The Enterprise Tool Set – An Open Enterprise Architecture

John Fraser & Austin Tate

Artificial Intelligence Applications Institute
University of Edinburgh
80 South Bridge
Edinburgh EH1 1HN
United Kingdom

J.Fraser@ed.ac.uk & A.Tate@ed.ac.uk

Abstract

The Enterprise Project is collaborative work between AIAI at the University of Edinburgh, IBM UK, Lloyd's Register of Shipping, Logica and Unilever. The project is establishing a generic framework within which enterprise tools can be used to assist users in their tasks. It is based on an Enterprise ontology which establishes shared terminology for communication between users and tools. The paper begins with an overview of the Enterprise Project and its current status.

The main aim of the paper is to describe the open systems integration architecture which underlies the design of the Enterprise Tool Set. This draws on earlier work in Open Agent-based Planning and Scheduling Architectures (e.g., O-Plan [2],[8] and TOSCA [1]). A means to more easily integrate new capabilities into the toolkit is provided through the architecture which acts as a mediator between the various components. This draws on earlier work on mediators which act to help users of data base systems (e.g., PEXES/SDBA [4],[6]).

The core of the tool set will support user tasks via a workflow engine which will assist the user in performing a task, allow access to appropriate tools and methods, and make available suitable information resources. An abstraction of this central workflow within the tool set is provided in this paper. This acts to provide a framework for describing the various components integrated within the tool set and allowing them to be provided in a modular fashion [9].

1 UK Enterprise Project

1.1 Introduction

The Enterprise project is about halfway through its 3-year life (August 1993 to July 1996). The partners, AIAI, IBM, Lloyd's Register, Logica and Unilever, have produced a state-of-the-art survey [3], built two demonstrator programs and built an enterprise ontology. We are in the process of defining exemplar enterprise modelling scenarios for the user organisations and designing a tool set to support these and other scenarios. Later this year we will be implementing the tool set and testing it against our exemplar scenarios. Next year we will produce a further, freely available scenario, which will be used to demonstrate the full power of the Enterprise tool set.

1.2 Context: Management of Change

Enterprise is the UK Department of Trade and Industry's major initiative to promote the use of knowledge-based systems in enterprise modelling. The project, part of the DTI Intelligent Systems Integration Programme (ISIP), is budgeted at over £2.6 million and scheduled to run from August 1993 to October 1996.

The focus for our interest in enterprise modelling is the management of change. Understanding and visualising complex businesses enables you to identify and address areas that might be constraining business performance. Enterprise modelling helps you focus on those areas you can change, how these areas are currently functioning, how they might be optimised, and how any changes might impact other areas.

1.3 Issues: Generic Models, Reuse and Integration

Generic models are those that are not built for a specific purpose: the implication is that they can be used for different purposes at different times. There are two ways in which the Enterprise project is building reusable models.

First, we recognise the power of having information structures which people can share: for communication, for consistency and for understanding. Second, we recognise the power of having shared methods for tackling tasks. Together, the shared information structures and shared methods constitute a common view or perspective of a particular subject or 'domain'. The development of shared mental models can be enhanced by such a common view. We have been devoting much of our efforts recently to the derivation of the Enterprise ontology, which we hope provides a common view of the information and activities involved in enterprise modelling.

The Enterprise ontology helps provide a gel for integrating what is currently a disparate set of modelling techniques and tools. This gel is 'semantic': it helps clarify the meaning of the terms used. The existence of a gel with clearly specified properties also make it easier to design new techniques and tools with the intention of integrating them easily with existing ones.

Integration of computer tools also requires an infrastructure for communicating messages between tools – ours is based on an agent model – and a means of translating a user's needs into the demands on the tools – ours is supplied by what we call our task management.

1.4 Enterprise Ontology

We have explored five areas pertinent to enterprise modelling (activity, organisation, strategy, marketing and time) and, after discussion, we have 'bought in' to the definition of over 100 terms. We acknowledge the time, expertise and material of various other people and bodies who have contributed, directly or indirectly, to the development of the ontology. These contributors include:

KSE: ARPA Knowledge Sharing Effort

ARPI: ARPA/Rome Laboratory Planning and Scheduling Initiative

O-Plan: O-Plan Project, University of Edinburgh

PIF: Process Interchange Format and the Process Handbook work at MIT and the University of Hawaii

TOVE: Toronto Virtual Enterprise Project, University of Toronto

ORDIT: Esprit project No. 2301

CYC: Common Sense Knowledge Base Project at MCC and Cycorp

WfMC: Workflow Management Coalition

The first version of the ontology is paper based and we are now working on encoding it in KIF, the Knowledge Interchange Format developed under the Knowledge Sharing Effort. We know that the ontology will evolve as the project proceeds. We envisage the Enterprise tool set providing facilities to maintain and expand the ontology.

1.5 Enterprise Application Scenarios

IBM, Lloyd's Register and Unilever are contributing to the project as tool set users, and each is focusing on a particular enterprise modelling scenario of relevance to themselves. These scenarios are currently being described in process and object notations in, as far as possible, the terms of the ontology. The scenarios will then be used as testbeds for both the ontology and for the Enterprise tool set when it has been implemented.

1.6 Enterprise Tool Set

We have mentioned the tool set several times already. It will support various roles of user, from ontology maintainer, through method modeller (who describes generic enterprise modelling scenarios), through tool administrator (who defines which tools are applicable at certain stages in the scenario), to business analysts (who are guided in the use of the common methods as they follow the scenario).

An open systems integration architecture is being used as the basis for the tool set design. We are using available technology for the plug-in components wherever possible, for instance standard business spreadsheets and tools. We are also using the HARDY tool and wxWindows library, which have been developed at AIAI, for aspects of the user interface. The CommonKADS method [5] for the development of knowledge based systems has been used for analysis and design, and the STUDIO method is being referred to for user interface design.

1.7 Final Demonstrator

Towards the end of the project we will be using the complete Enterprise tool set to define and build a general demonstrator which will embody, as far as possible, common features typical enterprise modelling scenarios. We welcome any suggestions for scenarios which you may think would interest and benefit a wide audience.

2 Approach to an Open Enterprise Tool Set Architecture

Figure 1 shows a systems integration architecture whose general structure has been adopted on a number of AIAI projects.

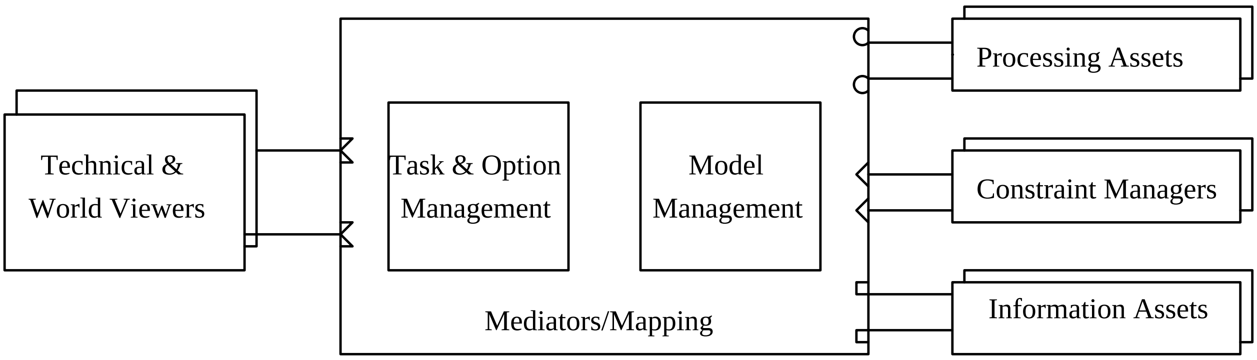

Figure 1: Generic AIAI Systems Integration Architecture

The various components "plug" into "sockets" within the architectural framework. The sockets are specialised to ease the integration of particular types of component.

The components are as follows:

Viewers – User interface, visualisation and presentation viewers for the model - sometimes differentiated into *technical* model views (charts, structure diagrams, etc.) and *world* model views (simulations, animations, etc.)

Task and Option Management – The capability to support user tasks via appropriate use of the processing and information assets and to assist the user in managing options being used within the model.

Model Management – coordination of the capabilities/assets to represent, store, retrieve, merge, translate, compare, correct, analyse, synthesise and modify models.

Mediators – Intermediaries or converters between the features of the model and the interfaces of active components of the architecture (such as viewers, processing assets, constraint managers and information assets).

Processing Assets – Functional components (model analysis, synthesis or modification).

Constraint Managers – Components which assist in the maintenance of the consistency of the model.

Information Assets – Information storage and retrieval components.

The generic architecture has been used within projects such as:

- O-Plan (figure 2) – the Open Planning Architecture agent-based task assignment, planning and plan execution support system,
- PEXES/SDBA (figure 3) – a mediator system which allows model-based access to data bases, and
- Enterprise (which uses the generic architecture most directly – figure 4).

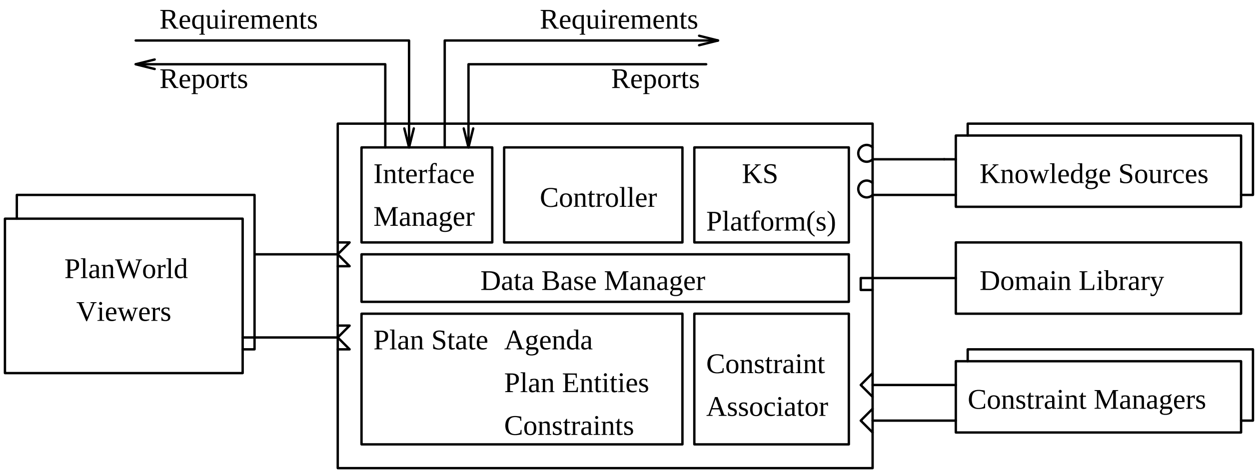

Figure 2: O-Plan Agent Architecture

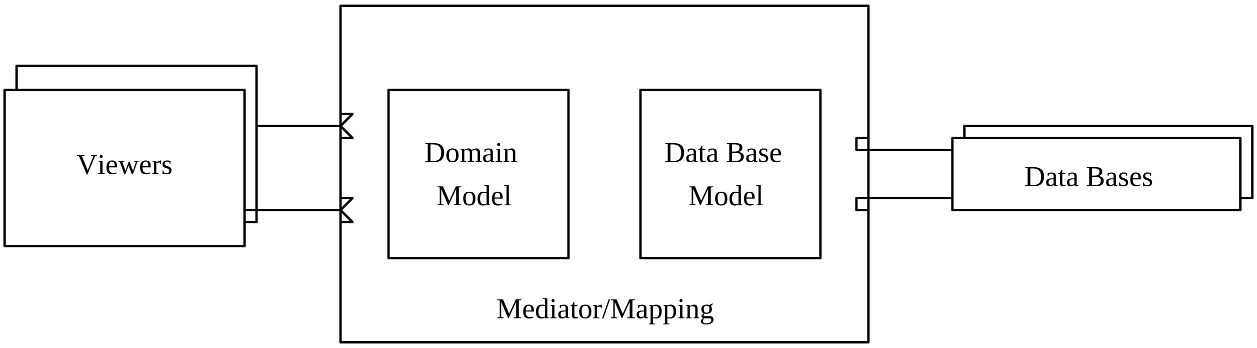

Figure 3: PEXES/SDBA Architecture

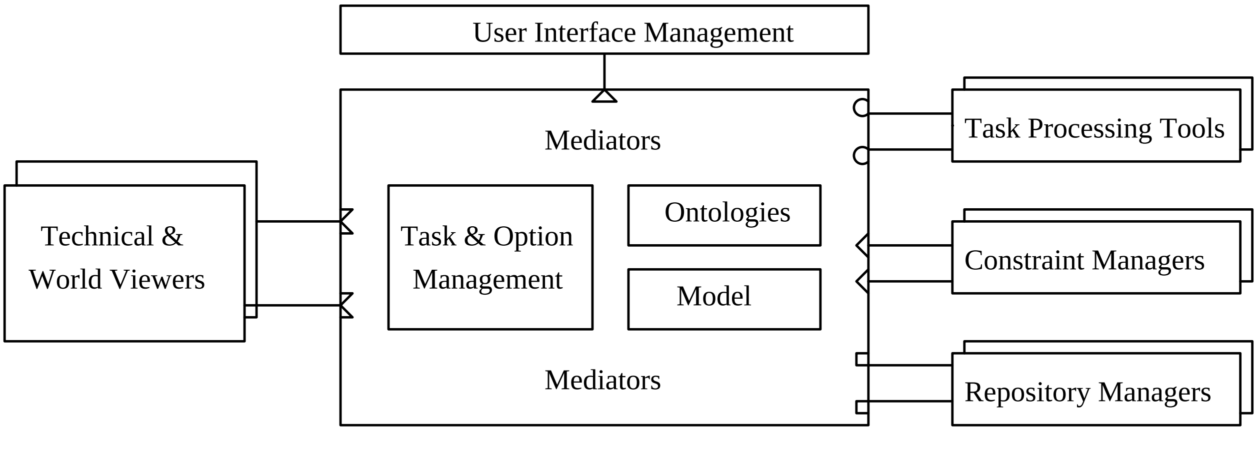

Figure 4: Enterprise Architecture

3 Task Management and Workflow in the Enterprise Tool Set

Many of the systems AIAI builds operate on a workflow principle, being driven by an agenda of "issues". The same concepts are being investigated as a potential candidate for the central processing framework for the Enterprise Tool Set.

It is useful to present a simple abstraction of the workflow within such systems (figure 5).

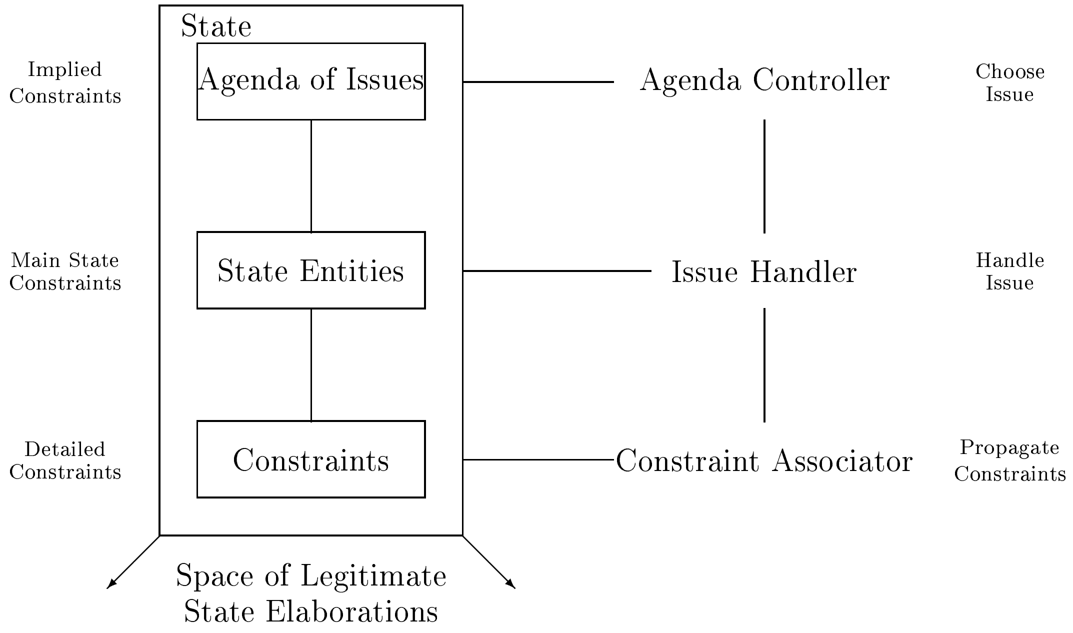

Figure 5: Framework of Components in an Agenda-based System

These systems refine a "current state". They may maintain one or more *options* within the state in which the previous alternative decisions that can be taken restrict the space of state elaborations which can be reached from that point.[1] The system needs to know what outstanding processing requirements exist in the state (shown in figure 5 as the *Agenda of Issues*). These represent the implied constraints on valid future states. One (or sometimes more) of these outstanding processing requirements is chosen to be worked upon next (by the *Agenda or Option Controller*). This calls up processing capabilities (or *Issue Handlers*) within the system which can make decisions and modify the State. The modifications can be in terms of definite changes to entities in the state or by noting further processing requirements (as a result of state analysis and critiquing, etc).

We have found it to be useful to separate the entities representing the decisions already made during processing into:

[1] State constraint relaxation is also possible to increase the space of state elaborations in some systems.

- a high level representing the main entities shared across all planning system components and known to various parts of the systems, and
- a lower level with the more detailed entities which form a specialised area of the representation of the state. These compartmentalised parts can represent constraints within the state such as time, resource, spatial and other constraints.

This separation can assist in the identification of modularity within the system.

O-Plan, for example, has an *Associated Data Structure* (ADS) level of representation which holds the main plan entities (such as activities). The lower level constraints then separately handle constraints on ordering and time points in the plan, resource constraints, etc. The lower level constraints are tied to the higher ADS level entities via associations. The TOSCA manufacturing scheduling system which was based on the O-Plan architecture makes use of quite a different ADS level based on resource reservations, but shares the same time point constraint management code at the lower level. To improve the modularity of writing the Issue Handlers which must maintain detailed constraints on the main entities being manipulated, the architecture includes a *Constraint Associator* [7]. The interface to this component allows for the handling of various types of constraint through plug-in constraint handlers.

4 Summary

An open systems integration architecture is being used as the basis for the Enterprise Tool Set now being constructed on a collaborative project in the UK. This architecture provides a modular framework within which the various components of an enterprise system can function to support a range of users in identifying and performing their tasks. Workflow support is provided to enable users and system components to cooperatively address the tasks and issues facing the user and the enterprise.

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