Project IST 2001-37652 HRTC

Hard Real-time CORBA

Periodic Control Report
Deliverable D6.9

Reference Period: (from 01/07/2003 to 30/09/2003)

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Project Co-ordinator

Organisation: *Universidad Politécnica de Madrid*
Responsible person: *Ricardo Sanz*
Address: *Jose Gutierrez Abascal 2*
28006 Madrid, Spain
Phone: *+34 91 336 30 61*
Fax: *+34 91 336 30 10*
E-mail: *Ricardo.Sanz@etsii.upm.es*

Consortium

	Participant name	*Participant acronym*
1	*Universidad Politécnica de Madrid*	*UPM*
2	*Lund University*	*ULund*
3	*Technical University of Vienna*	*TUVienna*
4	*SCILabs Ingenieros S.L.*	*SCILabs*

DOCUMENT HISTORY (example)

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0.0	Oct 1, 2003	Empty draft	Draft	Internal
0.1	Oct 10, 2003	Some content added	Draft	Internal
1.0	Oct 23, 2003	Final additions and corrections	Final	Project

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1. OVERVIEW

This report describes the activity of the project during M12-M15 (from July 2003 to September 2003).

During this period the implementation and realization of tests for both testbeds has continued. The specification and implementation of the new protocols (TTP and RTE) continued during this period.

Coordination of activities within OMG has also continued and the draft RFI has been issued.

2. MAIN ACTIVITIES AND ACHIEVEMENTS

2.1 WP1 – WP leader: ULund (Karl-Erik Årzén)

The work within WP1 has been focused on the finalisation of deliverables D1.2 and D1.3. Deliverable 1.2 was accepted at the final review meeting and deliverable D1.3 was delivered at the end of the project.

2.2 WP2 – WP leader: TUWien (Thomas Losert)

In the reporting period some problems that have turned out during the integration of the two HRT transports with the ICa ORB for the testbeds have been fixed.

Further tests have been performed regarding function and performance of the HRT transports. Although most of the problems could be fixed these tests revealed timing-problems caused by the ORB that is running in user-mode of Linux and thus provides less predictable performance than the OCI-plugin that is running mostly in kernel-mode.

Regarding D2.2 (“HRT Protocol Specification”) some modifications have been made in order to make things clearer and reflect the recommendations from the first review. The work for deliverable D2.3 (“HRT Protocol”) has been finished. Further two additional deliverables 066 and 067 (“RT Ethernet Definition” and “TTP Transport Definition”) have been finalized.

The design for the scheduled switched Ethernet-based pluggable transport layer has been completed. The solution is based on adding a separate real-time layer (the ThrottleNet layer) below the IP-layer in the IP stack. The layer distinguishes between ordinary CORBA traffic and schedules hard real-time traffic and makes sure that the latter traffic meets its deadlines. The ThrottleNet layer has been implemented for ix86 (Linux), Motorola PPC (RTAI), and Etrax (RTAI). Several unanticipated problems have been detected in RTAI that have slowed down development.

2.3 WP3 – WP leader: ULund (Klas Nilsson)

The RCT has been subject to very intensive development. The virtual testbed was further developed, including ORB connections and prototyping of RCT IDLs, and soft/non real-time parts of the RCT could be connected to parts of the virtual RCT, and the benefits of CORBA became apparent. In total for the soft real-time RCT (D3.4), the development was close to the plans, but reporting was not completed in time since some issues that had to do with the hard real-time RCT remained open.

The main topic of WP3, the RCT including support for hard real-time CORBA/communication, turned out to be a very difficult problem. There was an alternative plan to use the Irb-2400 robot with its modern PCI-based controller in case of difficulties with the VME-based Irb-2000 system. As reported in the Q3 report, preparations of the alternative platform was successful, including the efforts to get Linux running on the PPC-G4 processors and device drivers for communication with the robot system. However, the aim was to use the VME-based system due to its better possibilities for demanding test cases, and as reported in the Q4 report we saw no significant technical obstacles for completing the work successfully.

The work during Q5 was then centered around:

- Deployment of the ORB, including many problems with run-time libraries, compiler versions, and the like.
- Final implementation of the ThrottleNet, including better abstractions and properties for configuration, revealed several problems with the software that was considered to be ready. That is, the well known RTAI for Linux contained bugs, deficient networking support, and undesired timing properties making the development of our drivers really tricky and time consuming.
- The use of the OCI for ThrottleNet turned out to be difficult in terms of understanding, coding, and due to the involvement with the rest of the ORB. Using an API such as the OCI should be simpler, but with the very good help from SCILabs the problems were solved.
- The hardware drivers for IO and shared memory were not considered as any problem since we had implementations made for the legacy Stork system using exactly this hardware, and during Q3 the corresponding work was done for the new PC-G4 hardware. However, the involvement with the Linux kernel and other device drivers (for instance handling.
- PCI-bus resources for the internal on-board PCI bus that connects to the external VME bus) made additional development necessary. For instance, the bus-global shared memory worked well during initial tests, but deployed in the full system is failed due to hardware configuration reasons.

In total, this meant that five persons were intensively developing the RCT during Q5. The failure to demonstrate the RCT experiment during the final review will most likely result in the work being considered to be less successful, but we think the accomplished HRT networking using low-lost hardware will create considerable attention in the future (beyond the time-frame of the current HRTC project).

2.4 WP4 – WP leader: UPM (Manuel Rodríguez)

The work was focused in the realization of experiments on the NHRT testbed. All the experiments (except the cancelled 4.4.) have been developed and the tests run. The results have been analyzed and some conclusions (presented in D4.7) are drawn.

Also we have ported the testbed to the TTP MonitoringNode platform (PowerPC) including migration of object interfaces to meet TTPIOP characteristics. Due to the late availability (October 8th) of the TTP transport only some simple programs have been developed and run under the TTP network using the IOP protocol.

Some cases running under over the TTP network but with the conventional IOP protocol were programmed and tested.

The real HRT testbed experiments have not been done yet as the implementation of the TTP protocol (TTPIOP) that was used for in-house tests in Vienna and integrated with the ICa ORB was not flexible enough to support the PCT. Work is being done at the time of this writing to solve last issues.

Although the tests have not been done at this time, they are being implemented and the test will be performed [1] and results published in the project web page.

[1] An addendum to D4.5, D4.6 and D4.7 with the test and results can be reported if considered by the reviewers.

2.5 WP5 – WP leader: SCILabs (Miguel Segarra)

Concerning dissemination, the work in WP5 has been centred during this period in OMG standardisation task, in international conferences and in the analysis and elaboration of the questionnaire data for the exploitation and use planning.

T5.1 Dissemination Planning: This task concluded in the second quarter. In the first quarter a first release of the Dissemination Planning deliverable was made and small modifications were included in the second quarter.

T5.2 OMG Standardization: During this quarter the Consortium did not attend to the September OMG meeting as it was just before the 2nd Project Technical Verification. In the meeting which was held in June in Paris, there was an agreement to issue a RFI regarding HRTC for the next OMG meeting. This RFI has already been submitted to the OMG CSWG and has been very well received.

T5.3 Publications: Regarding publications, the activity in WP5 during this period has been the following:

- OMG Workshop on Distributed Computing for Real-Time and Embedded Systems (Washington, USA, July 14-17, 2003). A poster on the HRTC project and a lecture on "CORBA in the Time – Triggered Architecture" have been presented in this meeting.

- 9th International Conference on Emerging Technologies and Factory Automation (Lisbon, Portugal, Sept. 16-19, 2003). Two papers were presented, "An experiment in distributed objects for real-time control" and "A Pattern Schema for Complex Controllers". Also a tutorial on the HRTC technology was scheduled for the 16th but it had to be cancelled as it was the same day of the 2nd project technical verification (Sept. 16, 2003).

- ADCHEM 2003, the International Symposium on Advanced Control and Chemical Processes (Hong Kong, China, January 11-14, 2004). A paper "Hard Real-Time CORBA for Process Control Systems" has been accepted in this symposium.

T5.4 HRTC Web site: The HRTC web site has been maintained during the last quarter and new documents, presentations and news posts have been added to it. The Consortium followed and implemented the recommendations of the reviewers (1st Review Report) regarding the inclusion of the HRTC Questionnaire (document IST37652/051) in the web page. Information regarding the HRTC project has also been included at SCILabs web site and the HRTC questionnaire can be accessed from this site. Additionally, a short report on the contents of the web site was written for the convenience of the review team (document IST37652/083 D5.4).

T5.5 Exploitation and Use Planning: During the work related to Exploitation and Use Planning sixty four companies which might have interest in distributed frameworks for real-time systems have been contacted. Six of them replied to the questionnaire. In the last quarter a document (IST37652/082 The Hard Real-Time CORBA Market Study) analysing the results of the survey has been prepared. The document presents the conclusions regarding the information obtained from the interviewed companies. Another document, IST37652/085 HRTC Exploitation and Use Plan, gathers all the conclusions regarding exploitation and use based on the information from the market study and on information from the previous IST37652/049 Draft Exploitation and Use Plan.

3. KEY EVENTS DURING THE REPORTING PERIOD

3.1 Events directly related/funded by HRTC

Event	Dates/ Duration	Location	Purpose/Justification/Major Outcome (this section should be detailed, if appropriate)	Project Participants

OMG Workshop on Distributed Computing for Real-Time and Embedded Systems	Jul. 14-17	Washington, USA	Presentation of the HRTC Poster and the lecture "CORBA in the Time – Triggered Architecture"	UPM(Sanz), TUV (Kopetz)
HRTC Technical Meeting	Ago. 4-10	Madrid, Spain	Implementation of the TTPIOP protocols	SCI (Segarra, Clavijo, Moreno), TUV (Losert)
HRTC Technical Meeting	Sep. 8	Madrid, Spain	Definition of strategies for PCT migration to TTPIOP	UPM (Rodriguez, Galán, García, Chinchilla), SCI (Clavijo)
HRTC Plenary Meeting	Sep.15	Lund, Sweden	Coordination of work & preparation of the review	UPM (Sanz, Rodriguez), LTH, (Arzen, Nilsson), SCI (Segarra), TUV (Losert)
HRTC Review Meeting	Sep.16	Lund, Sweden	Review Meeting	EC (Bogliolo, Watine, Thompson), UPM (Sanz, Rodriguez), LTH, (Arzen, Nilsson), SCI (Segarra), TUV (Losert)
ETFA 1003	Sep. 16th–19th	Lisbon, Portugal	Presentation of the papers "An Experiment in Distributed Object for Real-Time Control" and "A Pattern Schema for Complex Control Systems"	UPM (García)

4. LIST OF DELIVERABLES

Id	Deliverable Name	Lead	Original Due	Revised Due	Actual Date	Status of EC Review
D5.1	Dissemination Plan	UPM	M1/MS1	M3/MS1	M3	Accepted
D6.1	Project Management Manual	UPM	M1/MS1	M3/MS1	M3	Accepted
D3.1	RCT Requirements specification	ULUND	M2/MS1	M4/MS1	M6	Accepted
D4.1	PCT Requirements specification	UPM	M2/MS1	M4/MS1	M6	Accepted
D6.2	Evaluation Plan	UPM	M2/MS1	M5/MS1	M5	Accepted
D2.1	Protocols for Real-time Control	TUWien	M3/MS1	M5/MS1	M6	Accepted
D3.2	RCT Design	ULUND	M3/MS1	M5/MS1	M6	Accepted
D4.2	PCT Design	UPM	M3/MS1	M5/MS1	M6	Accepted
D6.3	Quarterly Report M3	UPM	M3/MS1	M5/MS1	M5	Accepted
D3.3	RCT Procurement	ULUND	M5/MS1	M7/MS1	M8	Accepted
D4.3	PCT Procurement	UPM	M5/MS1	M7/MS1	M6	Accepted
D1.1	CCS Domain Analysis	ULUND	M6/MS1	M8/MS1	M8	Accepted
D2.2	HRT Protocol Specification	SCILabs	M6/MS1	M8/MS1	M8	Accepted
D5.5	Draft Exploitation and Use Plan	SCILabs	M6/MS1	M6/MS1	M6	Accepted
D6.4	Periodic Report M6	UPM	M6/MS1	M6/MS1	M6	Accepted
D1.2	CCS Domain Architectures	UPM	M9/MS1	M11/MS2	M12	Accepted
D2.3	HRT Protocol	SCILabs	M9/MS2	M11/MS2	M12	Accepted
D3.4	Non HRTP RCT Implementation	ULUND	M9/MS2	M11/MS2	M15	Pending
D4.4	Non HRTP PCT Implementation	UPM	M9/MS2	M11/MS2	M12	Accepted
D6.5	Quarterly Report M9	UPM	M9/MS2	M9/MS2	M10	Accepted
D3.5	HRTP RCT implementation	ULUND	M11/MS3	M13/MS3	M15	Pending

D4.5	HRTP PCT implementation	UPM	M11/MS3	M13/MS3	M15	Pending
D1.3	CCS Engineering Handbook	UPM	M12/MS3	M15/MS3	M15	Pending
D3.6	RCT Testing	ULUND	M12/MS3	M13/MS3	M15	Pending
D3.7	RCT Documentation	ULUND	M12/MS3	M13/MS3	M15	Pending
D4.6	PCT Testing	UPM	M12/MS3	M14/MS3	M15	Pending
D3.7	PCT Documentation	UPM	M12/MS3	M14/MS3	M15	Pending
D5.4	HRTC Project Web Page	SCILabs	M12/MS3	M14/MS3	M14	Accepted
D5.6	Exploitation and Use Plan	SCILabs	M12/MS3	M14/MS3	M14	Accepted
D6.6	Periodic Report M12	UPM	M12/MS3	M14/MS3	M14	Accepted
D6.7	Project Evaluation Report	UPM	M12/MS3	M15/MS3	M15	Pending
D6.9	Periodic Report M15	UPM	-	M15/MS3	M15	Pending
D6.8	Final Report	UPM	M12/MS3	M15/MS3	M15	Pending
Deliverables not listed in the contract						
D5.2.1	HRTC Overview	UPM	-	-	M3	Accepted
D5.2.2	Hard Real Time CORBA	TUV	-	-	M3	Accepted
D5.2.3	IST HRTC Toward HRT CORBA	UPM	-	-	M5	Accepted
D5.2.4	OMG CSWG Charter	UPM	-	-	M5	Accepted
D5.3.1	HRTC Flyer	All	-	-	M3	Accepted
D5.3.2	ADCHEM Paper	UPM	-	-	M6	Accepted
D5.2.5	CSWG Meeting SF	UPM	-	-	M7	Accepted
D5.2.6	CSWG Rationale	UPM	-	-	M7	Accepted
D5.2.7	CSWG White Paper	UPM	-	-	M8	Accepted
D5.2.8	HRTC Poster at OMG	UPM	-	-	M13	Accepted
D5.2.9	CORBA over TTP at OMG	TUV	-	-	M13	Accepted
D5.2.10	Control Systems RFI	UPM	-	-	M15	Pending
Other Documents						
HRTC057	TrueTime and Jitterbug	LTH	-	-	M8	Accepted[2]
HRTC066	RTE Protocol Definition	SCI	-	-	M11	Accepted
HRTC067	TTP Protocol Definition	SCI	-	-	M11	Accepted
HRTC082	HRTC Market Study	SCILabs	-	-	M14	Accepted
HRTC088	Technology Implementation Plan	SCILabs	-	-	M15	Pending

5. MANAGEMENT, CO-ORDINATION , RESOURCES

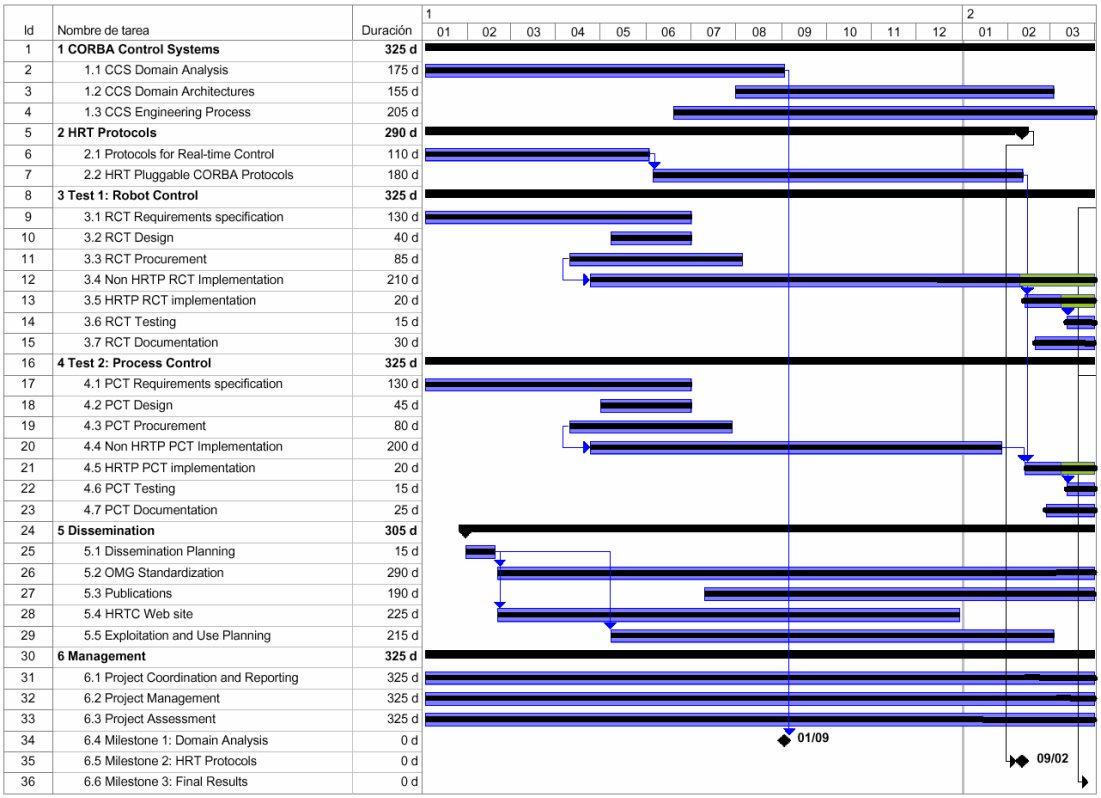
5.1 Project Co-ordination and management activities/issues

The collaboration between partners is quite good and we have had no major problem during this period.

5.2 Project Workplan

The only modification in relation with the previous Gantt chart is he extension of the implementation of the testbeds up to the end of the project.

[2] Accepted with qualification. Revision needed.



Id	Nombre de tarea	Duración
1	**1 CORBA Control Systems**	**325 d**
2	1.1 CCS Domain Analysis	175 d
3	1.2 CCS Domain Architectures	155 d
4	1.3 CCS Engineering Process	205 d
5	**2 HRT Protocols**	**290 d**
6	2.1 Protocols for Real-time Control	110 d
7	2.2 HRT Pluggable CORBA Protocols	180 d
8	**3 Test 1: Robot Control**	**325 d**
9	3.1 RCT Requirements specification	130 d
10	3.2 RCT Design	40 d
11	3.3 RCT Procurement	85 d
12	3.4 Non HRTP RCT Implementation	210 d
13	3.5 HRTP RCT implementation	20 d
14	3.6 RCT Testing	15 d
15	3.7 RCT Documentation	30 d
16	**4 Test 2: Process Control**	**325 d**
17	4.1 PCT Requirements specification	130 d
18	4.2 PCT Design	45 d
19	4.3 PCT Procurement	80 d
20	4.4 Non HRTP PCT Implementation	200 d
21	4.5 HRTP PCT implementation	20 d
22	4.6 PCT Testing	15 d
23	4.7 PCT Documentation	25 d
24	**5 Dissemination**	**305 d**
25	5.1 Dissemination Planning	15 d
26	5.2 OMG Standardization	290 d
27	5.3 Publications	190 d
28	5.4 HRTC Web site	225 d
29	5.5 Exploitation and Use Planning	215 d
30	**6 Management**	**325 d**
31	6.1 Project Coordination and Reporting	325 d
32	6.2 Project Management	325 d
33	6.3 Project Assessment	325 d
34	6.4 Milestone 1: Domain Analysis	0 d
35	6.5 Milestone 2: HRT Protocols	0 d
36	6.6 Milestone 3: Final Results	0 d

5.3 Effort consumption in the period M13-M15 (Q5)

	WP1 (PMs)	WP2 (PMs)	WP3 (PMs)	WP4 (PMs)	WP5 (PMs)	WP6 (PMs)	**Total used in Reporting Period (PMs)**	Planned Reporting Period (PMs)	Number of hours per month/ months per year		**Total used accum. (PMs)**	Total Planned in Annex 1 (PMs)
UPM	4,5	0	0	2	1	2	**9,5**	0	135/12		**52.95**	46
ULUND	1	5	10	0	0	0,25	**16,25**	0	140/12		**43.75**	37
TU Vienna	1,47	1,43	0	0,57	0,5	0,48	**4,45**	0	133,33/12		**16.44**	13,5
SCILabs	0,7	0,7	0,5	0,5	0,5	0,3	**3,2**	0	140/12		**19.7**	19
Total Used in Period	7.67	7.13	10.5	3.07	2	3.03	**33.4**					
Planned in Period	0	0	0	0	0	0		0				
	WP1 (PMs)	WP2 (PMs)	WP3 (PMs)	WP4 (PMs)	WP5 (PMs)	WP6 (PMs)						
Total used accumulated	29.16	20.99	26.87	32.27	10.535	13.02					**132.84**	
Total planned (Annex 1)	31	13	20	22	17.5	12						115.5

This includes work by project manager during M16 (October 2003) to prepare final project reports.

5.4 Deviations from plan

We have relocated parts of the efforts assigned to specific workpackages. There are different reasons for relocations (focus of partner work, the use of two complementary real-time protocols within the project, rather than a single one, etc).

Lund has relocated parts of their efforts from WP1 and WP5, and all of their efforts from WP5 to WP2 and WP3. The main reasons for the relocation is the use of two complementary real-time protocols within the project, rather than a single one, and the real-time kernel problems encountered.

Also UPM has relocated part of the effort originally panned for WP3 and WP5 to WP4.

These movements can be appreciated in the summary table in the next section.

5.5 Project Efforts Summary

This report is the last periodic report of the project. The following table is the summary of the effort done in different workpackages (WP1-WP6) by different partners (UPM, ULUND, TUV, SCI) in different periods (Q1-Q5) .

Partner		WP1	WP2	WP3	WP4	WP5	WP6	Total	Accumulated
UPM	Q1	1	0	0,2	2	1	1,5	5,7	5,7
	Q2	2	0,5	0	8	1	1,5	13	18,7
	Q3	3	0,5	0	7,5	1	1,5	13,5	32,2
	Q4	2	0	0	8	0,25	1	11,25	43,45
	Q5	4,5	0	0	2	1	2	9,5	**52,95**
	Used	11,5	1	0,2	27,5	4,25	7,5	**52,95**	
	Planned	12,5	2	5	12	7,5	7	46	
ULUND	Q1	1,5	0,5	2	0	0	0,5	4,5	4,5
	Q2	5	0,5	3	0	0	0,5	9	13,5
	Q3	2,5	0,5	3	0	0	0,25	6,25	19,75
	Q4	2,5	2	3	0	0	0,25	7,75	27,5
	Q5	1	5	10	0	0	0,25	16,25	**43,75**
	Used	12,5	8,5	21	0	0	1,75	**43,75**	
	Planned	14	2	10	5	4	2	37	
TUV	Q1	0	1,34	0,13	0	0,465	0,645	2,58	2,58
	Q2	0,5	2,1	0	0,2	0,2	0,5	3,5	6,08
	Q3	0	0,92	0,18	0	0,89	0,67	2,66	8,74
	Q4	0,49	0	1,86	0	0,73	0,17	3,25	11,99
	Q5	1,47	1,43	0	0,57	0,5	0,48	4,45	**16,44**
	Used	2,46	5,79	2,17	0,77	2,785	2,465	**16,44**	
	Planned	3	4	1	1	2,5	2	13,5	
SCI	Q1	0	1	0,5	0,5	0,75	0,25	3	3
	Q2	0	1,5	1	1	1,25	0,25	5	8
	Q3	1	1,5	0,5	0,5	0,5	0,3	4,3	12,3
	Q4	0	1	1	1,5	0,5	0,2	4,2	16,5
	Q5	0,7	0,7	0,5	0,5	0,5	0,3	3,2	**19,7**
	Used	1,7	5,7	3,5	4	3,5	1,3	**19,7**	
	Planned	1,5	5	4	4	3,5	1	19	

Global		WP1	WP2	WP3	WP4	WP5	WP6	Total	Accumulated
	Q1	2,5	2,84	2,83	2,5	2,215	2,895	15,78	15,78
	Q2	7,5	4,6	4	9,2	2,45	2,75	30,5	46,28
	Q3	6,5	3,42	3,68	8	2,39	2,72	26,71	72,99
	Q4	4,99	3	5,86	9,5	1,48	1,62	26,45	99,44
	Q5	7,67	7,13	10,5	3,07	2	3,03	33,4	**132,84**
Total	Used	29,16	20,99	26,87	33,27	10,535	13,02	**132,84**	
Total	Planned	31	13	20	22	17,5	12	**115,5**	