools such as the Business Process Execution Language for Web Services (BPEL4WS)[12] which provides an orchestration language for web services enabling them to be sequenced and structured. The question of identifying relevant standards and specifications is central to ensuring the web services selected will be interoperable [13]. The development of reference implementations will help identify those services which are available and where gaps exist.

JISC Reference Model Projects

The JISC e-Learning Programme has recently funded five projects to develop Reference Models for the ELF, as part of the JISC Distributed e-Learning Programme. These are based on the above approach to producing reference models. JISC circular 10/04 [14] called for proposals to "specify reference models for the e-Learning Framework". The domain areas these projects were asked to address included Assessment, Learning Content, Enterprise, Personal Development Planning, Personal Learning Environments and Resource Repositories. All these areas relate directly to CETIS SIGs [15] which means they will have access to established communities of practice, and projects will be working closely with these. They will also provide support in their domain to DeL Regional Pilot projects, and this will begin the process of integrating wide ranging aspects of the e-Learning Programme. The circular provides more information on the background, the aims of the projects and the approaches they are expected to take and includes a specification for developing these reference models.

Reference models - the next important step

The Reference Model Projects –

This first set of reference model projects is wide ranging in scope, some focus on quite specific problems such as course validation, and others on more general domains such as assessment.

eP4LL - ePortfolio for Lifelong learning

LADIE - Learning Activity Design in Education

FREMA - FREMA will develop the reference model for the Assessment domain area.

XCRL - Exchanging course related information The XCRI project aims to define a generic course description specification for the UK.

COVARM - This project will develop a Course Validation Reference Model

Discussion

Reference models have been developed in the software world for some time, and interpretations of the concept have been wide ranging. From the perspective of the e-Framework they can play a key role in bridging the world of users with the underlying invisible world of services. They thus also provide a route for institutional planners and users to finding appropriate tools and services that meet their needs[16]

The recently funded projects for the e-Learning Programme will allow this concept to be explored in the particular context of the ELF, and enable us to –

- look at ways of analysing and articulating what we do, and would like to be able to do when we engage in teaching and learning
- look at and identify the tools we need to be able to engage in these activities, and how we wish to use them
- look at ways of describing tools and processes in sufficiently precise and unambiguous ways to allow developers to use this information to produce practical implementations
- find out whether the tools and components we need exist or need developing
- show whether the tools we have available can be combined into a 'composite application' and are truly interoperable.

The projects that have been funded vary widely in their scope from tightly defined processes such as course validation, through to large domains such as assessment. The major significance of this work however, will be that it will help us to understand the territory more deeply in terms of a) mapping what is actually out there, including toolkits, standards, services and so on, b) the understanding we have of the human and pedagogical processes, and c) what people are actually doing now and want to be able to do in the future. It will also help us to explore the usefulness of reference models as an approach to helping us to develop working systems.

The process of developing reference models will bring different

strands of the e-Learning Programme's work together. It can be seen as a considerably technical exercise both in terms of expressing what people actually do through tools such as UML, and of combining web services from the ELF so they can support this. The first reference model projects will be an important learning exercise, and will help us begin to understand what is involved in the development of such models, and the role they can play implementing this approach in the real world. It is well recognised that large IT projects in both the public and commercial sectors often fail to fulfil their promise, and this is often because the alignment between the needs of users and the IT system itself is poor. [17] By looking carefully at both the human and the technical context, it is hoped that reference models will be an important contribution to ensuring that systems can be put together that realise the potential of a service oriented approach.

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