

# SEVENTH FRAMEWORK PROGRAMME

THEME [ICT-2007.8.0]  
[FET Open]

Grant agreement for: Collaborative project

<b>Annex I - "Description of Work"</b>
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Project acronym: CerCo

Project full title: " CERTIFIED COMPLEXITY "

Grant agreement no: 243881

Date of preparation of Annex I (latest version): 2009-10-06

Date of approval of Annex I by Commission:

# A1: Our project

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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One form per project

## General information

Project title <sup>3</sup>	CERTIFIED COMPLEXITY		
Starting date <sup>4</sup>	01/02/2010		
Duration in months <sup>5</sup>	36		
Call (part) identifier <sup>6</sup>	FP7-ICT-2009-C		
Activity code(s) most relevant to your topic <sup>7</sup>	ICT-2007.8.0: FET Open		
Free keywords <sup>8</sup>	Verification, proof checking, program extraction, compilers, assembly, complexity		

## Abstract <sup>9</sup>

The project aims to the construction of a formally verified complexity preserving compiler from a large subset of C to some typical microcontroller assembly, of the kind traditionally used in embedded systems. The work comprise the definition of cost models for the input and target languages, and the machine-checked proof of preservation of complexity (concrete, not asymptotic) along compilation. The compiler will also return tight and certified cost annotations for the source program, providing a reliable infrastructure to draw temporal assertions on the executable code while reasoning on the source.  
The compiler will be open source, and all proofs will be public domain.

# A2: List of Beneficiaries

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## List of Beneficiaries

No	Name	Short name	Country	Project entry month <sup>10</sup>	Project exit month
1	ALMA MATER STUDIORUM-UNIVERSITA DI BOLOGNA	UNIBO	Italy	1	36
2	UNIVERSITE PARIS DIDEROT - PARIS 7	UPD	France	1	36
3	THE UNIVERSITY OF EDINBURGH	UEDIN	United Kingdom	1	36

# A3: Budget Breakdown

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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One Form per Project

Participant number in this project <sup>11</sup>	Participant short name	Fund. % <sup>12</sup>	Ind. costs <sup>13</sup>	Estimated eligible costs (whole duration of the project)					Total receipts	Requested EC contribution
				RTD / Innovation (A)	Demonstration (B)	Management (C)	Other (D)	Total A+B+C+D		
1	UNIBO	75	T	542,080.00	0.00	66,480.00	0.00	608,560.00	0.00	473,040.00
2	UPD	75	T	412,022.00	0.00	5,441.00	0.00	417,463.00	0.00	314,457.00
3	UEDIN	75	S	482,735.00	0.00	14,985.00	0.00	497,720.00	0.00	377,036.00
<b>TOTAL</b>				1,436,837.00	0.00	86,906.00	0.00	1,523,743.00	0.00	1,164,533.00

Note that the budget mentioned in this table is the total budget requested by the Beneficiary and associated Third Parties.

**\* The following funding schemes are distinguished**

Collaborative Project (if a distinction is made in the call please state which type of Collaborative project is referred to: (i) Small of medium-scale focused research project, (ii) Large-scale integrating project, , (iii) Project targeted to special groups such as SMEs and other smaller actors), Network of Excellence, Coordination Action, Support Action.

**1. Project number**

The project number has been assigned by the Commission as the unique identifier for your project, and it cannot be changed. The project number **should appear on each page of the grant agreement preparation documents** to prevent errors during its handling.

**2. Project acronym**

Use the project acronym as indicated in the submitted proposal. It cannot be changed, unless agreed during the negotiations. The same acronym **should appear on each page of the grant agreement preparation documents** to prevent errors during its handling.

**3. Project title**

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

**4. Starting date**

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a detailed justification on a separate note.

**5. Duration**

Insert the duration of the project in full months.

**6. Call (part) identifier**

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

**7. Activity code**

Select the activity code from the drop-down menu.

**8. Free keywords**

Use the free keywords from your original proposal; changes and additions are possible.

**9. Abstract**

**10. The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.**

**11. The number allocated by the Consortium to the participant for this project.**

**12. Include the funding % for RTD/Innovation – either 50% or 75%**

**13. Indirect cost model**

**A: Actual Costs**

**S: Actual Costs Simplified Method**

**T: Transitional Flat rate**

**F :Flat Rate**

**INSERT YOUR PART B**



# Workplan Tables

Project number

243881

Project title

CerCo—CERTIFIED COMPLEXITY

Call (part) identifier

FP7-ICT-2009-C

Funding scheme

Collaborative project

# WT1

## List of work packages

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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### LIST OF WORK PACKAGES (WP)

WP Number <sup>53</sup>	WP Title	Type of activity <sup>54</sup>	Lead beneficiary number <sup>55</sup>	Person-months <sup>56</sup>	Start month <sup>57</sup>	End month <sup>58</sup>
WP 1	Project Management	MGT	1	11	1	36
WP 2	Untrusted Compiler Prototype	RTD	2	45	1	18
WP 3	Verified Compiler - front end	RTD	3	57	5	36
WP 4	Verified Compiler - back end	RTD	1	53	5	36
WP 5	Interfaces and Interactive Components	RTD	2	37	13	36
WP 6	Dissemination and exploitation	RTD	1	11	1	36
<b>TOTAL</b>				214		

# WT2: List of Deliverables

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## List of Deliverables - to be submitted for review to EC

Deliverable Number <sup>61</sup>	Deliverable Title	WP number <sup>53</sup>	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D6.1	Project Web Site and Software Repository	6	1	3	P	PU	3
D2.1	Compiler Design and intermediate languages	2	2	15	R	PU	6
D6.2	Plan for the Use and dissemination of foreground	6	1	2	R	CO	6
D3.1	Executable Formal Semantics of C	3	3	6	P	PU	10
D4.1	Executable Formal Semantics of Machine Code	4	1	6	P	PU	10
D1.1	Periodic Activity Report and Financial Statements	1	1	3	R	CO	12
D2.2	Untrusted Cost-annotating OCaml Compiler	2	2	30	P	PU	12
D3.2	CIC encoding: Front-end	3	3	11	P	PU	18
D3.3	Executable Formal Semantics of front end intermediate languages	3	3	5	P	PU	18
D4.2	CIC encoding: Back-end	4	1	10	P	PU	18
D4.3	Executable Formal Semantics of back-end intermediate languages	4	1	4	P	PU	18
<b>Total</b>				<b>214.0</b>			

# WT2: List of Deliverables

Deliverable Number <sup>61</sup>	Deliverable Title	WP number <sup>53</sup>	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D1.2	Periodic Activity Report and Financial Statements	1	1	3	R	CO	24
D5.1	Untrusted CerCo Prototype	5	2	8	P	PU	24
D6.6	Packages for Linux distributions and Live CD	6	1	2	P	PU	30
D6.4	Organization of an Event Targeted to Potential Industrial Stakeholders	6	1	1	O	PU	34
D6.5	Organization of an Event Targeted to the Scientific Community	6	1	1	O	PU	34
D1.3	Periodic Activity Report and Financial Statements	1	1	2	R	CO	36
D1.4	Final Report	1	1	3	R	CO	36
D3.4	Front end Correctness Proofs	3	3	35	P	PU	36
D4.4	Back-end Correctness Proofs	4	1	33	P	PU	36
D5.2	Trusted CerCo Prototype	5	2	5	P	PU	36
D5.3	Case study: analysis of synchronous code	5	2	24	P	PU	36
D6.3	Final Report on user validation	6	1	2	R	CO	36
<b>Total</b>				<b>214.0</b>			

# WT3: Work package description

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## One form per Work Package

Work package number <sup>53</sup>	WP1	Type of activity <sup>54</sup>	MGT
Work package title	Project Management		
Start month	1		
End month	36		
Lead beneficiary number <sup>55</sup>	1		

## Objectives

The overall objective of the management WP is the smooth realisation of the CERCO project, and in particular:

1. To coordinate and supervise activities to be carried out
2. To carry out the overall administrative and financial management of the project
3. To manage the Grant Agreement with the European Commission and the Consortium Agreement
4. To manage contacts with the European Commission
5. To monitor quality and timing of project deliverables
6. To establish effective internal and external communication procedures

## Description of work and role of partners

Management activities will be organized by the Coordinator, and carried out with the assistance of the Project Management Team and with the contribution of the partners of the project. Efficient communication and management procedures and tools will be set up for facilitating exchange among partners (internal communication) and with interested entities outside the consortium (external communication). A kick-off meeting will be organized at project start-up, and periodical meetings will be held at month 12, 24 and 36. Periodic Reporting of the project activity at the European Commission, including the collection of contributions from the partners, financial statements and certificates is scheduled on an annual basis.

## Description of deliverables

D1.1) Periodic Activity Report and Financial Statements: The deliverables describes the financial and administrative management of the project, including the circulation of EC contribution as well as the collection and check of financial statements and related information (certificates on financial statements). [month 12]

D1.2) Periodic Activity Report and Financial Statements: The deliverables describes the financial and administrative management of the project, including the circulation of EC contribution as well as the collection and check of financial statements and related information (certificates on financial statements). [month 24]

D1.3) Periodic Activity Report and Financial Statements: The deliverables describes the financial and administrative management of the project, including the circulation of EC contribution as well as the collection and check of financial statements and related information (certificates on financial statements). [month 36]

D1.4) Final Report: Final Project Report according to EU guidelines, including the Final Report on User Validation and Exploitability. [month 36]

## Person-Months per Participant

# WT3: Work package description

Participant number <sup>10</sup>	Participant short name <sup>11</sup>	Person-months per participant
1	UNIBO	9
2	UPD	1
3	UEDIN	1
<b>Total</b>		<b>11.0</b>

## Schedule of relevant Milestones

Milestone number <sup>59</sup>	Milestone name	Lead beneficiary number	Delivery date from Annex I <sup>60</sup>	Comments
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## List of deliverables

Deliverable Number <sup>61</sup>	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D1.1	Periodic Activity Report and Financial Statements	1	3	R	CO	12
D1.2	Periodic Activity Report and Financial Statements	1	3	R	CO	24
D1.3	Periodic Activity Report and Financial Statements	1	2	R	CO	36
D1.4	Final Report	1	3	R	CO	36
<b>Total</b>			<b>11.0</b>			

# WT3: Work package description

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## One form per Work Package

Work package number <sup>53</sup>	WP2	Type of activity <sup>54</sup>	RTD
Work package title	Untrusted Compiler Prototype		
Start month	1		
End month	18		
Lead beneficiary number <sup>55</sup>	2		

## Objectives

The goal is to implement a proof-of-concept prototype of the cost annotating compiler. The compiler will be untrusted, meaning that no proof will be given that the machine code and the cost annotations returned by the compiler are correct. It will be written in a high-level, comfortable programming language particularly tailored to compiler construction (OCaml). This untrusted prototype compiler will drive the design and implementation of the trusted version, and at the same time will allow to start experimenting with the management of cost annotations, the declaration of complexity assertions, the generation of complexity obligations and their interactive solution (tasks covered by WP5).

## Description of work and role of partners

The work is organized in four tasks:

- \* Task.2.1 Architectural design (indicative effort: UNIBO: 3; UDP: 4; UEDIN: 3)
- \* Task.2.2 Intermediate languages and data structures (indicative effort: UNIBO: 1; UDP: 3; UEDIN: 1)
- \* Task 2.3 Implementation (indicative effort: UNIBO: 1; UDP: 17; UEDIN: 2)
- \* Task 2.4 Integration, validation and testing (indicative effort: UNIBO: 2; UDP: 6; UEDIN: 2)

Most of the work (Tasks 2.1-3) is concentrated in the first year. All partners will participate to the architectural design of the compiler and to the definitions of its intermediate languages, and final output, since this work will drive most of the later activities in the project. The implementation effort will be mainly endured by UPD. The last task is mostly meant to modify the compiler according to the feedback received by the validation phase, and to keep it in synch with the trusted version, in case of architectural or methodological revisitations.

## Description of deliverables

D2.1) Compiler Design and intermediate languages: The report will contain an overall architectural description of the compiler, a detailed description of intermediate languages and a discussion about the format of cost annotations, and the way of computing them. [month 6]

D2.2) Untrusted Cost-annotating OCaml Compiler: A proof of concept untrusted prototype of the cost annotating compiler, written in the OCaml programming language. [month 12]

## Person-Months per Participant

Participant number <sup>10</sup>	Participant short name <sup>11</sup>	Person-months per participant
1	UNIBO	7
2	UPD	30
3	UEDIN	8
<b>Total</b>		<b>45.0</b>

## Schedule of relevant Milestones

# WT3: Work package description

Milestone number <sup>59</sup>	Milestone name	Lead beneficiary number	Delivery date from Annex I <sup>60</sup>	Comments
MS1	Untrusted Cost-annotating Compiler	2	12	Means of verification: prototype D2.2

## List of deliverables

Deliverable Number <sup>61</sup>	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D2.1	Compiler Design and intermediate languages	2	15	R	PU	6
D2.2	Untrusted Cost-annotating OCaml Compiler	2	30	P	PU	12
<b>Total</b>			<b>45.0</b>			

# WT3: Work package description

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## One form per Work Package

<b>Work package number</b> <sup>53</sup>	WP3	<b>Type of activity</b> <sup>54</sup>	RTD
<b>Work package title</b>	Verified Compiler - front end		
<b>Start month</b>	5		
<b>End month</b>	36		
<b>Lead beneficiary number</b> <sup>55</sup>	3		

## Objectives

This Work Package is devoted to the formal encoding and correctness verification of the compiler front end, from some abstract syntax tree representation of (a large subset of) the C language to three-address like intermediate code.

## Description of work and role of partners

The work is organized in the following tasks:

- \* Task.3.1 Formal semantics of C (indicative effort: UNIBO: 0; UDP: 0; UEDIN: 6)
- \* Task.3.2 Functional encoding in the Calculus of Inductive Construction (indicative effort: UNIBO: 1; UDP: 1; UEDIN: 9)
- \* Task 3.3 Formal semantics of intermediate languages (indicative effort: UNIBO: 0; UDP: 0; UEDIN: 5)
- \* Task 3.4 Correctness proofs (indicative effort: UNIBO: 2; UDP: 2; UEDIN: 31)

Following an already tested and successful methodology, we plan to use the Interactive Theorem Prover both as a programming environment and as a verification tool to reason on programs written in its internal language: the Calculus of Inductive Constructions (CIC). Hence, the work is naturally organized in two main, consecutive phases: the formal rewriting of the (untrusted) compiler front-end in CIC (Task 3.2), and the machine checked proof of its correctness with respect to the semantics and complexity of programs (Task 3.4). The functional design of the compiler will follow the trace of the untrusted prototype of WP1, and can only start during the second year. However, a preliminary phase (Task 3.1) consisting in defining the formal semantics and the cost model of the C programming language, can be anticipated in the first year, and done in parallel to WP2. We also naturally split in a separated Task (3.3) the (executable) formal semantics of the intermediate language. Due to their past experience in the formalization of properties of high level programming languages, UEDIN is the best candidate to carry out most of the activities of WP3.

## Description of deliverables

D3.1) Executable Formal Semantics of C: Formal definition of the semantics of the C programming language. The semantics will be given in a functional (and hence executable) form, useful for testing, validation and project assessment. [month 10]

D3.2) CIC encoding: Front-end: Functional Specification in the internal language of the Proof Assistant (the Calculus of Inductive Construction) of the front end of the compiler. The input is an abstract syntax tree representation of the program, and the output is a three-address-code-like intermediate language. For the representation of data and all transformations we shall extensively exploit dependent types (not available in OCaml). A first validation of the design principles and implementation choices for the Untrusted Cost-annotating OCaml Compiler D2.2 is achieved and reported in the deliverable, possibly triggering updates of the Untrusted CerCo Compiler sources (D2.2 and D5.1). [month 18]

D3.3) Executable Formal Semantics of front end intermediate languages: This prototype is the formal counterpart of deliverable D2.1 for the front end side of the compiler and validates it. [month 18]

# WT3: Work package description

D3.4) Front end Correctness Proofs: Formally checked proof of the semantics correspondence between the intermediate code and its source, and of the preservation/modification of the control flow. An extensive validation of implementation of the Untrusted CerCo Prototype D5.1 is achieved and reported in the deliverable, possibly triggering updates of the Untrusted CerCo Compiler sources and CIC encoding (D2.2, D5.1 and D3.2). [month 36]

## Person-Months per Participant

Participant number <sup>10</sup>	Participant short name <sup>11</sup>	Person-months per participant
1	UNIBO	3
2	UPD	3
3	UEDIN	51
<b>Total</b>		<b>57.0</b>

## Schedule of relevant Milestones

Milestone number <sup>59</sup>	Milestone name	Lead beneficiary number	Delivery date from Annex I <sup>60</sup>	Comments
MS2	Untrusted CerCo Compiler	2	24	Means of verification: prototypes D3.2, D4.2, D5.1
MS3	Trusted CerCo Compiler	2	36	Means of verification: prototypes D3.1, D3.3, D3.4, D4.1, D4.3, D4.4, D5.2, D5.3

## List of deliverables

Deliverable Number <sup>61</sup>	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D3.1	Executable Formal Semantics of C	3	6	P	PU	10
D3.2	CIC encoding: Front-end	3	11	P	PU	18
D3.3	Executable Formal Semantics of front end intermediate languages	3	5	P	PU	18
D3.4	Front end Correctness Proofs	3	35	P	PU	36
<b>Total</b>			<b>57.0</b>			

# WT3: Work package description

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## One form per Work Package

<b>Work package number</b> <sup>53</sup>	WP4	<b>Type of activity</b> <sup>54</sup>	RTD
<b>Work package title</b>	Verified Compiler - back end		
<b>Start month</b>	5		
<b>End month</b>	36		
<b>Lead beneficiary number</b> <sup>55</sup>	1		

## Objectives

The goal of this Work Package is to build the trusted versions of the compiler back-end, from intermediate three address code to assembly language.

## Description of work and role of partners

The work follows the same organization of WP3 and is meant to be done in parallel with it.

- \* Task.4.1 Formal semantics of machine code (indicative effort: UNIBO: 6; UDP: 0; UEDIN: 0)
- \* Task.4.2 Functional encoding in the Calculus of Inductive Construction (indicative effort: UNIBO: 8; UDP: 2; UEDIN: 0)
- \* Task 4.3 Formal semantics of intermediate languages (indicative effort: UNIBO: 4; UDP: 0; UEDIN: 0)
- \* Task 4.4 Correctness proofs (indicative effort: UNIBO: 27; UDP: 4; UEDIN: 2)

The work starts at the first year with the formalization of the semantics of the target code (Task 4.1). Then, we translate the untrusted OCaml compiler into the internal language of the Interactive Theorem Prover (Task 4.2) and proceed to write and check its formal correctness proof (Task 4.4). Due to the dimension of the latter task, and in view of the self assessment of the state of advancement of the work, it looks reasonable to keep the formal semantics of the intermediate languages as a separate subtask (Task 4.3). The main bulk of the activities in WP4 will be carried out by UNIBO, taking advantage of some past experience in the formalization of assembly languages in the MATITA proof assistant.

## Description of deliverables

D4.1) Executable Formal Semantics of Machine Code: Formal definition of the semantics of the target language. The semantics will be given in a functional (and hence executable) form, useful for testing, validation and project assessment. [month 10]

D4.2) CIC encoding: Back-end: Functional Specification in the internal language of the Proof Assistant (the Calculus of Inductive Construction) of the back end of the compiler. This unit is meant to be composable with the front-end of deliverable D3.2, to obtain a full working compiler for Milestone M2. A first validation of the design principles and implementation choices for the Untrusted Cost-annotating OCaml Compiler D2.2 is achieved and reported in the deliverable, possibly triggering updates of the Untrusted Cost-annotating OCaml Compiler sources. [month 18]

D4.3) Executable Formal Semantics of back-end intermediate languages: This prototype is the formal counterpart of deliverable D2.1 for the back end side of the compiler and validates it. [month 18]

D4.4) Back-end Correctness Proofs: Formally checked proof of the semantics correspondence between the intermediate code and the target code, and of the preservation/modification of the control flow for complexity analysis. An extensive validation of implementation of the Untrusted Cerco Prototype D5.1 is achieved and reported in the deliverable, possibly triggering updates of the Untrusted CerCo Compiler sources and CIC encoding (D2.2, D5.1 and D4.2). [month 36]

# WT3: Work package description

## Person-Months per Participant

Participant number <sup>10</sup>	Participant short name <sup>11</sup>	Person-months per participant
1	UNIBO	45
2	UPD	6
3	UEDIN	2
<b>Total</b>		<b>53.0</b>

## Schedule of relevant Milestones

Milestone number <sup>59</sup>	Milestone name	Lead beneficiary number	Delivery date from Annex I <sup>60</sup>	Comments
MS2	Untrusted CerCo Compiler	2	24	Means of verification: prototypes D3.2, D4.2, D5.1
MS3	Trusted CerCo Compiler	2	36	Means of verification: prototypes D3.1, D3.3, D3.4, D4.1, D4.3, D4.4, D5.2, D5.3

## List of deliverables

Deliverable Number <sup>61</sup>	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D4.1	Executable Formal Semantics of Machine Code	1	6	P	PU	10
D4.2	CIC encoding: Back-end	1	10	P	PU	18
D4.3	Executable Formal Semantics of back-end intermediate languages	1	4	P	PU	18
D4.4	Back-end Correctness Proofs	1	33	P	PU	36
<b>Total</b>			<b>53.0</b>			

# WT3: Work package description

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## One form per Work Package

Work package number <sup>53</sup>	WP5	Type of activity <sup>54</sup>	RTD
Work package title	Interfaces and Interactive Components		
Start month	13		
End month	36		
Lead beneficiary number <sup>55</sup>	2		

## Objectives

The aim of WP5 is to develop a proof of concept prototype, by interfacing to already existing tools, to show how the annotations produced by the compiler can be exploited to draw complexity assertions on the execution time of the program. We will develop abstract interpretation techniques to infer automatically complexity bounds and, in particular, we will test these techniques on the C code generated by the compilers of synchronous languages, such as Lustre or Esterel.

## Description of work and role of partners

The work is organized in two main tasks:

- \* Task 5.1 Management of complexity assertions (indicative effort: UNIBO: 1; UDP: 4; UEDIN: 1)
- \* Task 5.2 Automation of complexity proofs (indicative effort: UNIBO: 4; UDP: 3; UEDIN: 0)
- \* Task 5.3 Case studies (indicative effort: UNIBO: 4; UDP: 17; UEDIN: 3)

The first two Tasks above refer to the two final stages of the user interaction flow. In particular, the first task is devoted to the management of the cost annotations (produced by the compiler) and the complexity assertions (added by the user or synthesized automatically by abstract interpretation algorithm), in order to produce the right complexity obligations, that is the goals to be proved in order to check the correctness of the assertions. The second task is focused on tools and techniques for the automatic/computer-assisted solution of such obligations. The techniques developed in Tasks 5.1 and 5.2 will be validated in Task 5.3 on the C code generated by a synchronous language compiler. In particular, we expect to reach a significant amount of automation on invariants generation for compiled synchronous programs.

## Description of deliverables

D5.1) Untrusted CerCo Prototype: First functional prototype of the system (M2). The compiler is already written in a language suited to be formally checked for correctness, but still lacking (complete) proofs. [month 24]

D5.2) Trusted CerCo Prototype: Final, fully trustable version of the system. The validation of the prototype will be performed in D5.3 and D6.3. [month 36]

D5.3) Case study: analysis of synchronous code: Automatic generation of invariants for the C code generated by a synchronous language compiler. Application to the computation of a certified reaction time bound for synchronous programs and testing on significant examples. This deliverable provides the main functional validation for the Trusted CerCo Prototype D2.2 and will report on the validation experience from the implementor perspective. A more detailed report from the user perspective will constitute the deliverable D6.3. [month 36]

## Person-Months per Participant

# WT3: Work package description

Participant number <sup>10</sup>	Participant short name <sup>11</sup>	Person-months per participant
1	UNIBO	9
2	UPD	24
3	UEDIN	4
<b>Total</b>		<b>37.0</b>

## Schedule of relevant Milestones

Milestone number <sup>59</sup>	Milestone name	Lead beneficiary number	Delivery date from Annex I <sup>60</sup>	Comments
MS2	Untrusted CerCo Compiler	2	24	Means of verification: prototypes D3.2, D4.2, D5.1
MS3	Trusted CerCo Compiler	2	36	Means of verification: prototypes D3.1, D3.3, D3.4, D4.1, D4.3, D4.4, D5.2, D5.3

## List of deliverables

Deliverable Number <sup>61</sup>	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D5.1	Untrusted CerCo Prototype	2	8	P	PU	24
D5.2	Trusted CerCo Prototype	2	5	P	PU	36
D5.3	Case study: analysis of synchronous code	2	24	P	PU	36
<b>Total</b>			<b>37.0</b>			

# WT3: Work package description

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## One form per Work Package

<b>Work package number</b> <sup>53</sup>	WP6	<b>Type of activity</b> <sup>54</sup>	RTD
<b>Work package title</b>	Dissemination and exploitation		
<b>Start month</b>	1		
<b>End month</b>	36		
<b>Lead beneficiary number</b> <sup>55</sup>	1		

## Objectives

The overall objective of WP6 is to manage the knowledge generated by the project and IPRs, and to bring the technological advances developed within the CerCo project to the scientific community and potential users. The project will target not only the scientific and academic community but also industries at the European level potentially interested in applying formal verification techniques to embedded software design. The specific objectives of WP6 will be: (1) a tailored dissemination activity that will make use of specific dissemination mechanisms in order to reach the relevant communities; (2) supervision of the entire project with regard to result applicability and the promotion of the exploitation.

## Description of work and role of partners

Strategies and activities for the dissemination of project results towards the European scientific community and industries potentially interested in their adoption will be carried out in order to improve the visibility and to enhance the exploitation of project results. All the partners will participate in the dissemination activities, which will include

\* Task 6.1 User validation and exploitability (indicative effort: UNIBO: 1; UDP: 1; UEDIN: 2)  
During the last year the technologies developed so far will be assessed to ensure they fulfil actual requirements of the targeted exploitation communities.

\* Task 6.2 Contribution to portfolio and concertation activities at FET-Open level (indicative effort: UNIBO: 5; UDP: 1; UEDIN: 1)  
In order to support scientific cooperation at the FET-Open level and broad public awareness of project achievements, consortium members will ensure within the areas of interest of the project:

- a) Project results shall be published throughout the duration of the project in widely accessible science and technology journals, as well as through conferences and through other channels, including the Web, reaching audiences beyond the academic community.
- b) Beneficiaries shall deposit an electronic copy of the published version or the final manuscript accepted for publication of a scientific publication relating to foreground published before or after the final report in an institutional or subject based repository at the moment of publication.
- c) Beneficiaries are required to make their best efforts to ensure that this electronic copy becomes freely and electronically available to anyone through this repository:
  - immediately if the scientific publication is published "open access", i.e. if an electronic version is available free of charge via the publisher, or
  - within 6 months of publication
- d) Periodic press releases shall be issued, and other means of disseminating project progress to a wider audience e.g. via video.
- e) Participation in FET-organized events, for example conferences, dedicated workshops & working groups, consultation

# WT3: Work package description

meetings, summer schools, on-line fora, etc.

f) International co-operation - contribution to relevant national and international activities (ex. Joint workshops, calls, etc.)

g) In order to involve other relevant stakeholders, such as embedded systems industries other targeted dissemination channels

will be used (e.g. interaction with the Joint Technology Initiative on Embedded Systems, ARTEMIS, in which the University of

Bologna is actively involved).

The above activities will be reported in the project's Plan for the Use and Dissemination of Foreground and in periodic progress reports. In addition, the consortium agrees to include the following reference in all project-related publications, activities and events:

"The project CerCo acknowledges the financial support of the Future and Emerging Technologies (FET) programme within the

Seventh Framework Programme for Research of the European Commission, under FET-Open grant number: 243881"

## Description of deliverables

D6.1) Project Web Site and Software Repository: A web site will be designed and realised, and each partner will contribute to its content. The site will comprise a public part, accessible to everyone, and a private one, reserved to the project partners for the exchange of documentation, material, and to support project related activities. We will also install a revision control system (like SVN or GIT) to keep track of software evolution and we will adapt an existent continuous building system to trace software regressions nightly, in batch mode. [month 3]

D6.2) Plan for the Use and dissemination of foreground: An articulated dissemination plan, containing the individuation of the main target communities, and the relative exploitation strategies. [month 6]

D6.3) Final Report on user validation: An articulated analysis and critics of the user validation experiences. In particular we will review the effectiveness of the techniques for cost annotation exploitation that have been employed in the project and that have been validated on simple and non trivial examples. We will also identify additional techniques that could be exploited in the middle and long term to bring the CerCo compiler to its full potentialities. [month 36]

D6.4) Organization of an Event Targeted to Potential Industrial Stakeholders: We will organize a public event opened to industries and other potential stakeholders and we will invite a few potentially interested industries to be identified in D6.2 and during the project development. The event could be affiliated to an international conference relevant to the project and could involve a tutorial on the use of the software developed in CerCo. The deliverable date is only indicative, since we need to identify a suitable conference for affiliation. The event could be co-located and partially overlap with D6.5. [month 34]

D6.5) Organization of an Event Targeted to the Scientific Community: We will organize a public event aimed at presenting the CerCo compiler to the scientific community. The event could be affiliated to an international conference relevant to the project and it could involve a tutorial on the use of the software developed in CerCo. Alternatively, it could consist in a course give in an international summer school on the use and implementation of the CerCo compiler. The deliverable date is only indicative, since we need to identify a suitable conference or summer school for affiliation. The event could be co-located and partially overlap with D6.4. [month 34]

D6.6) Packages for Linux distributions and Live CD: In order to foster adoption of the CerCo compiler in a wider community, we will provide packages for selected Linux distributions and a Live CD with the software developed in the project. We will also consider and discuss the integration of our software in an extensible platform dedicated to source-code analysis of C software, like Frama-C. However, at the moment it is unclear how these rapidly changing platforms will evolve in the next two years, if integration would provide an added value and if it would be possible to practically achieve the integration in the project timeframe without an actual involvement of the platform developers (that would need to contribute man-power to the task). [month 30]

## Person-Months per Participant

# WT3: Work package description

Participant number <sup>10</sup>	Participant short name <sup>11</sup>	Person-months per participant
1	UNIBO	6
2	UPD	2
3	UEDIN	3
<b>Total</b>		<b>11.0</b>

## Schedule of relevant Milestones

Milestone number <sup>59</sup>	Milestone name	Lead beneficiary number	Delivery date from Annex I <sup>60</sup>	Comments

## List of deliverables

Deliverable Number <sup>61</sup>	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D6.1	Project Web Site and Software Repository	1	3	P	PU	3
D6.2	Plan for the Use and dissemination of foreground	1	2	R	CO	6
D6.3	Final Report on user validation	1	2	R	CO	36
D6.4	Organization of an Event Targeted to Potential Industrial Stakeholders	1	1	O	PU	34
D6.5	Organization of an Event Targeted to the Scientific Community	1	1	O	PU	34
D6.6	Packages for Linux distributions and Live CD	1	2	P	PU	30
<b>Total</b>			<b>11.0</b>			

# WT4: List of Milestones

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## List and Schedule of Milestones

Milestone number <sup>59</sup>	Milestone name	WP number <sup>53</sup>	Lead beneficiary number	Delivery date from Annex I <sup>60</sup>	Comments
MS1	Untrusted Cost-annotating Compiler	WP2	2	12	Means of verification: prototype D2.2
MS2	Untrusted CerCo Compiler	WP3, WP4, WP5	2	24	Means of verification: prototypes D3.2, D4.2, D5.1
MS3	Trusted CerCo Compiler	WP3, WP4, WP5	2	36	Means of verification: prototypes D3.1, D3.3, D3.4, D4.1, D4.3, D4.4, D5.2, D5.3

# WT5: Tentative schedule of Project Reviews

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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## Tentative schedule of Project Reviews

Review number <small>65</small>	Tentative timing	Planned venue of review	Comments, if any
RV 1	14	To be defined	
RV 2	26	To be defined	
RV 3	38	To be defined	

## Project Effort by Beneficiary and Work Package

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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### Indicative efforts (man-months) per Beneficiary per Work Package

Beneficiary number and short-name	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	Total per Beneficiary
1 - UNIBO	9.0	7.0	3.0	45.0	9.0	6.0	79.0
2 - UPD	1.0	30.0	3.0	6.0	24.0	2.0	66.0
3 - UEDIN	1.0	8.0	51.0	2.0	4.0	3.0	69.0
<b>Total</b>	11.0	45.0	57.0	53.0	37.0	11.0	214.0

## Project Effort by Activity type per Beneficiary

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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Indicative efforts per Activity Type per Beneficiary

Activity type	Part. 1	Part. 2	Part. 3	Total
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### 1. RTD/Innovation activities

WP 2	7.0	30.0	8.0	45.0
WP 3	3.0	3.0	51.0	57.0
WP 4	45.0	6.0	2.0	53.0
WP 5	9.0	24.0	4.0	37.0
WP 6	6.0	2.0	3.0	11.0
<b>Total Research</b>	<b>70.0</b>	<b>65.0</b>	<b>68.0</b>	<b>203.0</b>

### 2. Demonstration activities

<b>Total Demo</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
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### 3. Consortium Management activities

WP 1	9.0	1.0	1.0	11.0
<b>Total Management</b>	<b>9.0</b>	<b>1.0</b>	<b>1.0</b>	<b>11.0</b>

### 4. Other activities

<b>Total other</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
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<b>Total</b>	<b>79.0</b>	<b>66.0</b>	<b>69.0</b>	<b>214.0</b>
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# WT8: Project Effort and costs

Project Number <sup>1</sup>	243881	Project Acronym <sup>2</sup>	CerCo
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One Form per Project

Particip- pant number	Participant short name	Estimated eligible costs (whole duration of the project)						Total receipts (€)	Requested EC contribution (€)
		Effort (PM)	Personnel costs (€)	Subcontracting (€)	Other Direct costs (€)	Indirect costs OR lump sum, flat-rate or scale-of- unit (€)	TOTAL costs		
1	UNIBO	79.0	331,800.00	6,000.00	44,800.00	225,960.00	608,560.00	0.00	473,040.00
2	UPD	66.0	224,401.00	0.00	36,514.00	156,548.00	417,463.00	0.00	314,457.00
3	UEDIN	69.0	310,617.00	3,400.00	39,604.00	144,099.00	497,720.00	0.00	377,036.00
<b>Total</b>		214.0	866,818.00	9,400.00	120,918.00	526,607.00	1,523,743.00	0.00	1,164,533.00

### **1. Project number**

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

### **2. Project acronym**

Use the project acronym as given in the submitted proposal. It cannot be changed unless agreed so during the negotiations. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

### **53. Work Package number**

Work package number: WP1, WP2, WP3, ..., WPn

### **54. Type of activity**

For all FP7 projects each work package must relate to one (and only one) of the following possible types of activity (only if applicable for the chosen funding scheme – must correspond to the GPF Form Ax.v):

- **RTD** = Research and technological development (incl. scientific coordination applicable for Collaborative Projects and Networks of Excellence)
- **DEM** = Demonstration - applicable for collaborative projects
- **MGT** = Management of the consortium - applicable for all funding schemes
- **OTHER** = Other specific activities, applicable for all funding schemes
- **COORD** = Coordination activities – applicable only for CAs
- **SUPP** = Support activities – applicable only for SAs

### **55. Lead beneficiary number**

Number of the beneficiary leading the work in this work package.

### **56. Person-months per work package**

The total number of person-months allocated to each work package.

### **57. Start month**

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

### **58. End month**

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

### **59. Milestone number**

Milestone number: MS1, MS2, ..., MSn

### **60. Delivery date for Milestone**

Month in which the milestone will be achieved. Month 1 marking the start date of the project, and all delivery dates being relative to this start date.

### **61. Deliverable number**

Deliverable numbers in order of delivery dates: D1 – Dn

### **62. Nature**

Please indicate the nature of the deliverable using one of the following codes

**R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

### **63. Dissemination level**

Please indicate the dissemination level using one of the following codes:

- **PU** = Public
- **PP** = Restricted to other programme participants (including the Commission Services)
- **RE** = Restricted to a group specified by the consortium (including the Commission Services)
- **CO** = Confidential, only for members of the consortium (including the Commission Services)

- **Restreint UE** = Classified with the classification level "Restreint UE" according to Commission Decision 2001/844 and amendments
- **Confidentiel UE** = Classified with the mention of the classification level "Confidentiel UE" according to Commission Decision 2001/844 and amendments
- **Secret UE** = Classified with the mention of the classification level "Secret UE" according to Commission Decision 2001/844 and amendments

**64. Delivery date for Deliverable**

Month in which the deliverables will be available. Month 1 marking the start date of the project, and all delivery dates being relative to this start date

**65. Review number**

Review number: RV1, RV2, ..., RVn

**66. Tentative timing of reviews**

Month after which the review will take place. Month 1 marking the start date of the project, and all delivery dates being relative to this start date.

**67. Person-months per Deliverable**

The total number of person-month allocated to each deliverable.