Periodic Progress Report N°: 1

Covering period 1/1/2002 – 31/12/2002

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WonderWeb Project

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Contents

Executive summary

The project is proceeding according to plan, and significant results have already been achieved.

The necessary organisational infrastructure was quickly established, including a project management board (PMB), mailing list and web site. Regular meetings have been held (including PMB meetings), one of which included a workshop attended by members of the Industrial Advisory Board. Being a small consortium, we have been able to keep the organisational overhead to a minimum and spend the majority of our time on technical issues.

Members of the consortium have been working within the W3C Web Ontology language working group on the development and standardisation of a web ontology language that will form the basis of the WonderWeb language architecture. The result is the OWL language, which is expected to achieve W3C candidate recommendation status in early 2003. WonderWeb consortium members have made a vital contribution to the development of OWL, e.g., editing key documents such as the language reference, the syntax and semantics, and the user guide.

As far as tools and services are concerned, a key result of this period has been the development of the KAON server prototype. KAON provides for the management and integration of other software components (editors, reasoners etc.), and provides a uniform API for both components and client applications. The API will support the OWL web ontology language (as well as "raw" RDF). Work has already started on the development and adaption of components, including the LiFT ontology extraction tool, editors such as OilEd and OntoEdit, and reasoners such as FaCT, RACER and Cerebra.

Work on the development of the foundational ontology library and ontology design methodologies has also been proceeding. An important result has been the development of DOLCE (Descriptive Ontology for Linguistic and Cognitive Engineering), a first reference module for the library. Because of its expressivity, DOLCE has been implemented in a full first-order language, but a "light" version of it has also been implemented in DAML+OIL/OWL. In addition to the library, a "roadmap" of major ontology design choices has also been produced.

Finally, work on ontology engineering methodologies has been centered on ontology versioning, the objective being to provide ontology engineers with versioning facilities comparable to those available to software engineers. This has led to the development of an ontology versioning approach that is now being implemented in the "OntoView" system. In cooperation with the Protégé development team at Stanford University, their PROMPT tool has also been adapted to use the WonderWeb versioning approach, thus making it available to the Protégé user community.

The main goal of the next period will be the completion of the KAON server, and the integration of the various components that have been and are being developed.

Work progress overview

Objectives

The overall objective of the project is to develop a methodology and toolkit supporting Web based ontological engineering. In the first year, the foundations for this work were to be laid by:

1. *Project organisation and management.* In particular, the constitution of a project management board, and the setting up of an email list and web site.

2. *Development of language architecture.* In particular, the development of a suitable ontology language. This was to be carried out in cooperation with relevant international research efforts and standardisation bodies, in particular the DARPA DAML program and the W3C. Work was also to begin on the development of language extensions, in particular a rule language extension.

3. *Development of technical infrastructure.* In particular, the development of a component based architecture providing a uniform API (for both components and client applications) and some basic services. Work was also to begin on connecting existing clients via this architecture, and the development of a new client for extracting lightweight ontologies from legacy resources such as database schemas.

4. *Development of foundational ontologies.* In particular, the production of a roadmap and methodological guidelines for designing well-founded ontologies, and a first reference module for the ontology library. Participation in relevant standardisation activities was also envisaged.

5. *Development of ontological engineering methodologies.* In particular, the development of a versioning framework for ontologies. Work was also to begin on the development of modularisation mechanisms.

6. *Requirements analysis and assessment.* In particular, cooperating with members of the industrial advisory board in order to assess their requirements and get feedback on the results of the project.

Progress

The project is well on track, and even exceeding expectations in some respects. All deliverables have been produced on time (see Appendix A), and all milestones have been achieved.

Organisation

A kick off meeting was held in Amsterdam on the 31/1–1/2/02. Subsequent meetings were held in Karlsruhe on the 21–22/05/02 and Manchester on the 9-11/09/02. The next meeting will be held in Amsterdam on the 15–17/01/03.

A Project Management Board was elected at the kick off meeting, the members being Ian Horrocks (VUM), Frank van Harmelen (VUA), Steffen Staab (AIFB) and Nicola Guarino (ISTC); a project management meeting was held at this and each subsequent project meeting. Project management meetings are open and both minutes and presentation materials are posted on the project web site.[1]

A project web site has been set up[2] and a mailing list established for communication amongst the members of the consortium.[3] An additional mailing list has been established to enable non-members to communicate with the project.[4]

Activities

Workpackage 1: Language Architecture

Work has been proceeding on the development of the Ontology Language Layer. This work has been carried out in cooperation with the DARPA DAML program and the W3C. In particular, several members of the consortium have been active in the W3C's Web Ontology working group,[5] whose brief is to develop the DAML+OIL language into a W3C web ontology language standard. Sean Bechhofer (VUM), Frank van Harmelen (VUA), Ian Horrocks (VUM) and Raphael Volz (AIFB) are all members of the working group. [6] They have participated in weekly telephone conferences and have attended face to face meetings in New Jersey (14–15 January 2002), Amsterdam (8–9 April 2002), Stanford (1–2 July 2002) and Bristol (7–8 October 2002). Full details can be found on the WebOnt web site.

The resulting ontology language, which is called OWL, is expected to achieve W3C candidate recommendation status in early 2003, with the various technical reports currently being subject to a final review. Members of the consortium are editors of several of these documents: van Harmelen (VUA) is an editor of the Feature Synopsis, the Language Reference and the Abstract Syntax and Semantics, Horrocks (VUM) is an editor of the Language Reference and the Abstract Syntax and Semantics, and Volz (AIFB) is an editor of the Requirements analysis and the User Guide. The (probably) final meeting of the working group was hosted by VUM in Manchester (9–10 January 2003).

"In house", VUM have also developed tutorial materials using the OilEd ontology editor, [7] and have gathered an extensive collection of expository material relating to ontology engineering.[8]

Work has already begun on language extensions, starting with a rule language extension. This work is being carried out in cooperation with the DARPA DAML program and the Joint EU/US committee on agent markup languages[9] (of which van Harmelen and

[1] http://wonderweb.semanticweb.org/meetings.shtml
[2] http://wonderweb.semanticweb.org/
[3] mailto:wonderweb@lists.man.ac.uk
[4] mailto:wonderweb-info@lists.man.ac.uk
[5] http://www.w3.org/2001/sw/WebOnt/
[6] http://www.w3.org/2001/sw/WebOnt/#Membership
[7] http://oiled.man.ac.uk/tutorial/
[8] http://oiled.man.ac.uk/building/
[9] http://www.daml.org/committee/

Horrocks are both members). At the request of the DAML joint committee, a working paper has been produced that describes this work.[10]

Workpackage 2: Tools and Services

At the core of this WP is the development of the KAON server, which provides for the management and integration of other software components (editors, reasoners etc.), and provides a uniform API for both components and client applications. The API will support the OWL web ontology language (as well as "raw" RDF). KAON also includes components for persistent storage of both RDF data and OWL ontologies.

The KAON Server is developed in the context of the KAON open-source ontology management infrastructure, which is targeted for business applications. It includes a comprehensive tool suite allowing easy ontology creation and management, as well as building ontology-based applications. An important focus of KAON is on integrating traditional technologies for ontology management and application with those used in business applications, such as relational databases. KAON is jointly developed and used in several EU-funded projects, amongst which are Ontologging,[11] Vision,[12] SWWS,[13] Harmonise [14] and VICODI.[15] This maximizes the dissemination of the project results and allows for synergies across projects.

Work is also proceeding on the development and adaption of components for use with KAON. This has included the development of the LiFT client, a tool for extracting lightweight ontologies from legacy resources such as database schemas, UML software specifications and XML schemas.

Work has already begun on the development of a new reasoning engine, based on the FaCT system, that will be used with KAON to provide reasoning support for the OWL ontology language. This includes the addition of reasoning support for datatypes (integers, strings etc.). An important feature of this work has been the establishing of the DL Implementation Group[16] (DIG), and the subsequent agreement on a standard API for DL reasoners. This means that the integration of the FaCT reasoner into the KAON framework will result in all other DIG compliant DL reasoners (e.g., RACER[17] and Cerebra[18]) being usable with KAON.

Workpackage 3: Foundational Ontologies

The main progress within this workpackage has been a clarification of the role of foundational ontologies for the semantic web, the definition of an architecture for the WonderWeb library of foundational ontologies, and the development of a first reference module

[10] http://ebusiness.mit.edu/bgrosof/paps/dlp-wp-v19.pdf
[11] http://www.ontologging.com/
[12] http://wim.fzi.de/vision/
[13] http://swws.semanticweb.org/
[14] http://www.harmonise.org
[15] http://www.vicodi.org/
[16] http://dl.kr.org/dig/
[17] http://www.fh-wedel.de/∼mo/racer/
[18] http://www.networkinference.com

for the library — DOLCE: a Descriptive Ontology for Linguistic and Cognitive Engineering. DOLCE is a rich, carefully axiomatized top-level ontology, which despite its clear cognitive bias (especially appropriate for the semantic web) has been designed in such a way to avoid hidden ontological assumptions, by relying on a rich axiomatization.

Indeed, a peculiarity of the WonderWeb Foundational Ontology Library (with respect to, say, ontology repositories) is that it aims at making rationales and alternatives underlying ontological choices as explicit as possible, in order to form a network of different but systematically related modules that the various Semantic Web applications can commit to, according to their own ontological assumptions. From this perspective, making people (and computers) understand one another (possibly including the reasons for any ontological disagreement) is more important than enforcing interoperability by means of a common, overarching ontology. Positive feedback on DOLCE has already been expressed by distinguished researchers involved in major ontology projects.[19] In an extended version, it is being used by ISTC-CNR in ontology-related projects involving various application domains.

Because of its expressivity, DOLCE has been implemented in a full first-order language, namely KIF.[20] However, a "light" version of it has been implemented in DAML+OIL/OWL. To show how a foundational ontology can be used to improve the quality of ontologies developed using WonderWeb tools, an example ontology produced by the LiFT tool has been re-modeled/integrated within DOLCE according to the methodology developed within this workpackage.

An initial document describing such methodology (the "Ontology Roadmap", D15) has also been produced. It includes a discussion on the role of foundational ontologies, a presentation of some of the most important axiomatized ontologies (which are compared to DOLCE), and a roadmap of some major ontological choices.

Workpackage 4: Ontology Engineering

Like software engineers, ontology engineers need methodological guidelines and tool support if they are to produce high quality and maintainable ontologies. In this period the main focus has been on the development of a versioning framework, and in particular the development of techniques comparing two ontologies and reporting on the differences between them—the underlying idea is to provide tools that perform a kind of semantic based "diff" on two ontologies. After a detailed study of relevant techniques (see D20), a suitable framework has been developed and is being implemented in the "OntoView" system. This system will be integrated with the KAON server to provide a versioning mechanism for OWL ontologies.

Part of the result is an ontology of changes that can be used to describe the transformation (differences) between two versions of an OWL-lite ontology. The OntoView versioning tool 1) is able to derive such a transformation description by comparing two

[19] Including: Christiane Fellbaum, WordNet, Princeton University; Tony Cohn, University of Leeds; Barry Smith, IFOMIS, University of Leipzig; Chris Welty, IBM Watson Research Center; Bill Andersen, OntologyWorks; Werner Ceusters, Language and Computing; Peter Eklund, WebKB, University of Queensland; Joost Breuker, University of Amsterdam.

[20] The new language CL http://cl.tamu.edu is being considered.

ontology versions and 2) will be able to use this transformation to calculate the effects of changes.

In cooperation with the Protégé development team at Stanford University, their PROMPT tool has been extended so that it can find and export the differences between two Protégé ontologies. The export format uses the WonderWeb change ontology. This will thus make the WonderWeb versioning approach available to the Protégé user community. A number of algorithms are currently being developed that can find complex changes (like "a class got new subclasses and its former subclasses are now subclasses of the new ones"). Such complex changes are often more useful for describing the effects of changes, or presenting them visually to the user.

Work has already begun on modular ontologies. Up to now, we have concentrated on the benefits of modular ontologies with respect to local containment of terminological reasoning. We defined an architecture for modular ontologies that supports local reasoning by compiling implied subsumption relations. We further addressed the problem of guaranteeing the integrity of a modular ontology in the presence of local changes. Based on the change framework, we developed a strategy for analyzing changes in ontology modules and guiding the process of updating compiled information.

Workpackage 5: Assessment, Dissemination and Evaluation

The meeting in Manchester (9-11/09/02) included a workshop for members of the IAB. At this workshop the latest results of the project were presented, IAB members presented up to date information about their own related research activities and there was an extended technical discussion, with particular emphasis on language architecture and the core API and component based architecture being developed in WP2. Several members of the IAB, including Boeing, IBM and SUN, are evaluating tools and methodologies developed in the project by using them in internal R&D projects.

Papers related to the work carried out in the project have been presented at numerous conferences and workshops,[21] and several keynote presentations have been given, e.g., at EDBT 2002 and at CADE-18. A poster publicising the project was presented at the first International Semantic Web Conference (ISWC 2002) in Sardinia.

Members of the consortium are also heavily involved in the organisation of relevant conferences and journals such as ISWC, the Semantic Web track of the World Wide Web conference and the new Elsevier Semantic Web journal.

Work plan

In the next period, a main focus will be on the completion of the KAON server, and the integration of the various components that have been and are being developed. This will be facilitated by an extended visit to VUM by Raphael Volz, a key member of AIFB's KAON team. Work will also continue on the extension of the language architecture, on the development and adaption of a range of additional components, on the development of the ontology library, and on the development of ontology modularisation and refinement methodologies.

[21] http://wonderweb.semanticweb.org/publications.shtml

Project management and co-ordination

Contractual Issues

Due to an internal restructuring within the Italian National Research Council (CNR), the name of LADSEB-CNR is now ISIB-CNR (Istituto di Ingegneria Biomedica), and the director is dr. Ferdinando Grandori. With effect from January 1st, 2003, the ISIB-CNR research group working on WonderWeb (with two staff members: Nicola Guarino and Claudio Masolo) has changed affiliation (while remaining within CNR), and now they belong to the Institute of Cognitive Sciences and Technologies (ISTC-CNR), directed by Professor Cristiano Castelfranchi.

The director of ISIB-CNR has no objection to the transfer of WonderWeb-related activities and funding to ISTC-CNR, and the change of affiliation will not affect the work being carried out within the project.

Project meetings

Regular project meetings have been held, each of which included a meeting of the Project Management Board (see the "Organisation" section on page 2 for more details).

Infrastructure

A project web site has been set up[22] and a mailing list established for communication amongst the members of the consortium.[23] An additional mailing list has been established to enable non-members to communicate with the project.[24]

Cooperation and co-ordination

As well as the regular face to face meetings, telephone conferences have been used to facilitate close co-ordination between the various work packages. Visits and exchanges are also anticipated, with the first being scheduled for January 2003, when Raphael Volz (one of the key members of the AIFB team) will visit VUM for a period of 3 months.

Industrial advisory board

Members of the Industrial Advisory Board (IAB) have been kept informed about the progress of the project via the web site and mailing list. The mailing list has also enabled more active members of the IAB to participate in technical discussions (see list archive[25]). The meeting in Manchester (9-11/09/02) included a very successful workshop for members of the IAB (see "Dissemination" section on Page 6).

[22] http://wonderweb.semanticweb.org/
[23] mailto:wonderweb@lists.man.ac.uk
[24] mailto:wonderweb-info@lists.man.ac.uk
[25] http://lists.man.ac.uk/mailman/listinfo/wonderweb

External co-ordination and cooperation

Members of the consortium are active in the IST OntoWeb Network:[26] Nicola Guarino (ISTC) chairs the Special Interest Group on Content Standards, Ian Horrocks (VUM) and Frank van Harmelen (VUA) chair the Special Interest Group on Ontology Language Standards, and Andreas Persidis (IAB) and Alain Léger (IAB) chair the Special Interest Group on Industrial Applications. Clustering is also facilitated by members' participation in related projects. E.g., AIFB are members of a number of IST projects including Ontologging, Vision, SWWS, Harmonise and VICODI (see WP2 on page 4), and both AIFB and VUA are members of the Esprit i-brow project.[27]

Members of the consortium are also very active in international cooperation and standardisation efforts. Both VUM and AIFB are involved in the DARPA DAML program,[28] and several members of the consortium are on the Joint EU/US Committee on Agent Markup Languages,[29] which was responsible for the design of the highly influential DAML+OIL web ontology language. VUA have also been working with the Protégé development team at Stanford University, helping them to extend their versioning tools to use the framework developed in WP4. Members of the consortium have also been very active in the W3C Web Ontology language standardisation working group,[30] and in the IEEE SUO Standard Upper Ontology (SUO) Working Group.[31] VUM is a founder member of the Description logic Interface Group (DIG),[32] whose objective is to develop a standard interface for description logic reasoners.

Effort and Cost breakdown

Effort in person months and costs for the reporting period are shown in Appendix B and Appendix C respectively. It can be seen that VUM actual effort was only 62.5% of the estimate; this was due to unexpected delays in recruiting suitable research staff. In contrast, both VUA and AIFB actual effort exceeded estimate, but as staff costs were lower than expected they were still within budget. Overall, actual costs were 80% of the estimate.

Information dissemination and exploitation of results

A project web site and various mailing lists have been established in order to publicise the project and facilitate the dissemination of results. A project presentation has been produced (D26) and is available from the web site.[33] A two page "flier" has also been

[26] http://ontoweb.aifb.uni-karlsruhe.de/
[27] http://www.swi.psy.uva.nl/projects/IBROW3/home.html
[28] http://www.daml.org/
[29] http://www.daml.org/committee/
[30] http://www.w3.org/2001/sw/WebOnt/
[31] http://ltsc.ieee.org/suo/
[32] http://dl.kr.org/dig/
[33] http://wonderweb.semanticweb.org/deliverables/documents/D26.pdf

produced for distribution at conferences, workshops etc.[34] Other dissemination activities, including publications, are described under WP5 on Page 6.

Exploitation opportunities look promising, with results of the project already being used by members of the IAB such as Boeing, IBM and SUN, as well as by other research groups and projects. SME members of the IAB, such as aidministrator, Network Inference and ontoprise, have also expressed an interest in the commercial exploitation of tools developed in the project.

[34] http://wonderweb.semanticweb.org/deliverables/documents/Flyer.pdf

A Deliverables

Del. No.	Rev.	Title	Type[1]	Class.[2]	Due Date	Issue Date
1	1.0	Ontology Language	R	Pub.	30/09/02	30/09/02
5	2.0	OntoServer Architecture	R	Int.	30/06/02	30/06/02[3]
6	1.0	OntoServer Prototype	R/S	Pub.	31/12/02	18/12/02
11	1.1	LiFT Prototype	R/S	Int.	31/12/02	20/12/02
15	1.0	Ontology Roadmap	R	Pub.	31/12/02	27/12/02
17	2.0	Ontology Library (prelim.)	R/S	Int.	30/06/02	30/06/02[4]
20	1.1	Versioning Framework	R	Pub.	31/08/02	26/08/02[5]
26	1.0	Project Presentation	O	Pub.	31/03/02	15/03/02
27	1.0	Dissemination and Use plan	R	Int.	30/06/02	30/06/02

[1] R: Report; D: Demonstrator; S: Software; W: Workshop;
O: Other - Specify in footnote

[2] Int.: Internal circulation within project (plus Commission Project Officer and reviewers if requested)
Rest.: Restricted circulation list (specify in footnote) plus Commission SO and reviewers only
IST: Circulation within IST Programme participants
FP5: Circulation within Framework Programme participants
Pub.: Public document

[3] Version 2.0 issued 05/09/02

[4] Version 2.0 issued 15/08/02

[5] Version 1.1 issued 18/12/02

Appendix B

Effort in person months for reporting period 1/1/2002 – 31/12/2002

	VUM				VUA				LADSEB				AIFB				Total			
	Period		Total		Period		Total		Period		Total		Period		Total		Period		Total	
WP/Task	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.
WP1																				
D 1	7.0	4.0	7.0	4.0	1.0	1.5	1.0	1.5					1.0	2.0	1.0	2.0	9.0	7.5	9.0	7.5
D 2	1.0	0.5	1.0	0.5	0.5	0.5	0.5	0.5					0.5	1.5	0.5	1.5	2.0	2.5	2.0	2.5
D 3	1.0	0.0	1.0	0.0	0.5	0.5	0.5	0.5					0.5	1.5	0.5	1.5	2.0	2.0	2.0	2.0
D 4																	0.0	0.0	0.0	0.0
WP2																				
D 5	0.5	0.5	0.5	0.5									2.5	5.5	2.5	5.5	3.0	6.0	3.0	6.0
D 6													3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0
D 7													0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0
D 8													3.5	4.0	3.5	4.0	3.5	4.0	3.5	4.0
D 9													4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0
D 10	2.5	1.5	2.5	1.5									0.0	0.0	0.0	0.0	2.5	1.5	2.5	1.5
D 11													3.0	4.5	3.0	4.5	3.0	4.5	3.0	4.5
D 12													0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D 13	3.0	1.5	3.0	1.5									0.0	0.0	0.0	0.0	3.0	1.5	3.0	1.5
D 14													0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

WP3																			
D 15									6.0	5.0	6.0	5.0					6.0	5.0	6.0	5.0
D 16									0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
D 17									6.0	7.0	6.0	7.0					6.0	7.0	6.0	7.0
D 18					1.0	1.0	1.0	1.0	3.0	3.5	3.0	3.5					4.0	4.5	4.0	4.5
D 19									0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
WP4																			
D 20					7.0	9.0	7.0	9.0									7.0	9.0	7.0	9.0
D 21					4.5	6.0	4.5	6.0									4.5	6.0	4.5	6.0
D 22					0.0	1.0	0.0	1.0									0.0	1.0	0.0	1.0
WP5																			
D 23	1.0	0.5	1.0	0.5	0.5	0.5	0.5	0.5									1.5	1.0	1.5	1.0
D 24																	0.0	0.0	0.0	0.0
D 25																	0.0	0.0	0.0	0.0
WP6																			
D 26	2.0	2.0	2.0	2.0													2.0	2.0	2.0	2.0
D 27	2.0	2.0	2.0	2.0													2.0	2.0	2.0	2.0
D 28	0.0	0.0	0.0	0.0													0.0	0.0	0.0	0.0
D 29	0.0	0.0	0.0	0.0													0.0	0.0	0.0	0.0
Total	20.0	12.5	20.0	12.5	15.0	20.0	15.0	20.0	15.0	15.5	15.0	15.5	18.0	26.0	18.0	26.0	68.0	74.0	68.0	74.0

Notes:

1. Due to unexpected delays in recruiting suitable research staff, VUM actual effort was only 62.5% of estimate. This problem has now been resolved.
2. Both VUA and AIFB actual effort exceeded estimate, but as staff costs were lower than expected they were still within budget.

Appendix C

Costs in keuro for reporting period 1/1/2002 -31/12/2002

	VUM				VUA				LADSEB				AIFB				Total			
	Period		Total		Period		Total		Period		Total		Period		Total		Period		Total	
Cost category	Est.	Act.	Est.	Act.	Est.	Act.*	Est.	Act.*	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.*	Est.	Act.*
Direct costs																				
1. Personnel	138	61	138	61	68	73	68	73	67	66	67	66	85	95	85	95	358	295	358	295
2. Durable equipment	0	0	0	0	9	7	9	7	12	8	12	8	5	2	5	2	26	17	26	17
3. Subcontracting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Travel and subsistence	15	14	15	14	12	10	12	10	9	11	9	11	12	2	12	2	48	37	48	37
5. Consumables	7	3	7	3	1	1	1	1	2	1	2	1	1	1	1	1	11	6	11	6
6. Computing	13	6	13	6	0	0	0	0	0	0	0	0	0	0	0	0	13	6	13	6
7. Protection of knowledge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8. Other specific costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	173	84	173	84	90	92	90	92	90	86	90	86	103	100	103	100	456	361	456	361
Indirect costs																				
9. Overheads	35	17	35	17	18	18	18	18	54	53	54	53	21	20	21	20	128	108	128	108
Total	**208**	**101**	**208**	**101**	**108**	**110**	**108**	**110**	**144**	**139**	**144**	**139**	**124**	**120**	**124**	**120**	**584**	**469**	**584**	**469**

Period: Est.: estimated costs in contract for period Act.: actual costs in period
Total: Est.: estimated cumulative costs to date in contract Act.: cumulative actual costs to date

* These costs are estimated as we do not yet have final figures from VUA, but personnel costs are based on hours quoted for the management report.