JISC

CO-ODE Extension Project Plan

Overview of Project

1. Background

The need for user oriented tools for ontology, metadata and annotation

Ontologies and metadata are key to knowledge management and service architectures for E-Research, E-Learning and E-Scholarship. They are critical for annotating services and resources so that they can be discovered and used by semantic middleware in service oriented architectures and workflows. Whereas traditionally, most ontologies, metadata and annotation were interpreted by humans, increasingly they are intended to be interpreted by machines.

With the interpretation by machines comes a requirement for increased formality and logical precision. They are becoming "knowledge middleware". However, unlike software middleware, ontologies and metadata have to be compiled primarily by the researcher-users in each scientific domain. Although there are an increasing number of means for gathering the necessary knowledge informally, either directly from users via the web or indirectly from text, the process of formalising it for use in software remains a bottleneck.

The W3C's new Web Ontology Language OWL, along with its associated rule languages (SWRL) and related standards (RDF, RDFS, Dublin Core, SKOS, etc.) have brought new power and the formality required for machine use. However, in their raw form, they are difficult to understand and use. Researchers want access to the power of the new languages but need better tools and training and need to be able to integrate them into their existing working environments and practices. The challenge is to provide researchers with tools that they can understand and use while at the same time producing ontologies, metadata and annotations of sufficient quality to enable software. User oriented tools were identified at a recent JCSR meeting (22 Feb 2006) as the highest priority for the Semantics and Knowledge Management Services initiative.

Target Communities

Many communities are developing and systematising their resources for search and discovery, from traditional scholarly communications to new forms of data repositories. Most notable are the life sciences and environmental sciences community, where the Open Biomedical Ontologies consortium[1] is managing a large range of resources, of which the most important is the Gene Ontology (GO). These have recently been brought together in the National Center for BioOntologies (CBio[2]) funded by the US National Institute of Health (NIH). Protégé-OWL and the CO-ODE tutorials have users from projects sponsored by BBSRC, MRC, and NERC, CRUK, and ESRC, the EC, as well as research institutes such as FreshWater Life and commercial groups including the Ordinance Survey and Siemens Health.

The problem of user-oriented tools is particularly acute for those creating workflows and metadata for the service architectures which are expected to form the backbone of the Semantic Grid and who are focusing on bioinformatics. Resources can only be used if they can be discovered; they can only be discovered if they have been described; they can only be described if there is an adequate vocabulary and grammar to describe them – *i.e.* an adequate ontology and meta data schema.

[1] http://obo.sourceforge net/
[2] http://bioontology.org/

The CO-ODE and HyOntUse Projects

The CO-ODE and HyOntUse projects were funded under the Semantic and Autonomic Computing Initiative by JISC and the EPSRC respectively from autumn 2003. CO-ODE was initially funded for two years extended to three to match the three-year funding from the EPSRC of HyOntUse. The project ended in autumn 2006. Further funding for CO-ODE was requested to maintain the user-oriented development work and take on the results of the HyOntUse project to make them available to the research community. Further funding for the research begun in the HyOntUse project will be wrapped into applications to the Research Councils to support specific developments now in preparation.

The projects have been highly successful in producing a user oriented plug-and-play environment in collaboration with Stanford based on their Protégé architecture. CO-ODE took a major role in the overall interface design and responsibility for the user-oriented plug-ins and wizards that have reduced the time required to build a basic ontology in workshop conditions from hours to minutes. The system has had several thousand downloads and a user community supporting a mailing list running to over one hundred fifty emails per week, and implying over 500 active users world-wide. It has become the *de facto* standard user oriented development environment for OWL.

CO-ODE tutorials, workshops and tutorial material have been a major success, leading to invitations to a series of invited tutorials and workshops in the US, Japan, and for commercial groups in the UK fully paid for by the sponsors. The written tutorial material has become the standard text on OWL-DL[2][3].

The future for CO-ODE

Demand for the project's workshops and tutorials are increasing. Users in the workshops have consistently raised a series of high priority requirements that can be met with relatively straightforward developments. The OWL standard is moving rapidly in response to these user demands, many of which have been high-lighted in CO-ODE tutorials, and has produced a new OWL 1.1 interim standard. To meet user requirements, the tools need to be brought in line with these new OWL 1.1 specifications and the *de facto* standard API from the WonderWeb consortium (see below). At the same time, there are a series of persistent user requests, the most important of which is for interworking with less formal frameworks and for better communication and modularisation tools to aid collaborative development. We have already shown with OBO and the specialised IOTA interface[4] that we can make most of OWL's power available while hiding the details behind a simple familiar user interface and format.

Given the limited resources, activities must be carefully focused and must balance the effort required with users against development. The development activities chosen have been selected to maximise impact by a small team. Further funding is being sought for a broader range of more research-oriented activities.

Interim developments

OWL 1.1 and the new OWL API have required much more extensive redevelopment than anticipated. Much of this has been achieved using other funding during the break in funding between the end of the previous phase of CO-ODE and the commencement of the current phase. However, another effect has been that the OWL development is now centred in Manchester and increasingly moving towards more actively cooperative, open source modules, initially with other projects in Manchester.

2. Aims and Objectives

Extending engagement with users

The aim is to deepen and broaden the interaction with existing users and take advantage of collaborations with the National Centre for E-Social Science (NCESS).

Specific objectives are:

- *Deepen the workshops to a new style of problem solving "surgeries"* through an extended set of workshops tutorials and "surgeries".

[3] Available from the project website: http://www.co-ode.org
[4] http://www.apsf.org/initiatives/infosys.mspx; http://www.co-ode.org/downloads/termbuilder/

- *Collaborate with the National Centre for E-Social Science.* Formal collaboration including human factors evaluations and observations of the process of ontology development resulting in changes in practices and formal reports.
- *Collaborate with UKOLN, MIMAS and the British Library* The goal is to work towards a common approach to supporting annotation, discovery and use of e-resources within the life sciences community across the digital library, e-learning and e-research programmes. Successfully bringing these communities together will enable resources to be more fully exploited and avoid duplication of effort in knowledge management.
- *Continue education and training in a series of introductory and advanced workshops.*
- *Provide a new, semantically driven project website using the project's tools and other exemplar applications.*

Extending the user-oriented tools and environment

A significant rewrite and adaptation of the software is being undertaken in direct response to user requirements elicited during the workshops and tutorials in the first phase of the project. The aim is series of well-scoped development tasks have been chosen to have maximum impact.

Specific objectives are:

- *Plugins to bridge the gap from familiar informal representations to OWL.* Semi structured representations such as concept maps to generic standards such UML[5] and SKOS[6] to domain specific standards such as OBO-Edit are critical means of gathering knowledge. The objective is to collaborate in making available tools for such conversions within the Protégé-OWL framework..
- *Support for collaboration and communication amongst ontology developers.* Most ontologies are developed collaboratively. The revised architecture makes it much easier to support collaborative development. In cooperation with NCESS the objective is to support specific features and tools to make collaboration easier.
- *Other high priority user oriented tools to be extended and generalised to support:*
  - *Higher levels of abstraction.*
  - *Generic "neophytes' interface*
- *Apply and adapt the tools for a generic solution to the annotation of web services focusing on OMII requirements via an exemplar application for [my]Grid middleware and Taverna workflows.* The [my]Grid workflow platform (Taverna) is currently being ingested into OMII and is a prime example of semantically enabled software. Better tools for ontologies and metadata have been identified as a gap in its current infrastructure. As a test case, we are collaborating with the OMII [my]Grid team to adapt the tools to annotation of web services and workflows for the [my]Grid middleware architecture and Taverna workflow engine.
- *Completing the conversion to OWL 1.1, the new de facto standard OWL API from WonderWeb, and the DIG 2 reasoner interface.* The CO-ODE team has been instrumental in catalysing the specification for a quick revision of the OWL standard to an unofficial OWL 1.1 version agreed by all major developers of OWL tools.
- *Establish links to BootStrep[7], the new EU funded project led by the National Centre for Text Mining.* This is a large project just starting in April 2006. Discussions on collaboration have been initiated.

Long-term sustainability

The UK E-Science infrastructure will require ontology development and annotation environments for the foreseeable future. Our goal is to develop the collaborations to underpin a range of support mechanisms including:

- *Collaboration on specific projects*, particularly in the life sciences. To this end the project has close links with projects funded by the MRC and BBSRC in the UK and the NIH in the US.
- *Support for Grid Middleware being developed by OMII* beginning with [my]Grid/Taverna.
- *A network of open source developers,* is being encouraged via a more accessible interface aligned to the OWL standard.

[5] The need for a conversion to and from UML is a particular requirement for the NHS National Programme for IT/Connecting for Health and is being addressed via a separate application to the DTI for a KTP project on conjunction with the NHS and the company responsible for its tool development, QuickSilva Ltd.

[6] http://www.w3.org/2004/02/skos/

[7] http://supreme.coling.uni-jena.de/BootStrep/bin/view/Extern/WebHome

3. Overall Approach

Extending engagement with users

The goal is to deepen and broaden the interaction with existing users and take advantage of collaborations with the National Centre for E-Social Science (NCESS).

- *Deepen the workshops to a new style of problem solving "surgeries".* The "surgery" structure, in which content is built around a series of problems identified by users for a four to five day workshop, has emerged spontaneously from experience with users in the advanced and commissioned workshops. Besides BioPAX, three groups are currently targeted: a) The Open Biological Ontologies (OBO)[8] consortium, which provides an umbrella for the Gene Ontology and many related standards in molecular biology, b) The National Cancer Research Institute's Bioinformatics Initiative[9] c) The Ontogenesis network[10].
- *Collaborate with the National Centre for E-Social Science.* The Centre has agreed to provide initial resources for work with users at the workshops to improve understanding of the work processes and human factors issues involved. The Centre will participate in the workshops and perform additional pilot studies with users. It is anticipated that these studies will result in bids for further funding to other agencies.
- *Collaborate with UKOLN, MIMAS and the British Library.* It is planned to hold a series of two workshops with members of the life sciences community*, linked to ongoing JISC activities.* The format will be similar to other domain activities but with an higher emphasis on requirements. NCESS will be full involved.
- *Continue the series of introductory and advanced workshops.* The programme of introductory and advanced tutorial/workshops will continue, aiming at approximately three introductory and two advanced per year, primarily but not exclusively directed at the life sciences community. Whereas most workshops have so far been held in Manchester, we expect to extend them to the National E-Science Centre and/or other venues.
- *Provide a new, semantically driven project website using the project's tools.* Users consistently request both more information and exemplar applications. The web site will address both needs. There are as yet few easily accessible web sites that make extensive use of OWL or use ontologies explicitly derived from OWL. All material from the workshops will be made available on this web site.

In addition to supporting groups in developing their own ontologies, the project is beginning to make available generic ontologies developed in response to demand in the workshops and collaborations. The members of the project are also active members in the new Health Care and Life Sciences Special Interest Group in W3C.

Extending the user-oriented tools and environment

The planned extensions to the software are direct responses to user requirements elicited during the workshops and tutorials. Protégé was chosen as a platform initially because of its open source plug-and-play environment. It allows new functionality to be added easily either by the team or by others in the open source community. A series of well-scoped development tasks have been chosen to have maximum impact. The proposed extension will focus on a few areas consistently raised as high priority by users. Many of the proposed developments are relatively simple in themselves, but combined they are expected to have a major impact on usability.

- *Plugins to bridge the gap from familiar informal representations to OWL.* We have found that users are used to working in a variety of less formal representations ranging from simple word lists to semi structured representations such as concept maps to generic standards such UML[11] and SKOS[12] to domain specific standards such as OBO-Edit. In addition, many user communities collect and expect to receive much information in Excel spread sheets and MSWord outlines. There is a need for tools to facilitate transforming these to and from OWL. The difficulty in each case is that information that is implicit in the informal representation must be made explicit when it is transformed to OWL. Since information must be added, it is not possible to define a single 'best' transformation. Rather what is required is a means of describing 'profiles' for transformation that allow users to specify easily and systematically the extra information required by OWL. For example, OWL requires a clear distinction between meta data (annotations and comments) and the ontology proper. Many other representations mix the two. To convert to OWL, therefore, users must identify which categories of information are to be regarded as annotations and which as part of the

[8] http://obo.sourceforge net/
[9] http://www.ncri.org.uk/activities/index.cfm?navsub=8&main=activityitem&rmain=rdocs&type=2&id=4
[10] http://www.ontonet.org/
[11] The need for a conversion to and from UML is a particular requirement for the NHS National Programme for IT/Connecting for Health and is being addressed via a separate application to the DTI for a KTP project on conjunction with the NHS and the company responsible for its tool development, QuickSilva Ltd.
[12] http://www.w3.org/2004/02/skos/

ontology proper. Bridging the gap from informal to formal, therefore, requires two steps a) syntactic conversion specific to each representation, usually using scripts, and b) semantic transformation using profiles. A simple mechanism of profiles will be adapted from previous research. A more generic approach to ontology transformation will form part of a submission to the EPSRC.

- *Support for collaboration and communication amongst ontology developers.* Most ontologies are developed collaboratively. A prime request from users is better support for collaborative development. Collaboration can be either loosely or tightly coupled, either asynchronous or synchronous. In either case, the two keys are communication and modularisation. Simple tools for communication and argumentation will be one focus of CO-ODE's contribution. Simple communication tools range from 'post-it' notes to threaded discussions and argumentation linked to the ontology. Modularisation will be the other focus. CO-ODE will incorporate the results of the EPSRC sponsored HyOntUse project and EU projects (WonderWeb and OntoGrid) as well as its own work on modularising ontologies. Separately, Stanford is redeveloping the multiuser version of Protégé for synchronous collaboration, and joint funding from NIH is expected to support the incorporation of CO-ODE collaboration tools into the multiuser environment.
- *Other high priority user oriented tools to be extended and generalised*
  - *Higher levels of abstraction.* Users consistently ask to be able to view and deal with the ontology at a higher level of abstraction than OWL's fine-grained logical representation. One major source for patterns is the work on Ontology Engineering Patterns by the W3C Best Practice Working Group.[13] CO-ODE has already implemented wizards for several such patterns plus others based on its own experience. However, once completed, the original pattern is hidden, although the information is retained for future editing. The next step is to make the patterns permanently visible and to allow users to edit them directly. This requires more detailed annotation than is possible in the original OWL standard, which is one of the prime motivations for OWL 1.1.
  - *Generic "neophytes' interface"* A specialised highly simplified interface to a carefully selected subset of OWL functionality has been developed for one set of users, the IOTA group from the Anaesthesia patient safety association. The principles of interface have been greeted enthusiastically by other users and it is now being generalised. Similarly, a more flexible forms-style interface appropriate for classes as well as individuals is under development.
- *Apply and adapt the tools for a generic solution to the annotation of web services focusing on OMII requirements via an exemplar application for myGrid middleware and Taverna workflows.* Ontologies are only valuable if applied. Ontology tools can only be tested properly in use with applications. The myGrid workflow platform (Taverna) is currently being ingested into OMII and is a prime example of semantically enabled software. Better tools for ontologies and metadata have been identified as a gap in its current infrastructure. As a test case, we will collaborate with the OMII myGrid team to adapt the tools to annotation of web services and workflows for the myGrid middleware architecture and Taverna workflow engine.
- *Completing the conversion to OWL 1.1, the new de facto standard OWL API from WonderWeb, and the DIG 2 reasoner interface.* The CO-ODE team has been instrumental in catalysing the specification for a quick revision of the OWL standard to an unofficial OWL 1.1 version agreed by all major developers of OWL tools. The goal is to provide technically straight-forward but user-critical improvements to the standard quickly – including better metadata handling and better handling of numbers, strings, and other concrete data types.[14] Attendees at the tutorials, who are mainly non-computer scientists from application domains, have been using OWL extensively. However, a number of features such as reasoning over data-type (number ranges etc.) and qualified cardinality restrictions have been missing from the standard. Users have said these simple extensions will have a disproportionate effect on what they can model. Outside the immediate OWL community, the OBO language has been developing towards an OWL expressivity and the OBO language uses OWL semantics. This parallel ensures that a wide body of research users will need both tutorial and tools for languages like OWL. Similarly, since the beginning of the project, the OWL community has converged on a new *de facto* standard for an API from the WonderWeb consortium[15] and the Description Logic Implementation Group (DIG) is updating the standard interface[16] to DL reasoners. Upgrades to Protégé-OWL are necessary if the tools are to meet user demands and stay in step with the community. They should enable much greater interworking and sharing of modules between projects. This work is already well in hand but requires the extension for completion and testing.

[13] http://www.w3.org/2001/sw/BestPractices/
[14] Planning for OWL 2 is taking place in parallel, but covers a wider range of issues and will require the full W3C process and a correspondingly longer time scale
[15] http://wonderweb.semanticweb.org/
[16] http://dl kr.org/dig/

- *Establish links to BootStrep[17], the new EU funded project led by the National Centre for Text Mining.* This is a large project just starting in April 2006. Discussions on collaboration have been initiated.

Long-term sustainability

The UK E-Science infrastructure will require ontology development and annotation environments for the foreseeable future. There are currently only two open source environments available for OWL, Protégé-OWL and SWOOP from University of Maryland. (A new EU funded project, NEON, has just been funded but is concentrating primarily on related RDF based technologies.) Of the mature projects, Protégé is distinguished by its commitment to user-oriented interfaces and its plug-and-play architecture. It is widely used with over a thousand downloads and has attracted a large and growing community. Its close links to the life sciences and environmental sciences means that it interacts with a vocal and committed user community. The collaboration with Stanford means that it leverages support from the National Library of Medicine and the National Cancer Institute in the US.

It is expected in the medium term that Protégé-OWL will be supported by a combination of infrastructure funding and specific collaborations with research communities that use it. In the UK, it is hoped that the infrastructure funds can come through providing support for the semantic resources required by OMII beginning with the *my*Grid/Taverna middleware. From the US, Stanford's work on Protégé has been supported by a combination of funding from the National Library of Medicine and National Cancer Institute. A joint application for a five-year extension is currently being prepared which will include support for CO-ODE for the integration with Protégé-Frames, the integration of the CO-ODE developments into the new Protégé multi-user environment, and for CO-ODE's contribution to joint user support and mailing lists.

4. Project Outputs

- A robust user-friendly editing and application environment for ontologies implemented in OWL 1.1. Based on both technical experience and close collaboration with human factors experts in NCESS.
- A body of domain experts, primarily in the biomedical and environmental sciences, with expertise and experience in using OWL both for developing and applying ontologies.
- A body of tutorial and workshop material on OWL and a library of exemplar ontologies.
- Exemplar applications and adapted tools and plugins for OMII and *my*Grid/Taverna

5. Project Outcomes

- Faster and more widespread collaborative development of ontologies and ontology based resources.
- Improved annotation and discovery of E-Science resources, both "knowledge resources" for the front line scientists and Bioinformatics Services in a Grid environment.
- A growing body of domain scientists – biologists, environmentalists, medical researchers and others – knowledge about and experienced in the use of ontologies for annotation, discovery, and knowledge integration.
- Established support for scientific projects funded by the key stakeholders and research councils.
- Established commercial collaborations

[17] http://supreme.coling.uni-jena.de/BootStrep/bin/view/Extern/WebHome

6. Stakeholder Analysis

Stakeholder	Interest / stake	Importance
Cancer and Molecular Biology Research Communities, and other basic science research and E-Research communities.	Improved tools and faster development for knowledge intensive research, plus a body of training material	medium
Semantic Web Community	Improved tools and dissemination of technology. Greater convergence on more practical standards informed by real applications	high
OMII	Improved collaborative tools for describing and annotating web services	medium
Digital libraries community	Improved convergence with E-Science and Semantic Web communities. Improved convergence between SKOS and OWL.	medium
Commercial collaborators	Commercial collaborators are already using the tools and training and parts of their critical development strategy	high

7. Risk Analysis

Risk	Probability (1-5)	Severity (1-5)	Score (P x S)	Action to Prevent/Manage Risk
Staffing	1	3	3	Staff in place; Multiple additional streams in Manchester for continuing employment. Skills being spread between projects
Organisational	2	4	8	Collaboration with Northwest Institute of BioHealth Informatics on project management and tutorial organisation
Technical	2	3	6	Migration to OWL 1.1 and new Protégé platform well underway with interim funding. Would otherwise have been major risk.
External suppliers: delays or problems with "reasoners' on which project is dependent and/or Stanford's work on multi-user systems	2-	4	8-	Both critical classifiers are being developed in Manchester, although under separate funding. As of March 2007 first versions are available and converging rapidly. Others in the open source community are also working on multi-user features.
Legal	1	1	1	Open source framework agreed with all parties.

Continuing scepticism over OWL in community	3	2	6	Extensive programme of education and exemplar applications
Failure or reduced level of renewed of support from US partners	3	2	6	UK OWL developments can proceed independently. Recruiting additional collaborators via Open Source mechanisms.
Being overtaken	2	2	4	New environment is being taken up enthusiastically.

8. Standards

Name of standard or specification	Version	Notes
OWL	1 and 1.1	Participant in standards committees and ad hoc pre-standards working group.
Manchester OWL Syntax	1	Alternative syntax for OWL that is being widely adopted or imitated.
RDF(s)	1	
Description Logic Interface Group (DIG)	1 and 2	Likely to be overtaken by OWL API as a *de facto* standard

9. Technical Development

The project uses rapid prototyping within an open source environment closely tied to users interspersed with explicit human factors and usability workshops and observations in collaboration with NCESS. The project has two groups of users: Power users who collaborate closely, some of which sit literally in the same room as the developers; Scientist users who use the tools to manage their e-science resources. Power users require maximum features; scientists maximum simplicity. This has led to a highly configurable environment a many features, but designed so that most users see only a small subset. End user testing takes place differently for power users and scientists. Power users normally report errors themselves. Testing regimes for specified combination of features needed in easy-to-use environments are being established. End-user testing then takes place during workshops and tutorials.

Previously, Software development has been managed through a quality control process in collaboration with the overall Protégé project at Stanford. However, since the new release is entirely developed in Manchester, version management and quality assurance are increasingly being done in Manchester.

The project has been a leading contributor to "best practices" in ontology development via the Semantic Web Best Practices Committee and other W3C bodies.

10. Intellectual Property Rights

All software, "knowledgeware" (ontologies and related resources), teaching and other support materials will be open source, currently under "Lesser GNU" license, but this is under review with potential commercial collaborators.

Project Resources

11. Project Partners

- University of Manchester: Prof Alan Rector, Kilburn Building, University of Manchester.
  : Dr Amanda Lamb, Stopford Building, University of Manchester.

- Stanford University: Mark A. Musen, M.D., Ph.D Professor; Head, Stanford Medical Informatics

12. Project Management

As a small (2 FTE) short (2 year) project, the project management structure depends heavily on support from the broader project management team in Manchester which supports major E-Science projects, CLEF, PsyGrid and the support of E-Science Northwest. It is embedded in a collection of projects within the School of Computer Science which share critical resources. It participates in the overall Protégé planning and management.

Staff: Nick Drummond – Software engineer – [redacted]
Matthew Horridge – software engineer – [redacted]
Amanda Lamb – NIBHI e-Science Project Manager [redacted]
Samantha Creighton – Shared Secretary with WonderWeb – [redacted]

13. Programme Support

It is intended to hold some of the workshops at NESC. Other help in the mechanics of organising and managing workshops outside of Manchester would be useful.

14. Budget

Appendix A.

Detailed Project Planning

15. Workpackages

Appendix B.

16. Evaluation Plan

Timing	Factor to Evaluate	Questions to Address	Method(s)	Measure of Success
With workshops	Effectiveness of workshops for participants. Demand for further workshops	Learning, Relevance	Questionnaires at workshops. Observations	Positive response on both measures
Year 1	Usability	Ease of use for new and experienced users? Specific areas for attention	Observed workshop in conjunction with NCESS. Monitoring of mailing lists and support group.	User response. Speed of learning. Avoidance of errors.
Year 2	Uptake of software	How widely is the software being used? Impact of different features	Follow up of known intensive users. Log of downloads	Range of projects using software. Uptake by several major projects and/or groups, *e.g.* NCRI bioinformatics initiative.

17. Quality Plan

Output					
Timing	**Quality criteria**	**QA method(s)**	**Evidence of compliance**	**Quality responsibilities**	**Quality tools (if applicable)**
Year 1 and continuing	Software robustness	Close interaction with community. Iterative softare engineering	Versioning, requirements and bug reports logs. Standard test suite.	Horridge, Drummond (and Maleki-Dizaji (from the larger team)	
Year 1 and continuing	Software usability – see evaluation	Observations and feedback from users in workshops and mailing lists	Reports from NCESS and internally	Horridge Procter	

18. Dissemination Plan

Timing	**Dissemination Activity**	**Audience**	**Purpose**	**Key Message**
M2-m24	Tutorials and Workshops	E-Science and basic science community, particularly in the basic biomedical sciences	Increased knowledge, skills, and application	Effective annotation, discovery, and representation using ontologies is practical and saves effort and resource.
M1-M24	Support and distribution of Protégé-OWLEd and related tools	Ontology developers.	Provide a robust, easy and quick to use ontology development and application environment	The tools are easy to use, highly adaptable, available, and well supported
M1-M24	Support for open source development community using OWL	Open source developers of knowledge ware, particularly in the biomedical community	Provide a broad base of support and expertise for the software. Provide "many eyes" quality assurance and bug fixing.	Join us and contribute to the development. Involvement of commercial collaborators.

19. Exit and Sustainability Plans

Project Outputs	**Action for Take-up & Embedding**	**Action for Exit**
Training material	Developed as distance learning modules. (They already form part of a bio-ontologies training module)	Collaborate with School for Computer Science and others to develop training modules
Ontology Development Environment (Protégé-OWL)	1) Embedding the project in the network of related projects and	Discussions with OMII and NCRI bioinformatics initiative.

	OMII/myGrid/taverna. Discussions with other projects using tools including CaGrid, 2 Commercial collaborations in place 3 Establishment of a more robust open source community.	2 Extent of on-going support to be explored 3) Revision of Open source environment and sites.

List any project outputs that may have potential to live on after the project ends, why, how they might be taken forward, and any issues involved in making them sustainable in the long term.

Project Outputs	Why Sustainable	Scenarios for Taking Forward	Issues to Address
The ontology development environment Protégé – OWL	Wide user base. Open source buy in. Commercial use. Use by OMII	Combined support from OMII, Research projects, and Commercial Applications	Agreement with commercial users on preferred Open source licensing. Development of broader community

Appendixes

Appendix A. Project Budget

Appendix B. Workpackages