BrainAble

G.A.247447

Collaborative Project of the 7th Framework Programme

SEVENTH FRAMEWORK PROGRAMME

BrainAble

WP1

Management and Coordination

D1.6: FINAL PROJECT REPORT (Year 3)

BDCT / all

v.2.6 (FINAL)

08/02/2013

www.BrainAble.org

Document Information

Project Number	247447			**Acronym**	BrainAble
Full title	Autonomy and social inclusion through mixed reality Brain-Computer Interfaces: connecting the disabled to their physical and social world				
Project URL	http://www.BrainAble.org				
EU Project officer	Jan Komarek				
Annex I version	**Number**	v3.3	**Dated**	12th December 2011	
Periodic Report	**Number**	3rd	**Covering**	From 1st January 2012 to 31st December 2012	

Date of delivery	**Contractual**	11th February 2013	**Actual**	11th February 2013
Status			final ☑	
Nature	Prototype ☐ Report ☑ Dissemination ☐ Other ☐			
Dissemination Level	Public ☐ Consortium ☑			

Authors (Partner)	BDCT			
Responsible Authors	Felip Miralles Mària Sánchez		**Email**	PMO_BrainAble@bdigital.org
	Partner	BDCT	**Phone**	+34 93 553 45 40

Abstract	Report and analysis on R&D and Managerial activities and Financial issues referring to the third and final year activities of the Project (from January 2012 to December 2012)

Version Log			
Issue Date	**Version**	**Author**	**Change**
15/01/2013	0	Maria Sanchez	First working draft and structure
25/01/2013	0.1… 0.9	BDCT / all	Partners contributions / towards 1st consolidation
28/01/2013	1.0	BDCT	First consolidated version for internal review
30/01/2013	1.1… 1.5	BDCT / all	Partners contributions / towards 2nd consolidation
01/02/2013	2.0… 2.2	BDCT	Sections 3.I.0..5 and section 4 contents
06/02/2013	2.3, 2.5	BDCT	Second and 3rd consolidated doc for sections 3 and 6 internal review
08/02/2013	2.6	BDCT	Formatting, final version released to the EC

Index

List of figures

The aim of this report is provide detailed information on the project implementation, outcomes and formal justification of the costs and efforts by the BrainAble Consortium during the third year of the project (Period P2 from January 2012 to December 2012) as well as a complete overview on the full project duration.

- Section 1 consists on the **self-declaration of the scientific project coordinator**
- The **publishable summary** is to be found in section 2.
- Section 3 provides and overview of the project objectives for the reporting period in question, as included in Annex I to the Grant Agreement, a summary of **progress towards objectives** and details for each WP, details on clearly significant results and a detailed report on the project management done.
- **Project Management** during the period is described in section 4.
- Section 5 details under table format the **current status of deliverables and milestones** for the project.
- Section 6 shows the **costs and resources deployed** by each beneficiary, including a brief explanation of the work performed. A detailed description of the PM use is also included.
- Finally, in Annexes 1 and 2, references to the **Dissemination and Use Plan** (which has been delivered as separate document , see D7.6) and the **report on societal implications** are given

This report shows how BrainAble **has achieved all the planned objectives** which the project proposed and defined in its Technical Annex. From the scientific and technological point of view BrainAble has successfully evolved to become a success story and a reference project in the area of ICT based Accessible and Assistive technologies. The proof for that statement is the outstanding impact the project has had and is still having in mainstream media, scientific congresses and journals, and in EC events. The last one is the invitation to showcase BrainAble as a success story in the next EC event "European Brain Research: Successes and Next Challenges".

The progress of this work has been abstracted in this report, but can be thoroughly studied in the 12 deliverables produced in the third period of the project, which complete the list of all project deliverables. All deliverables have been carefully written and revised, and delivered in time. They are the proof that the **5 milestones for this third period have been met.**

During this third year the commitment of all partners has continued to be truly remarkable. The withdrawal of former Partner METI was counterbalanced with minor impact by extra effort of BCDT in the technical side of WP5 and by G.TEC, TU-Graz and BDCT working collaboratively in WP7.

A testing plan for third year was designed and agreed by all partners, and the second BrainAble prototype, a truly integrated and usable prototype, **was deployed and tested with real end users**, both in FPING and in ANET. The results of those tests have effectively impacted the research and development process through a formal protocol and shared documents plus continuous communication with the technological partners. In fact, G.TEC, BDCT, TU-Graz and UPF had a direct implication in the preparation and conduction of those tests, and got the most valuable feedback to enhance usability and utility of the whole platform.

The main outcome of Third Period and the project, **the Final BrainAble prototype, is already a single system easy to install, configure and use.** BrainAble is an innovative platform designed with a user centric approach to improve physical and social independence, facilitate active living and improve quality of life of people with different degrees and types of disabilities and potentially anybody with special needs. It is a modular system which facilitates the interaction of humans with computers through the last generation of Brain Computer Interfaces (BCI), which require no training, easy setup, and adaptive configurations to meet any user requirements, especially those of the severely disabled. Furthermore, a user with evolving functional diversity is offered to interact with BrainAble using alternative assistive technologies combined or not with BCI techniques.

Through BrainAble, a disabled user may now interact with other people using email, facebook or twitter; control a wheelchair, lights, TV, webcams and potentially any domotic device; play games and navigate virtual communities; use and enjoy a range of digital devices and services which were not designed to be used by disabled people and which BrainAble offers in a smart, context-aware and assistive way.

BrainAble has been developed by a multidisciplinary team of therapists, carers, engineers and researchers in the frontier of neuroscience, signal processing, assistive technologies and machine learning; and is already impacting the growing market of accessible, inclusive and assistive products from a novel perspective.

Note: In the present document, project beneficiaries are named by their **short names** as per the below list:

1	**BDCT**	Fundació Privada Barcelona Digital Centre Tecnològic (Spain)
2	**TU-Graz**	Technische Universitaet Graz (Austria)
3	**UPF**	Universitat Pompeu Fabra, SPECS group (Spain)
4	***METI***	*Meticube Sistemas de Informação, Comunicação e Multimedia, Lda. (Portugal)*
5	**G.TEC**	Guger Technologies, OG (Austria)
6	**ANET**	Abilitynet (United Kingdom)
7	**FPING**	Fundació Privada Institut de Neurorehabilitació Guttmann (Spain)

1 Declaration by the scientific representative of the project coordinator

I, as scientific representative of the coordinator of this project and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;

The project:

√ has fully achieved its objectives and technical goals for the period;

- ☐ *has achieved most of its objectives and technical goals for the period with relatively minor deviations.*
- ☐ *has failed to achieve critical objectives and/or is not at all on schedule.*

The public website:

√ is up to date

- ☐ *is not up to date*

To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the *"report on the resources used for the project"* section and, if applicable, with the certificate on financial statement.

All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section *"Project Management"* in accordance with Article II.3.f of the Grant Agreement.

bdigital BARCELONA DIGITAL CENTRE TECNOLÒGIC

Felip Miralles Barrachina
BrainAble Project Coordinator (G.A. nº 247447)

Barcelona, on the 8th February 2013

2 Publishable summary

Severe cognitive or physical disabilities from any origin have a dramatic effect on autonomy, intimacy or dignity, and, by extension, on quality of life. A person with a severe brain injury resulting from a car collision or those suffered a brain stroke are examples of disabilities of neurologic nature. For years, the severely disabled have learned to cope with their restricted autonomy, restricting their daily activities like moving around or turning on the lights and limiting their social interaction.

The ***BrainAble project*** is about empowering them to mitigate this barriers of the everyday life to which those individuals are confronted. BrainAble has researched, designed and validated an *ICT-based HCI (Human Computer Interface) based on BNCI (Brain Neural Computer Interface) sensors combined with affective computing to control smarthome services and virtual environments.*

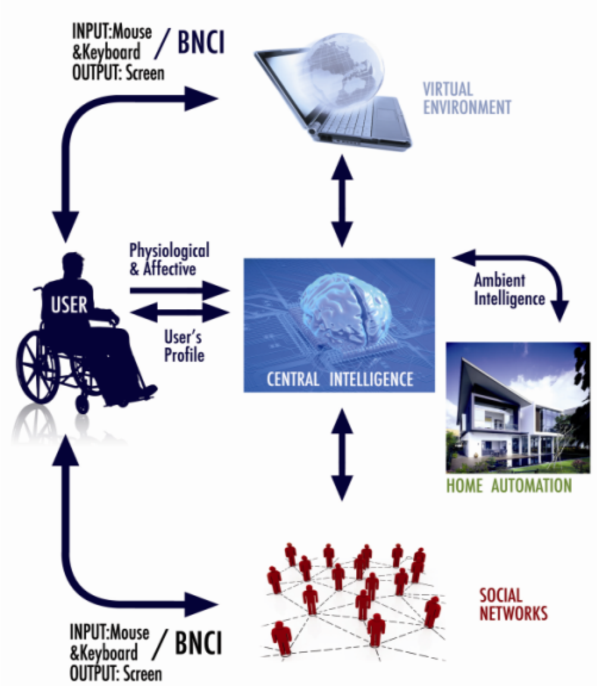
This combination is expected to *improve their quality of life of the severe disabled by overcoming the two main shortcomings they suffer* (1) at home by providing inner functional independence for daily life activities and autonomy withaccessible and interoperable smarthome services; and (2) enabling the participation in social activities with adapted social networks services.

BrainAble improves both direct and indirect interaction between the user and ICT services. Interaction is upgraded by creating tools that allow controlling inner and outer environments using a "hybrid" Brain Computer Interface (BNCI) system, combining diferent BCI techniques and BCIs with other inputs such as EOG or EMG signals. BrainAble also proposes a novel BCI training paradigm with the auto-calibration Adaptive ERD BCI paradigm, which allows for a very quick and highly effective setup of an ERD based BCI requiring only a minimal amount of sensors and no expert knowledge. Finally, BrainAble's BNCI also takes into account other input coming from the physiological and affective sensors increasing the BNCI performance to measure levels of alertness and fatigue, and detect and handle spasms.

BNCI first-time users are often confused and overwhelmed. While this BNCI familiarization takes place, BrainAble proposes an intelligent Virtual Reality-based user interface with avatars and scenarios that will help the disabled move around freely, and interact with any sort of devices as their first contact with BNCI. VR also enables the users to play serious games to counteract cognitive decline, and get trained in new functionalities and tasks.

To enhance the BNCI performance of the users, BrainAble incorporates machine learning techniques, Ambient Intelligence (AmI), so that the system provides an adapted assistance to the user. The role of AmI is mainly to carry out the interaction with the real environment by performing the user's commands (e.g., to turn on a light) in an intelligent manner. For this purpose, AmI counts on the Context-Awareness feature which is able to recognise the specific happening taking place.

The three-year project reached its termination in 2012. During this period, BrainAble has completed three cycles of prototype testing aligning the project with the User-centre design. Pilot testing sessions were participated by 8 disabled people and 10 non-disabled people in two separated locations in Spain and UK. By applying UCD, that is, working with end-user's organisations throughout the whole project life cycle, BrainAble has gained valuable insights into the processes by which emergent technologies are introduced, together with the drivers and barriers to uptake and adoption of the system.



Main scientific achievements accomplished are the development of a novel interface of BNCI, the Hex-O-Spell; the auto-calibration Adaptive ERD paradigm to facilitate the BNCI training presented in international congresses; Ambient Intelligent techniques such as the Context-dependent UI for BCI interfaces; and incorporation of the URC/UCH that facilitates the integration of new services or devices.

As an outcome, BrainAble has produced a pre-commercial product and a set of technologies intended to assist people with severe physical disabilities. The technology has the potential to assist those with special needs such as individuals living with Brain Damage or ALS. The modular architecture and middleware utilized by BrainAble to connect user-centered bio-interfaces and interactive immersive environments to networks of devices and people, provide attractive assets for the markets of intelligent and assistive *Smart Homes* and adaptive *Assistive Technologies*.

Project title: **Autonomy and social inclusion through mixed reality Brain-Computer Interfaces: Connecting the disabled to their physical and social world**
Project coordinator: Fundació Privada Barcelona Digital Centre Tecnològic
Scientific coordinator: **Felip Miralles** (**fmiralles@bdigital.org** or **PMO@BrainAble.org**) Tel: +34 93 553 45 40 41
For more information, please visit us at ***http://www.BrainAble.org***

3 Activity report for the period

3.1. Project objectives and achievements for the period

3.I.0 From Period-2 towards the project closure, how did the consortium address EC recommendations?

Following the review of the project Period-2 held in Brussels on March 2012 and based on the experts report, the Commission scored the project as “good progress”.

Meanwhile, a set of useful recommendations formulated by the European Commission aimed to ensure proper results in the final period was also provided.

All these points have been carefully treated and considered during the work implementation among the last year of the project execution. The below table provides outstanding details on the responses and actions taken by the BrainAble consortium:

EC recommendations	Consortium responses
Recommendation 1: ***It is strongly recommended to put all efforts into assembling two or more identical, complete, prototypes under a single PC platform (level 2) with user manuals, and to provide them to the two clinical partners for evaluation at the earliest opportunity.***	The final BrainAble Prototype has all the BCI functionality including EEG and physiological analysis running on a single computer (UserPC) which is also used as input interface. This computer is talking with the AdminPC which handles all domotic devices and services. This double approach helps to decouple both services and interfaces which supposes a more reusable architecture. This is a realistic setup that can also be used in home installations, as it is described in D7.5 *Final Exploitation Plan*, having the AdminPC as a dedicated station for interacting with services (e.g. embedded device) and the UserPC the station dedicated to interact with the end-user. Specifically, the UserPC has to be close to the patient and the AdminPC has to be attached to the domotic devices and services. From a technical perspective, the design of the final BrainAble system includes two different stations due to the resource requirements from both BCI and VR engine. Two full sets with were installed at the clinical partner sites in May 2012. They had been integrated, thoroughly debugged and tested at BDCT and G.TEC labs before and were deployed including user manuals. Continuous validation with real users was carried out both in FPING and ANET, and regular feedback was collected and communicated to the development team to enhance the system, which was regularly updated until a final version of the prototype was eventually installed in both locations in November 2012 for the final tests.
Recommendation 2: ***The reviewers strongly recommend amending the plan for Y3. To mitigate the risk of further dissipation of effort, it is recommended to discard development of prototype 3 from the final deliverables. Instead, it is advised to direct all resources to assembling prototype 2, to be operational as soon as possible so that clinical data can be collected and changes made to prototype 2 based on user feedback. Any further refinements should be***	During the project Review of Period 2, this crucial point was set up and the project consortium has been requested to submit clear plans on the integration of Y2P. In such a way, the BrainAble consortium has devised and agreed a clearly defined plan to perform a single and unique additional iteration during Y3 covering both aspects of the foreseen work plan: user’s feedback requirements and validation on the basis of testing Y2P and incorporating changes and improvements into the Y3P to be released at the end of the project. This plan was executed as foreseen following the scheme of

EC recommendations	Consortium responses
documented for future development but human resources should only be devoted to implementing them if technical support for prototype 2 is no longer necessary for user data collection. The final review would then focus on prototype 2 (with user-indicated improvements), and not on prototype 3.	three different phases: (1) Phase 1 – Prototyping of Y2P; (2) Phase 2 – Installation in FPING and ANET of Y2P; and (3) Phase 3 – Delivery of the user's feedback. As a result of these phases, the consortium generated an internal document where the outcomes of the different validation stages were reported. This document is included as an Annex in the D6.4.3.
Recommendation 3: ***In the forthcoming user experiments for the second-year prototype, it is recommended to include an analysis of ROC and bit rates for the BCI paradigms employed.***	To make performance assessment and comparison of the systems as easy as possible, we reported performance using a full range of measures including illiteracy rate (users performing better than chance), users performing better than criterion level (better than 70% accuracy), peak accuracy, Receiver Operator Characteristic (ROC) Area under Curve (AUC) for a range of thresholds and the Volume under the Surface spanned in the unit cube by ROCs for a range of dwell-time configurations. In addition we reported transfer rate in bits/min, percentage of achieved online smileys and the positive predictive value (PPV) during self-paced online operation of Hex-o-Select. For the matrix interface we are using a diagram that shows accuracy versus needed item flashes. This indicates the maximum speed the system can run without making mistakes. This is the best measure for the matrix interface to optimize it. The bit rate itself is not so important for smart home control, this measure is important mainly for text input.
The 3rd year exploitation plan needs to be much more quantitatively oriented, with revenue and ROI projections for the main identified market segments per geographical region. Likewise, a clear and quantified statement on use of results for each participant will be expected in this deliverable. A coherent IPR management plan should also be presented, including which partners are patenting what results.	The final exploitation plan (D.7.5) identifies clearly the project outcomes. It includes possible exploitable products, competitor analysis (BCI, assistive technology, smart home technologies), market size, pricing, sales forecast, distribution channels and a list of possible customers for Austria, Bavaria, Catalonia and UK. On D.7.5, envisaged ROI for the outcome products have been presented. In addition, expert interviews were done with researchers, assistive technology experts, fund raisers and family members to highlight important needs of different user groups. These interviews give important points of view for the usage of a BrainAble commercial product In its turn, deliverable D7.6 Dissemination and Use Plan complements and completes this information by individualising each partner' acquired IPR and/or knowledge from the project.
Recommendation 5: ***Narratives should be much more concise and with no repetition of information to improve readability of the documents. The coordinator (BDTC) is urged to accomplish this for the final review.*** *Recommendation 6:* ***This recommendation still stands (was given at review Y1).***	The project work plan includes several transversal tasks among various WPs as per result there is an inevitable repeating of information when describing progress of work at each WP level (since they need to be reviewed and assessed separately). As an example, the "D5.6 URC-enabled AmI scenarios" submitted on the third year needs to be understood as a consolidation and evolution of the "D5.3 Deployed AmI

EC recommendations	Consortium responses
	scenarios – Final Prototype" submitted on the second year. Therefore, some of the concepts exposed in both deliverables are similar, though D5.6 provides further and more consolidated information of the AmI engine compared to the D5.3. Finally, to alleviate this effect, the consortium has generated a **short additional document merging the information about the technologies issued during Period-3** reported in several different deliverables. In the same direction, the present deliverable, D1.6, summarises the work done for every work package highlighting the work done for the Period-3.
Recommendation 7: ***Use good, quantitative indicators for showing progress/performance/results.***	A set of Key Performance Indicators was **developed during the first semester of Period-3 and submitted to the approval of the Project Board held by June**; the process has carefully consider the expected results, EC expectations, avoided overly broad results statements. Last epigraph in Section 4 reports on the selected KPI.
Recommendation 8: ***It is highly recommended to add an input feature for users to indicate their mental/affective state to the AmI block, thereby allowing for the system to verify classification of mental states and train classifiers. This can drastically improve the adaptation schemes (e.g., predict declining performance and the circumstances that contribute). It might be considered to add an item to the VR presentation that allows a user to enter mental states either at intervals or continuously.***	Regarding the mental state with the VR, a series of facial expressions has been incorporated to the options selectable by the user in order to indicate his/her emotional state. This functionality is to be used in the BrainAble Virtual Community as an enhancement of the traditional communication means (e.g. chat, voice) incorporating the so-called self-expression tools. Users have the possibility to indicate their affective state through the BNCI interface, they can select an emotion and this is translated to a facial expression, avatar posture or music associated to the emotional state in the VR. The AmI block logs this emotional state selected by the user. On the other hand, within WP3 there was an effort to include affective computing as user input, in other words, an automatic way to detect the mental state of the user. The workload detector (also known as 'fatigue switch'), based on EEG signals, provides a measure of the degree of fatigue/alertness or workload which experiments proved to be reliable to a certain degree. Additionally, the consortium has successfully integrated in the prototype the spasticity switch based on a bipolar EMG in specific muscles. This input source will take into account possible spasms suffered by the user. It is remarkable that both switches derived automatically from EEG and EMG signals are used as well as input for the Ambient Intelligence Block. Recommendation 8 proposed to correlate mental state selected by users with that coming from physiological data to verify classifications and train classifiers. Although AmI block has been adapted to get all inputs, log and process them as stated above, there was a need to collect enough data during longer periods of time to be able to make effective and meaningful the training

EC recommendations	Consortium responses
	of classifiers and verification results. Therefore longer periods and more users would have been needed, which unfortunately were out of the scope of the validation done in WP6 in the time frame we had. More future work shall be done to reach a fully integrated and working solution to predict declining performance and adapt the system to it, which may become a really novel and interesting feature.
Recommendation 9: ***Contacts made with ALS, MS, and PD societies should be made at the earliest opportunity. This has not been done convincingly yet, due to complexity of prototype 1. Prototype 2 will be coherent system, which is much easier to present and explain to end user groups. Contacts with these groups is promised to be made in spring 2012***	With the availability of the advanced prototype and a clear understanding of the final prototype **the Consortium felt** much more comfortable **addressing ALS, MS and PD societies and other user group representatives** being able to present a much more differentiated solution, in all components: User Interaction, AmI, VR, Home, etc. Some examples of this actuations are summarised below. **ASPAYM** (http://www.aspaym.org/) is a Spanish SCI society. In a Workshop (Madrid, June 2012) organized by this society a PMR physician from Guttmann (Dr. Benito) talked about new technologies and opportunities for the SCI population, one of the covered issues was BCI and BrainAble project was presented. ANET contacted the **Motor Neurone Disease Association** (www.mndassociation.org/) in the UK about the BrainAble project. The Motor Neurone Disease Association is the only national charity in England, Wales and Northern Ireland that funds and promotes global research into the disease and provides support for people affected by MND. In 2011/22 their research portfolio reached 7.9 milion. Within the UK this is the main organisation that provides support for people with MND and their families and carers. They also fund MND care centres across the UK and work together with local branches and centres that provide funding and direct support to individuals within their localities. The **MNDA** put information about the BrainAble project on their national website as part of their information on MND research and in addition permitted us to work and recruit with a local branch near our research site. Our relationship with Merseyside MNDA (http://www.mnda-merseyside.org.uk/) was ongoing throughout the project and we have been invited to return to give feedback on the project and its final review in early 2013. T BrainAble also made contacts with **Neurosupport** which is an organisation that serves the North West of England and provides information and support to people with condtions of neurological origin http://www.neurosupport.org.uk/support-services.html and used this as our main recruitment site and recruited through them after giving a series of talks on Assitive technology and BrainAble.

EC recommendations	Consortium responses
	Finally, the consortium also did a talk at **Headway** and recruited 2 participants following the talk https://www.headway.org.uk/home.aspx. All these groups will be included in the dissemination of the final project user newsletter which will update them on the findings from the project and the possibilities of the BrainAble prototype. Dissemination has therefore continued to concentrate on the scientific and development communities.
***WP1:** Interaction with ANET needs to be intensified to expedite functionality of prototype 2 and acquisition of ethical approval..*	According to Recommendation 2, a clear plan was set up so as to truly integrate the user-centered design methodology in the full life-cycle of the product. The results of this plan are translated into an internal document, lately included as Annex in the D6.4.3, where the responsible for the validation stages (partners FPING and ANET) reported the issues encountered by the therapists and the end-users and, in parallel, the technical counterparts described the specific action to be taken. This methodology responds to the application of the UCD since the end-users participate in all the stages of the development that is, from the definition of the requirements and the development to the different iterations performed. Ethical approval (for the UK testing purposes) for the 2nd prototype was straightforward and consisted of requesting a substantial amendment to the original research proposal based on the developments to the 2nd prototype and how this could differently effect the users during testing sessions compared to the 1st iteration. It also included a request to revise and extend the time scale of the user testing. A subcommittee gave the project consortium (represented by ANET) permission to continue the study at the same site prior to installation of the 2nd prototype and the successful amendment was based on the detailed information that the development teams were able to give to ANET in advance of the installation and proposed user testing.
***WP2:** All seems to work but the systems were not based on a single platform, indicating that more work needs to be done to obtain a fully integrated and operational prototype 2*	All BCI and physiological inputs are handled by a single computer (UserPC) running the whole analysis and user input interface. This computer is speaking with the AdminPC which is handling the domotic devices. Reasons for that were described under Recommendation 1.
***WP5:** It is unclear what the point of deliverable D5.5 (Social Networking Infrastructure for patient-patient interaction final prototype) is. It briefly discusses the "Social Network Block" (SNB) as BrainAble's interface to social networking features (Twitter, microblogging, Facebook, etc.), which were already addressed in Year one. But, beyond mention of the URC/UCH gateway, how the SNB instrumentally*	The deliverable D5.5 was revised by the Work Package leader including additional information of the Social Network Block (SNB). Basically, the Social Network Block needs to be included as part of the intelligence of the system. It monitors the social information the information flowing from the user to the social network applications issued by the BCIModule, passing through the AmIBlock and relayed to the URC/UCH module. The SNB is extracts social information of the following fields :

EC recommendations	Consortium responses
implements the gateway to these services is described in insufficient detail. Except for Section 4 (BVC), the general nature of the information presented has weak relevance to the BrainAble system architecture. *A revision, addressing the above points, is requested within 3 months.*	date of the operation, initiator, type of operation and requested service. The information captured by the SNB helps the AmI engine to better understand the social circle of the user and, consequently, give an idea of the social inclusion of the subject.
WP7: *Progress in formulating a marketing and business development strategy is unremarkable. So far, merely general declarations on exploitation intentions have been presented, these lacking a detailed value chain description with estimates of revenue and ROI. Protectable IPR generation by any partner so far does not appear to have happened and the IPR use plan per partner is insufficiently elaborated.*	G.TEC was taking over the exploitation plan activities from METI. The possible exploitable products are explained in the exploitation plan and the dissemination and use plan (see D7.5 and D7.6). Possible competitors, prices, sales numbers, markets are given. Each partner declared its IPR to specific products.

The next subsections describe the works progress during 2012 compared to the project main objectives.

3.1.1 Project aim 1

> ***"To conduct a truly user-centric design of a platform which improves the quality of life of people with motor disabilities and investigate its effectiveness to compensate deficit after the rehabilitation process, increase autonomy in daily life activities, decrease barriers and increase participation favoring social inclusion and quality of life."***

Brain Computer Interface (BCI) enables communication without muscular control and can therefore help disabled people with severe motor disabilities as a result of injury, illness or disease. The usage of this technology enables those severely impaired to become more independent and interact with others with an interface adapted to their specificities.

BrainAble has aligned the project with a user-centric design (UCD) paradigm. By applying UCD, that is, working with end-user's organisations throughout the whole project life cycle, BrainAble has gained valuable insights into the processes by which emergent technologies are introduced, together with the drivers and barriers to uptake and adoption of the system.

Before starting the application of UCD, both partners FPING and ANET have directly obtained ethical consent from relevant authorities for their testing sites and practices: ANET from the UK National Research Committee and FPING from its own hospital ethics board. After this stage, The end-user organisations of the consortium, ANET and FPING, have produced an ethical framework, clinical definitions and the appropriate set of instruments and metrics for evaluating the prototype. This work was necessary for the successfully application of UCD which entailed the design and execution of validation pilots so that the end-user organisations report their feedback to the technical partners.

BrainAble has completed three cycles of prototype testing which translated into the installation and configuration of the prototype in two different locations: the John Moores University of Liverpool in the UK, and the Institut Gutmman in Spain. The evaluation of the integrated BrainAble prototype took place with 15 (8 in UK, 7 in Spain) disabled people with disabilities of neurological origin (including MND, Multiple Sclerosis, Parkinson, Traumatic Brain Injury, Guillain-Barre, SCI, etc.) and 10 non-disabled people over 3 periods of testing from November 2011 – January 2012 (Prototype 1), from May 2012 to July 2012 (Prototype 2) and for two weeks in late November 2012 (final Prototype). The outcome of this validation was reported in a document included as Annex in the D6.4.3 summarising the requests, thoughts and comments of both the end-users and therapists providing a broad review of the prototype. This document was used a means of communication between the end-user's and the technical teams so as to better perform the development iterations.

3.1.2 Project aim 2

> ***"To create a specifically designed HCI, which integrates BNCI with other specific sensor technologies."***

BrainAble has the spirit of assisting the end-users during their different phases of their disability. The BrainAble project was committed to research and develop so-called Hybrid BNCIs consisting of combining different BNCI techniques, BNCIs with other Assistive Technologies, and EEG with non-EEG signals to advance in the user experience of the BNCI systems. In this context, BrainAble incorporates EEG technologies (i.e. BNCI) as the main user interface for the end-users to access the services of the BrainAble platform though this platform also admits different alternative interfaces embracing the concept of multimodal interfaces. This concept entails the possibility of combining different technologies to enrich the user experience using them as tool for interaction. In particular, BrainAble incorporates different alternative non-EEG multimodal inputs with different interface modalities such as Wii-1D, Wii-2D, EMG-1D, EMG-2D, EOG, Assistive Technology Joystick, Eye Tracker, Mouse or Mouth Joystick.

The Hybrid-BNCI in BrainAble is also related to the recording of different physiological sensors (e.g. EEG, EOG, ECG, EDA and respiration) devoted to adapt the system according to the status of the user. After some tests performed with these signals, the consortium found that EEG and ECG were the most suitable signals for the scope of BrainAble. In this manner, these signals were used as input for algorithms performing workload detection algorithms based on a gold-standard paradigm and during self-paced ERD operation.

Finally, the project consortium spent additional research on topics not specifically addressed by the DoW like the outlier rejection. The results of this research proved to be very beneficial to the ERD BCI systems. In this sense, the first prototype of the auto-calibrating and adaptive ERD BCI system performed rigorous outlier rejection at every retraining step, which proved to be highly valuable as it increases literacy rate, accuracy and robustness.

3.I.3 Project aim 3

> ***"To create a user-centric virtual environment for home and urban automation control, social networking and training."***

BrainAble proposes to move from the traditional procedures of BCI training to an approach based on the principle of serious games. In this setting, Virtual Reality plays an important role in the BrainAble prototype for BNCI training since it allows the user to navigate in a virtual world and interact with the elements present in it. VR creates a user-centric virtual environment and tools for home automation control while the user get familiarised with the BNCI technology (e.g. BNCI training).

The conception, design and implementation of the Scenario Modelling Tool (SMT), allows the creation of a 3D representation of the user's house and the passive and active objects in his house helping in the familiarisation stage. Indeed, the SMT is intended to become a software engine able to create a representation of the end-users home by means of the so-called HomeML. The HomeML, an XML-based language, contains all the information for the SMT to create the virtual model of the user's own home.

The Virtual Reality of BrainAble includes the Virtual-To-Physical gateways functionality, which ensures an accurate synchronization between both virtual and physical worlds. That is, an action that takes place in the real world and has an effect on both virtual and real world (e.g. turn on/off the TV). This feature raises the experience perceived by the user while interacting with the system giving control over real assets through their virtual representation.

3.I.4 Project aim 4

> ***"To create Ambient Intelligent (AmI) and ubiquitous computing services for accessible device integration."***

Interactive systems have been the dominant computing paradigm over recent years. This paradigm is characterized by the fact that human user and the system communicate and interact explicitly using different modalities. In this setting, Ambient Intelligence is called to play an important role. The system provides control to users with special needs adapting the system to their specificities.

To enhance the usability of the final solution, BrainAble relies on the application of Ambient Intelligence techniques so that the system provides an adapted assistance to the user. The role of AmI is mainly to carry out the interaction with the real environment by performing the user's commands in an intelligent manner. The assistive scenario developed for this prototype consists of an unobtrusive network of pervasive devices acting to proactively manage emergency, security, comfort or energy-saving issues. For this purpose, AmI counts on the Context-Awareness feature which recognizes specific situations by means of the mentioned sensor network to subsequently perform the suitable action. The sources of information come from two sides: context which is corresponds to the immediate measurements of the surroundings (e.g. temperature, humidity, light) and the user habits, referred to the behaviour of the user (e.g. actions committed). This information is used as input by the Context-Awareness engine to provide as outcome a specific situation taking place which is lately used by a trained classifier to make a proper response to the user in the form of a personalised adaption of the interface, the Context-dependent UI. This feature is capable of adapting the interface (i.e. suggestion actions to make) according to the context, the application of the envisaged Ambient Intelligence to the BrainAble prototype.

3.1.5 Project aim 5

"To create self-expression tools and social networking services."

BrainAble also includes the implementation of a distributed Virtual Reality (VR) platform that lays the foundation for the BrainAble Virtual Community (BVC). This functionality is aimed at mitigating the isolation suffered by the disabled communities in terms of social interaction by providing tools for encountering new people. This community incorporates tool for enhanced interaction through the self non-verbal communication necessary to communication emotions. Two different approaches were developed in this direction: facial expression and postural behaviour.

Key means of on-line self-expression in virtual reality is provided via the control of the behaviour of one's Avatar, the so-called postural behaviour. BrainAble integrated the modular, controller based character animation system "SmartBody" into the Unity game engine used for the VR. This part of the prototype allows controlling the behaviour of an avatar via BCI, and comprises the elements of the behaviour generation via SmartBody inside Unity. As a second approach, the BrainAble includes the facial expression communication in the BVC with predefined facial items expressing different emotions available to the user created with the Unity game engine.

Eventually, the social networking services available in BrainAble are: the BrainAble Virtual Community (BVC) for user-to-user communication within BrainAble but also other widespread social networking services such as the connection to the popular Facebook and Twitter platforms. The latter enables the end-user to get in contact with other people non-disability related.

3.2. Work-packages progress and achievements during the period

3.II.1 Introduction

The next subsections give a global vision of the tasks developed within the WPs (except WP1 Project Management, reported in section 4) and the performed work and progress towards the respective objectives listed in the DoW.

Being at the final period of the project implementation, the following WPs' subsections describe both, the progress made during **Year-3 (detail by tasks in the DoW)** as well as the overview of the progress during the **full project duration** (as per the **objectives foreseen for each WP**).

3.II.2 WP2: Product life cycle, specifications to integration

The objectives of WP2 are to **specify the medical and technical requirements for different disability** scenarios, to **design the interfaces between the developed technologies** and to **integrate these technologies into the BrainAble prototype**. As a result, the **developed technologies must be integrated and packaged to one global system**.

To document the steps towards these objectives done by all partners, five Deliverables (D2.1, D2.2, D2.3, D2.4 and D2.5) and four Milestones (M1, M2, M3 and M4) were reported as listed below.

Relating to **Task 2.4** ***Global system integration and packaging of technology***: In the last year of the project all necessary components were integrated and packaged including a user manual for easy operation which yielded to the Final Prototypes that was also installed at the clinical partner sites. A key point in the last year was to integrate the user feedback into the design to optimize the prototype.

- D2.1: *Requirements specification* (PM06, submitted, upgraded revised version and approved)
- D2.2: *Human computer interaction interfaces* (PM09, submitted and approved)
- D2.3: *Interfacing of technologies* (PM12, submitted and approved)
- D2.4: *Technology packaged 2nd prototype* (PM24, submitted and approved)
- D2.5: *Technology packaged* (PM30, submitted)
- **M1**: System requirements available and rapid prototyping environment distributed (PM06, done)
- **M2**: HCIs design available (PM12, done)
- **M4**: Second version of BrainAble system installed (PM24, done)
- **M6**: Final version of BrainAble system installed (PM30, done)

OBJECTIVES FOLLOW-UP

Objective 2.1: "Specify the medical and technical requirements for different disability scenarios"

To specify medical requirements, the target user group is defined as people with severe motor disabilities of any source. An overview of these disabilities is provided by D2.1, detailed information on the target user groups and on exclusion/inclusion criteria is provided by WP6 (see D6.1 and D6.2). To specify the technical requirements, three use cases of increasing complexity were defined (see D2.1 for details). Each leads to a respective experimental platform, which will be sequentially integrated and demonstrated as the project proceeds.

The starting environment (i.e. the "Year-one-prototype", **Y1P**), was delivered in M12 of the project (see D2.3 for details). The Advanced environment (i.e. the "Year-two-prototype", **Y2P**) was delivered in M24 of the project (see D2.4 for details) and the Final Prototype was delivered in M30 (see D2.5 for details).

In the following the functionality of the different prototypes is shown:

Y1P functions:

- Navigating between different interfaces (i.e. moving within a hierarchic structure of parent menus and submenus)
- Selecting different applications (a virtual navigation tool, a speller, a smart home control system with different domotic devices)
- Using a spelling application (to spell freely and to copy text provided by an experimenter)
- Manipulating objects in a smart home control system (e.g. Turning on/off a TV set and a light; changing the TV volume and the TV channel)
- Navigation and manipulation of objects in an outer virtual environment using an Avatar (the avatar can be moved through a virtual flat and can be used to turn on/off the TV)
- Micro-blogging with Twitter using the spelling application (Log on/off Twitter, get messages, post messages)

Y2P functions:

- Controlling a camera (change pan/tilt orientation, display the video to the BCI user)
- Controlling a small robot (turning on and off the robot; performing basic commands like move forward, move backward, ...)
- Navigation of an Avatar in an inner virtual environment (use the BrainAble virtual community)
- Self-expression with VR based tools (change avatar appearance (clothing, hair, gender,…) and expression)
- Social interaction using Facebook (Log on/off FB, get messages, post messages)
- Media and VR based tools for cognitive stimulation and mastering BNCI

Final prototype, Y3P functions:

- Turning on/off button for system control
- Controlling the communication centre
- Controlling a robot (performing advanced commands)
- Controlling a wheelchair (moving forward/backward, turning right/left)
- Virtual-reality social networking via computer
- Refined networked virtual environment for communication and self-expression

Objective 2.2: "Design of the interfaces between the developed technologies"

Figure 1 provides an overview of the modules required for the BrainAble System, which was defined for the Y1P (see D2.3). Since the modular structure selected for the Y1P proved its usability, it remained unchanged also for the Y2P and Final prototype.

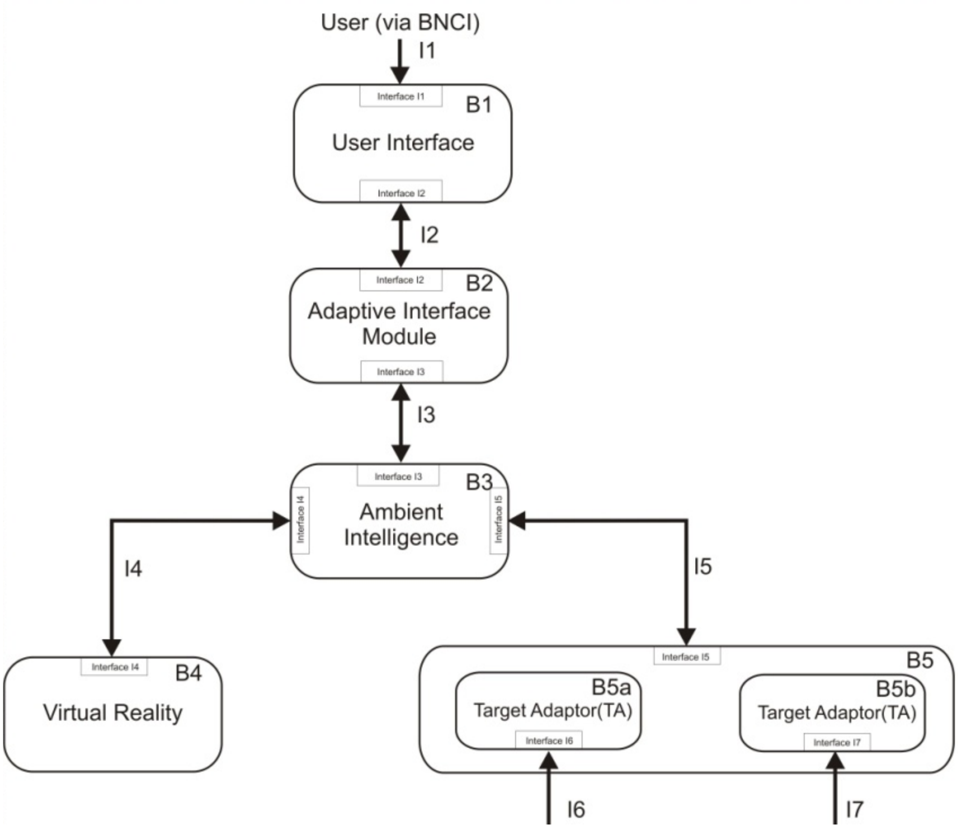


Figure 1: Modules of the BrainAble System

Blocks and interfaces can be outlined as follows:

- Input from the user is derived from the BNCI (interface ***I1***). In the final prototype, EEG and non-EEG based inputs are integrated. EEG based input modalities are ERD/ERS, P300, and SSVEP and non-EEG are EOG, motion tracker, EMG and mouse inputs. This modalities can be used as single control modality or as hybrid (e.g. SSVEP/P300, SSVEP/EMG, EEG-MI/spasticity control,…). These different input devices support patients with different physical capabilities.

- The GUI block ***B1*** presents the paradigm to the user and gives feedback. The prototype provides two options: (i) a Matrix GUI (used for P300, SSVEP, EMG 1D/2D, EOG and Wii) and an (ii) Hex-o-Select interface used for EMG 1D and motor imagery EEG (see **Table 1** and ***Figure 2***).
  Optional features as spasticity control to avoid miss-selections associated to uncontrolled movements and fatigue monitoring were implemented.

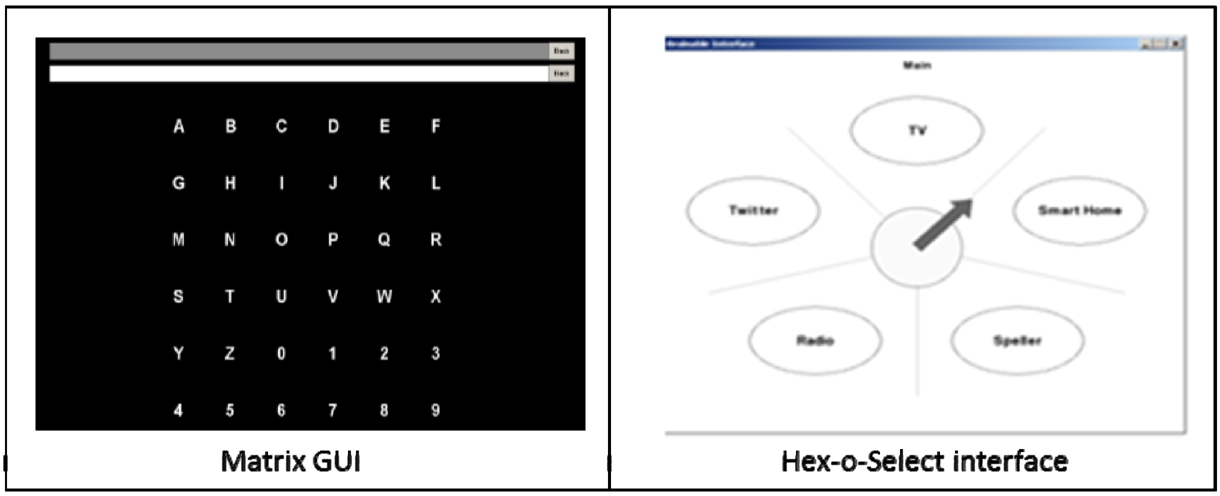


Figure 2: Matrix and HoS interfaces

- The Adaptive Interface Module (AIM, ***B2***) serves as middleware to connect the BNCI to the Ambient Intelligence (AmI, ***B3***), which creates contextual information (see WP5) and forwards messages from the AIM to blocks ***B4*** and ***B5***.

- The Virtual Reality (VR, ***B4***) and the Universal Control Hub (UCH, ***B5***) are connected to the AmI. The UCH contains Target Adaptors (TAs) to connect to external applications using interface ***I6*** and to a Smart Home environment using interface ***I7.*** The interfaced applications are Facebook and Twitter. The implemented devices are a TV set, a switchable light, IP cam and devices to open/close doors and curtains and to control room temperature and ventilation.

Table 1: Inputs for Matrix and Hex-o-Select input interfaces

	Matrix GUI	Hex-o-Select
EEG input: P300	x	-
EEG input: SSVEP	x	-
EEG input: Motor Imagery	-	x
Motion tracking	x	x
EOG input	x	x
EMG input	x	x
Mouse input (for caregivers)	x	x

Objective 2.3: "Integration of the developed technologies into the BrainAble prototype"

Throughout the project technologies developed by several project partners must be integrated to obtain three prototype systems, which are due in M12, M24 and M30 of the project. For this purpose, already for the Y1P an XML-scheme was established, which allows describing each interaction with a unique command ID, a command name and defined attributes.

At an initialization step, the contents of the user interface ***B1*** can be defined by a XML string: The string is sent by the AmI block (***B3***) to the Adaptive Interface Module (***B2***), which parses and forwards the commands to the user interface ***B1***. From the Y2P, also a remote update of the user interface at runtime is possible: If the context changes (e.g. outside it is getting dark), also the contents of the interface can be adapted (e.g. a short cut to the light switch is offered). Thus, interaction speed can be increased, and the number of required interactions to perform a certain action is lowered. In the final prototype the Hex-o-Select matrix has been updated by TUG to provide feedback to users.

Objective 2.4: "Global system integration and packaging of technology"

The global integration of the final prototype has been relevant in the final stage of the project: Milestone M6 (Final version of BrainAble system installed) demanded the final version of the BrainAble prototype installed in M30 of the project. Deliverable D2.5 describes all the functions of the final prototype in detail and serves as a user manual for operating the system.

Table 2 lists all the functionality that was finally implemented and achieved (SE = Stating Environment, AE = Advance Environment).

Table 2: Requirement overview for the user centred platform

Functionality	SE	AE	BrainAble Prototype	Nice to have
Laptop as input device	X	X		
Stimulation unit for P300	X			
Stimulation unit for SSVEP		X	X	
Combined stimulation unit (P300 + SSVEP)			X	
Screen for feedback		X	X	X
Communication unit			X	
User interface	X	X	X	
Dynamical adaptable user interface				X

Table 3 lists the functionality of the BNCI system that was implemented and is available in the Final BrainAble Prototype. Important improvements are the zero-class detection with statistical methods for P300 and SSVEP BCI communication and on-screen stimulation for SSVEP control.

Table 3: Requirement overview for the BNCI system

Functionality	SE	AE	BrainAble Prototype
EEG sensors for reduced artefacts	X	X	X
BCI control based on P300 measures	X	X	X
BCI control based on SSVEP measures		X	X
BCI control based on ERD measures		X	X
Combination of different techniques (hybrid BCI)		X	X
Non – EEG sensors and signal processing for improved control		X	X
Non – EEG data for control		X	X
EEG data for monitoring			X
Non – EEG data for monitoring		X	X
Combination of BCI techniques with communication via non – EEG data			X
Easy usable and extendable system			X

Table 4 lists the functionality of the AmI system.

Table 4: Requirement overview for the AmI system

Functionality	SE	AE	BrainAble Prototype
Context awareness (location and ambient)	X	X	X
Enhanced Context awareness (location, ambient and time)		X	X
Enhance Context awareness (saliency, continuous control)			X
Context awareness feedback to BNCI system	X	X	X

Table 5 lists the functions of the inner environment that are available now.

Table 5: Device list for inner environment

Device	SE	AE	BrainAble Prototype	Nice to have
Light	X	X	X	
Curtain		X	X	
Heating, Ventilating and Air Conditioning (HVAC)		X	X	
Door		X	X	
TV	X	X	X	
IP Camera		X	X	
Robot (high level com.)		X	X	
PC			X	
Robot (low level com.)			X	
Wheelchair model				X

Table 6 shows the Virtual Reality functions that were implemented.

Table 6: Description of the BVC functionality

Description of the functionality	SE	AE	BrainAble Prototype
Avatar control (avatar gestures)		X	X
Navigation in the VR	X	X	X
Manipulation of the virtual objects	X	X	X
Media based expression tools		X	X
Chat in VE		X	X

Table 7 shows the implemented social networking functionality.

Table 7: Social networking in BrainAble

Description of the functionality	SE	AE	BrainAble Prototype
Micro-blogging (e.g., Twitter)	X		
Standard social networking via computer (e.g., Facebook)		X	
Virtual-reality social networking via computer (e.g., Second Life)			X
Audio/Video teleconference			X

Summarizing it can be stated that all functions that were planned in D2.1 *Requirement Specifications* were successfully achieved and integrated into the Final Prototype. The Final Prototype was also installed at Guttmann and AbilityNet with all functions to perform testing.

Important is also that user feedback was reported in a Y2P Feedback form from Guttmann and AbilityNet. In total 121 issues were reported and handled by the consortium. **Table 8** shows three examples (issue ID 25, 74, 118) of the user feedback handling.

Table 8: User feedback handling

ID	Date	User Opinion	Reporter /Institution	Status	Technical actions	Partner / Date
25.	18/5/12	Matrix Interface should have an option to save the "clicks" along a session for research purposes, since it requires a lot of attention to record all the selections during a session.	Therapist Guttmann	Closed	It is now stored into log file.	G.TEC
74.	21/6/12	The empty slots (.) should be not "selectable" to avoid errors in this items	Subject 2	Closed	The matrix interface gets empty squares instead of dots. If an empty square gets selected, the system interprets it as an invalid command. G.TEC: This point has already done. The new update has not dot slots. It will be purchased on Y3P.	G.TEC
118.	28/5/12-9/7/12	The redesigned cap was better and the chip strap much easier with a very disabled person. When creating a classifier a pause between each new target selection would help	ANET9_PW	Closed	It is possible to increase the pause between the flickering trials. This leads to longer training duration, but may be more comfortable to the user. G.TEC: is possible to change the time between flashes modifying setup in Matlab models.	G.TEC

The final version has been integrated in Guttmann and AbilityNet facilities for validation and testing of each module develop. Major efforts have been done to implement and fix issues described by user's and therapist's feedback (end-users; see also Y2P End User Feedback Report).

The outcome of this validation can be found on WP6 (D6.3, D6.4 and D6.5). BDCT and G.TEC visited Guttmann in September 2012 and November 2012 and AbilityNet in May/June 2012 and November 2012 to perform measurements and to install updates.

The final prototype was tested with healthy persons to check the proper functionality. Users had to be 1 min at rest, then had to make 5 selections, 1 min rest, 11 selections and 1 min rest). This allowed to measure the time people need to perform the task and also to quantify wrong selections of false positives.

Table 9 and **Table 10** show testing results were each healthy user had to perform 25 selections and the time was measured to complete all the tasks.

Table 9: Time to complete all the tasks, errors and false positive rate (FP) for 11 healthy users performing 25 selections for different input devices

Subject	Mouse			Wii-1D			Wii-2D			EMG-1D			EMG-2D			EOG			EEG-SSVEP		
	time	errors	FP	time	errors	FP	time	errors	FP	time	errors	FP	time	errors	FP	time	errors	FP	time	errors	FP
#	(s)	#	#	(s)	#	#	(s)	#	#	(s)	#	#	(s)	#	#	(s)	#	#	(s)	#	#
1	242	0	0	300	0	0	281	0	0	328	0	0	340	0	0	435	0	0	450	1	2
2	269	0	0	414	5	0	313	3	0	342	1	0	346	0	1	520	6	3	905	13	6
3	257	0	0	327	3	0	289	1	0	390	0	0	340	0	0	424	0	0	598	5	1
4	259	0	0	452	4	0	278	0	0	350	0	0	364	2	0	360	1	0	895	8	10
5	261	0	0	386	1	0	283	0	0	374	0	0	597	2	0	-	-	-	525	5	5
6	270	0	1	383	0	0	314	1	0	350	1	0	420	1	0	392	0	0	-	-	-
7	266	0	0	342	0	0	302	2	0	348	0	0	315	0	1	354	0	0	-	-	-
8	266	0	0	434	4	0	296	0	0	330	0	0	350	0	0	395	1	0	500	10	2
9	255	0	0	430	3	0	296	0	0	343	0	0	327	0	1	317	0	0	580	4	1
10	257	0	0	395	0	0	320	1	1	367	2	0	360	0	0	384	2	0	710	3	0
11	242	0	0	345	0	0	343	3	0	363	1	0	376	0	1	363	0	0	616	7	4
mean	**258.5**	**0.0**	**0.1**	**382.6**	**1.8**	**0.0**	**301.4**	**1.0**	**0.1**	**353.2**	**0.5**	**0.0**	**375.9**	**0.5**	**0.4**	**394.4**	**1.0**	**0.3**	**642.1**	**6.22**	**3.4**
std-dev	**9.2**	**0.0**	**0.3**	**46.6**	**1.9**	**0.0**	**18.8**	**1.1**	**0.3**	**17.9**	**0.6**	**0.0**	**74.7**	**0.8**	**0.5**	**53.1**	**1.8**	**0.9**	**163.6**	**3.79**	**3.26**

Best performance was achieved with a standard computer mouse and the Wii-2D control. Wii-1D, EMG-1D, EMG-2D and EOG needed approximately the same amount of time. The EEG-SSVEP implementation needed about twice the time as a standard computer mouse.

Table 10: Time to complete the tasks, errors and false positive rate (FP) for 9 healthy users performing 25 selections for the EEG-P300 implementation

Subject	EEG-P300		
	time	errors	FP
#	(s)	#	#
1	960	2	1
2	880	0	0
3	1015	1	1
4	955	0	0
5	875	0	0
6	1185	4	3
7	910	1	0
8	880	0	0
9	1016	1	0
mean	**964**	**1,0**	**0,6**
std-dev	**93,8**	**1,2**	**1,0**

Figure 3 shows the complete final and portable prototype at an exhibition in Warwick, UK.

Figure 3: Final Prototype with input sensors and input screen (middle), BCI system (left computer) and AmI computer (right computer).

The final BrainAble prototype is a fully integrated, technical system that allows users with functional and neuronal disabilities to interact with devices (television, cameras, etc.) and services (Twitter, Facebook, etc.) inside and outside their home to increase independence and social inclusion. The Final Prototype integrates all the technologies develop for each partner under one system. A launcher starts all required software to run all input devices and user interfaces.

3.II.3 WP3: Multimodal sensing and monitoring system for BNCI, affective and biometrics signals

As it happened during the first 2 years, there was a very productive collaboration between TU-Graz (WP leader), G.TEC and UPF that led to the achievement of all tasks, deliverables and milestones specified in the description of work (DoW) document. Most of the meetings, especially those involving TU-Graz and G.TEC at G.TEC's office in February and April 2012, were for testing the sensor network integration in the prototype. The test also focused on the interplay between spasticity monitor and workload detector, and the auto-calibration and adaptation features of the BrainAble prototype.

In line with the plan in the DoW, most of WP3 activities in Year 3 were concerning **Task 3.6** ***Design, development, and testing of integrated sensor networks for human signal (BNCI, affective and biometric) acquisition and decoding.*** Some activities added additional value to earlier **Task 3.4** or **Task 3.5** that were already finished in Year 2. A significant amount of work of WP3 partners, especially testing the developed systems in end-users was directly supporting goals of WP6. The next paragraphs summarised the efforts performed for these tasks.

Addition to earlier **Task 3.4** ***Design, development, and testing of communication and monitoring systems based on EEG measures,*** TU-Graz and others published the work on the auto-calibrating and adaptive ERD BCI, which is part of the final Prototype system in the renowned, peer-reviewed engineering journal IEEE TNSRE (see D3.5 *Report on complete system*). This concerns Task 3.4 but also Task 3.6.

G.TEC designed, implemented, tested and integrated another state-of-the-art BCI, here based on SSVEP in the prototype (see D3.5 *Report on complete system*). This is an addition to the earlier Task 3.4.

Addition to earlier **Task 3.5** ***Design, development, and testing of communication and monitoring systems based on non-EEG measures:*** G.TEC and TU-Graz tested the performance of EEG and a variety of non-EEG based input signals for controlling either of the user interfaces of the BrainAble prototype (see D2.2 *Human computer interaction interfaces*, D2.5 *Technology packaged* and D3.5 *Report on complete system*). This concerns Task 3.6 and the earlier Task 3.5.

G.TEC implemented, tested and integrated a non-EEG based spasticity detection monitoring tool (see D2.5 *Technology packaged* and D3.5 *Report on complete system*). This is an addition to the earlier Task 3.5.

TU-Graz designed, implemented and tested an additional ECG-based workload detector (see D3.5 *Report on complete system*). This concerns Task 3.5.

During **Task 3.6** ***Design, development, and testing of integrated sensor networks for human signal (BNCI, affective and biometric) acquisition and decoding,*** G.TEC implemented, tested and successfully integrated multiple additional hybrid BCIs, one that used an SSVEP-based switch to toggle the P300 User Interface on and off, and another hybrid BCI that used SSVEP for navigation in the matrix speller and EMG for selection. G.TEC improved the P300 method using a statistical model. This methodology adapts to each user's evoked potential reducing the time needed for trigger a selection in P300. This adaptive P300 BCI decides online the minimal number of flashes needed to perform a selection (see D2.5 *Technology packaged* and **D3.5** *Report on complete system*). This mainly concerns Task 3.6. Furthermore a group study was conducted that showed that an SSVEP based BCI system can be control with a grand average accuracy of 95.5 % after 4-16 min of training only.

UPF performed experiments to study the relationship between visual parameters and emotion. UPF also studied the influence of non-symbolic graphic representations on emotion using computer generated abstract shapes and animations in a mixed reality environment (XIM). In the study, geometric and kinematic characteristics of figures and animations were manipulated in order to see their particular impact on the emotional state of participants using EDR, heart rate and respiration signals. The question addressed was if the language of non-symbolic graphic representations –particularly color, morphology and movement -, could evoke different affective states in the participants in the axes of valence and arousal. Some of the underlying concepts were applied in the BVC system. (see D3.5 *Report on complete system* and D4.5 *VR environments and elements, final prototype*).

In a published, peer-reviewed conference paper (IEEE EMBC; see D3.5), TU-Graz validated the efficacy of a number of critical prototype features and their interplay, such as the auto-calibrating and adaptive ERD training paradigm, the Hex-o-Select ERD control, the logic to halt ERD control as a result of enhanced mental workload and the ERD-hybrid feature that allows continue operating the prototype with other input signals (here a mouth joystick). In this validation the full chain of BrainAble prototype features, including control of smart-home devices and internet services was validated. This concerns Task 3.6 but to some degree also the earlier Task 3.4.

A formal evaluation of the efficacy of the EEG and ECG based workload detection systems and how they could be used to assist during ERD operation was accepted as a peer reviewed conference paper (TOBI conference IV). This concerns Task 3.6, but in part adds value also to the earlier Tasks 3.4 and Task 3.5.

The partners G.TEC and TU-Graz tested the interplay and integration of the EEG based workload detector with other integrated active-input and monitoring signals, such as the spasticity monitor. This was especially the topic of some very productive and intense face-to-face technical meetings. This concerns Task 3.6, but in part also adds value to Task 2.4 and the earlier Task 3.4 and Task 3.5.

Strictly following the user-centered design premise, TU-Graz in collaboration with FPING and ANET continuously improved the auto-calibrating and Adaptive BCI training paradigm (user interface, mental tasks, towards self-paced operation) and Hex-o-Select (e.g. friendly, functional look and feel & feedback; selection text field, etc.) according to feedback from healthy users, care givers and disabled individuals (end-users; see also Y2P End User Feedback Report). The scientifically, technically most up-to-date versions are integrated in the final prototype (see D2.5 *Technology Packaged*).

TU-Graz published research on how more integrated design approaches can benefit BCI interaction as a full, peer-reviewed journal article in the Machine Learning journal Soft Computing (see D2.5 *Technology Packaged*). This concerns Task 3.6 but also Task 3.4 and Task 3.5.

TU-Graz in collaboration with FPING, ANET tested the auto-calibrating and adaptive ERD training paradigm along with self-paced ERD Hex-o-Select extensively and successfully in 24 severely disabled users. Manuscripts summarizing the results are in preparation. Especially the data we collected during self-paced Hex-o-Select control is scientifically highly valuable and will certainly be useful in improving the performance of self-paced ERD BCI systems in disabled users. The end-user feedback was generally very positive (see D6.3 *Evaluation of the individual components of BrainAble system*). This concerns Task 3.6 and Task 3.4 and **WP6**.

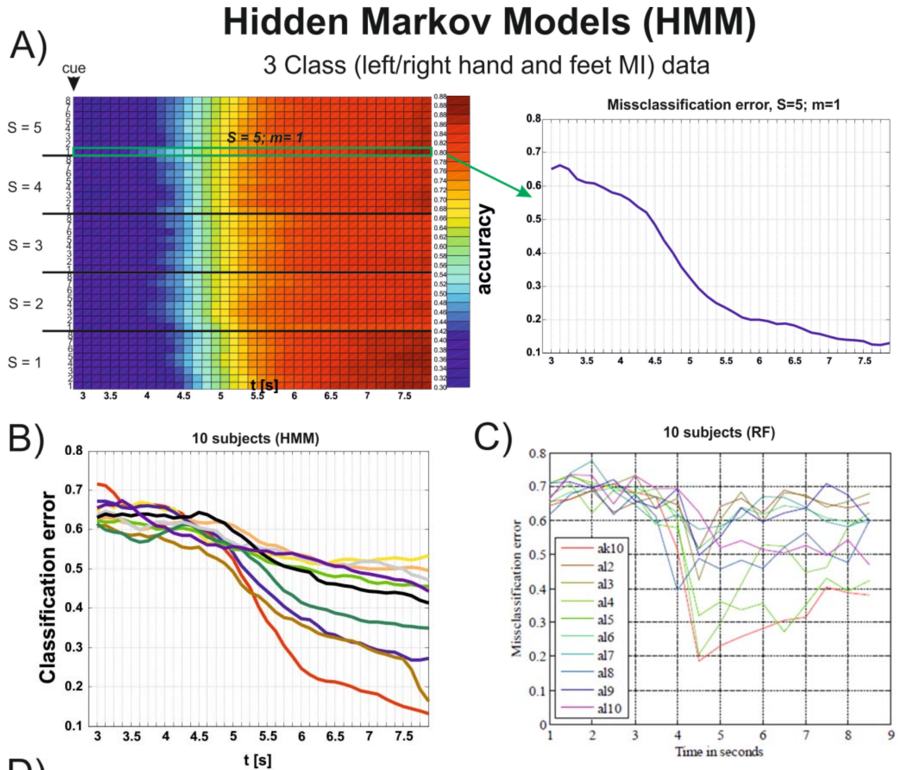
Very tight collaboration between G.TEC and TU-Graz led to improvements in the prototype that now make it possible and easier than ever before to operate either of the two user interfaces with a selection and possibly combination of EEG and non-EEG based active-input and monitoring signals. This leads to an unprecedented flexibility as to which input or monitoring signals and even user interfaces can be used by each user. This way the system can be very easily adapted to the needs and preferences of each user. In addition, the system automatically adapts to the user wherever technically possible and clinically or logistically sensible (see D2.4 *Technology packaged 2^nd^ prototype*, D2.5 *Technology Packaged* and D3.5 *Report on the complete system*).

WP3 activities beyond the initial work plan

Like in previous years, we did research not only on ERD systems directly related to the prototype but also additional academic work with advanced Machine Learning techniques: This reporting period we did extensive analysis with Hidden Markov Models both on data of healthy and disabled individuals (see

Figure 4). Manuscript is in preparation. This concerns the earlier Task 3.4.

While the DoW does not mention or require outlier rejection, we spent additional research on this topic, which proved very beneficial to the ERD BCI systems. The first prototype of the auto-calibrating and adaptive ERD BCI system perfomed rigorous outlier rejection at every retraining step, which proved to be invaluable as it increases literacy rate, accuracy and robustness.



D)

3 class	subjects										overall	
L vs. R vs. F	ak10	al2	al3	al4	al5	al6	al7	al8	al9	al10	mean	std
peak acc. HMM	0,87	0,50	0,49	0,73	0,84	0,54	0,65	0,53	0,59	0,56	0,63	0,14
peak acc. RF	0,82	0,48	0,57	0,80	0,73	0,48	0,43	0,54	0,50	0,53	0,59	0,14

Figure 4: Hidden Markov Models (HMM) for EEG classification and comparison with Random Forests (RF) classifier. A) Searching for best individual number of states (s) and mixtures (m) B) Classification error of 10 subjects using HMM C) Classification error of 10 subjects using RF D) Comparison HMM and RF.

Our more advanced Adaptive ERD BCI systems uses a much more sophisticated battery of outlier rejection mechanisms, that can be even configured to automatically reject noisy channels and seamlessly reconfigure spatial filters during full online operation. In addition, our advanced systems that are implemented in the prototype now also automatically detect artefacts online and provide feedback to users (e.g. display a yellow dot as a signal to the user to relax), which proved tremendously useful in the work with disabled users.

We did some very preliminary research already into how considering the online artefact detection could be used to increase self-paced ERD BCI performance (see D3.5 *Report on the complete system*).

We also examined the usefulness of the low-cost Emotiv EPOC headset, tested the build-in features of the device, and evaluated the wearing comfort. Overall, the results confirm the usefulness of facial EMG and gyro-sensors as input signals. Spectral analysis also confirmed the usefulness of the device for detecting visual evoked potentials (

Figure 4). Imagery BCI-based results were not as satisfying. Only 2 out of ten able-bodied users achieved reasonable control. One big disadvantage of the device is that the wearing comfort decreases after about 30 minutes of use. The results are summarized in a Master's thesis at TU-Graz.

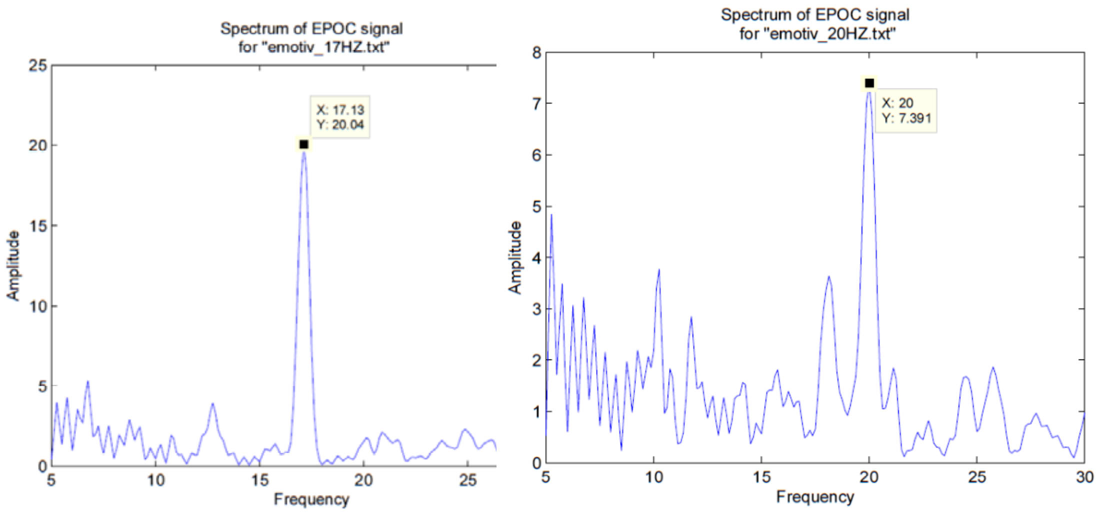


Figure 5: Power spectral density (PSD) computed from one 3-s EEG segment for one subject. Stimulation frequencies for the left and right plot were 17 Hz and 20 Hz, respectively. Clear peaks are visible in the PSD.

Conclusion Year 3 activities

We **successfully completed** the last deliverable of the work package, D3.5 *Report on the complete system.* The **requirements** for all **milestones** in the work package **have already been met** by the **end of month 24**. Again the contributors to this work package made a very high effort to not only meet but vastly exceed the requirements, in that we produced additional foundational and applied research and also implemented and fully integrated additional features in the prototype that were not required and effectively increase accuracy, robustness and literacy.

OBJECTIVES FOLLOW-UP

Objective 3.1: "Lay the foundations for rapid and effective development"

For month 6 we summarized the results of our state of the art analysis in the reports D3.1 *SoA analysis: BCI and BNCI Systems* and D3.2 *SoA analysis: sensors, signals and signal processing*. We successfully identified system requirements, setup the prototyping environment (D2.1 *Requirements specification*, M1) and fixed the HCI design (M2). Research led us to adapt known UI principles into our Hex-o-Select design as presented in D3.3 *First BCI system available*. We later improved our rapid prototyping environment to include a wide variety of input signals D3.4 *Second BNCI system available*. We produced a vast number of research articles, especially from the fields of SSVEP based or hybrid BCIs that served as valuable foundation for our systems (D3.3 *First BCI system available*).

Objective 3.2: "Build communication tools based on movements, EEG measures, and other physiological signals."

G.TEC in collaboration with TU-Graz designed, implemented and tested a number of movement-related and non-EEG signals as input modalities and integrated the majority of them into the prototype to be flexibly usable with either of the two User Interfaces, wherever sensible. We fully integrated the non-EEG modalities Wii-1D, Wii-2D, EMG-1D, EMG-2D, EOG, Assistive Technology Joystick, Eye Tracker, Mouse, Mouth Joystick and other common assistive technology devices. Our tests of these devices in healthy and disabled users are reported and described in more detail in D2.4 *Technology packaged 2nd prototype*, D2.5 *Technology packaged*, D3.3 *First BCI system available*, D3.4 *Second BNCI system available* and D.3.5 *Report on the complete system*.

We developed a number of BCI systems, the most effective of which were also integrated in the final BrainAble Prototype. We implemented an SSVEP based BCI that allowed controlling an avatar in a virtual or augmented reality environment and another BCI to control the vastly popular massive multiplayer online role play game World of Warcraft, first using only ERD later also using SSVEP signals (D3.4 *Second BNCI system available*). Together with G.TEC we also implemented various novel types of P300 spelling BCIs (D3.3 *First BCI system available*), SSVEP BCIs that allowed for asynchronous operation (D3.4 *Second BNCI system available*) and a vast number of Hybrid BCIs including systems that combined ERD and SSVEP, SSVEP and P300, ERD and mouth joystick and SSVEP and EMG (D3.3 *First BCI system available*, D3.4 and D3.5 *Report on complete system).*For either of the modalities EEG or non-EEG we explored the utility of low-cost consumer signal acquisition devices like the Emotiv EPOC system (D3.4 *Second BNCI system available*).

Results of studies and tests and references to published articles involving healthy volunteers using different types of BCIs including Hybrid BCIs can be found in (D3.3 *First BCI system available*, D3.4 *Second BNCI system available* and D3.5 *Report on complete system).* Specifically with disabled users, G.TEC tested P300 based Intendix interaction (D.3.3 *First BCI system available*), the BrainAble P300 system, the BrainAble SSVEP system (D3.5 *Report on complete system*) and other input modalities. Involving disabled users, TU-Graz recorded 24 sessions from 13 user offline (D3.3 *First BCI system available*), later 20 sessions in 10 users in a first online Adaptive BCI approach (D3.4 *Second BNCI system available*) and finally online tests of the newest and final auto-calibrating and Adaptive ERD BCI and Hex-o-Select in 24 end-users with both clinical partners (D6.3 *Evaluation of the individual components of BrainAble system*). UPF did studies on how to use physiological signals for non-symbolic expression in virtual environments involving healthy users (see D6.3 *Evaluation of the individual components of BrainAble system*).

Objective 3.3: "Build monitoring tools based on EEG and other physiological signals"

Based on profound literature research and state-of-the-art analysis, TU-Graz set up a very extensive study to find which EEG or non-EEG signals would be most suitable for cognitive and mental state monitoring in the scope of BrainAble. We recorded high coverage EEG, EOG, EMG, ECG, EDA and respiration, and found that EEG and ECG were most suitable (D3.4) for the scope of BrainAble. We later tested the used EEG and ECG based workload detection algorithms based on a gold-standard paradigm and during self-paced ERD operation (Results now published at peer reviewed TOBI conference IV). G.TEC designed, implemented and tested a spasticity detector based on EMG. Both the EEG-based workload detector and the EMG based spasticity detector are fully integrated in the prototype (D3.4 and D3.5).

Objective 3.4: "Integrate these tools with an adaptive software framework"

The BrainAble prototype supports a number of active input and monitoring signals, both EEG and non-EEG based. The EEG based signals include ERD, SSVEP and P300, while the non-EEG based input signals include Wii-1D, Wii-2D, Eye-tracker, EMG-1D, EMG-2D, EOG, Assistive Technology Joystick, Mouth Joystick, Mouse, motion tracker and other common assistive technology inputs (D3.3, D3.4 and D3.5). In addition we integrated EEG based workload detection and EMG based spasticity detection in the prototype (D3.4 and D3.5).

In tight collaboration, G.TEC and TU-Graz integrated all these active EEG and non-EEG based input and monitoring signals in a way so that most sensible selections and many combinations of them can be chosen to operate the full functionality of the BrainAble prototype using either of the User Interfaces Hex-o-Select or Matrix Speller. For example the system can be configured to allow for active ERD and Mouth Joystick interaction via Hex-o-Select. In addition one, both or neither of the monitoring systems based on EEG and EMG can be used in this exemplary setting (see D2.5).

This unprecedented flexibility in the signals to use with the system, allows to easily configure the input interface and signals to the needs and preferences of the user without requiring expert interaction. Wherever technically possible and clinically sensible the system adapts to to the users signal automatically, for example in the auto-calibrating and Adaptive ERD training paradigm (**D.3.4**, **D.3.5**). Also the P300 statistical model adapts to user performance to online decide the minimum number of flashes of the paradigm needed to trigger a selection, thus reducing the time needed to perform any action with the BrainAble system.

3.II.4 WP4: Networked virtual environments with increased communication and self-expression tools

During Period 3, the activities concentrated on finalizing all components of BrainAble VR. New features have been added to the VR: BCI navigation training module scenario and tools for emotional expression using colours, music and body postures. It also has been improved features like the avatar navigation (based on user's feedbacks) and visual tools to support the navigation (an overlaid house map), the addition of new devices to control (doors, curtains) in the virtual house and the improvement of the character customization tools.

During all year WP4 provided support for the implementation of additional features and bug fixing on the BrainAble VR based on the Y2P evaluation feedback in cooperation with clinical partners in WP6 and providing support for the installation of the prototype and the integration with the rest of the components. In month 30 it was produced D4.5. *VR environments and elements, final prototype*, describing the final prototype of the BrainAble VR and providing details of the latest implementations and achieving milestone M6 *Final version of BrainAble system installed*. This work contributed to **task 4.2** and **task 4.3**.

On the research aspects it has been continued the studies for cognitive stimulation using auditory signals, studies to understand the relationship between visual parameters and emotion, and a study to evaluate the effect of the training scenario on the use of the BrainAble prototype, all reported in deliverable D6.3 *Evaluation of the individual components of BrainAble system*. This work was developed on **Task 4.4 *VR and media based tools for cognitive stimulation and BNCI control***.

OBJECTIVES FOLLOW-UP

Objective 4.1: "Provide perceptually and cognitively effective VR-based link between BNCI and operation (home) and communication (community) services"

During the three years of the project WP4 has created a virtual environment operated via BNCI that allow various activities – smart home control, social interaction and self-expression in a networked environment, and training environment. The ***home***, containing home automation control room and the ***community*** with expression room, chat room, training room and the community areas. All these virtual spaces are implemented as one unique platform, with clear communication interfaces with the other modules of BrainAble (AmI,UCH) and controlled from the hybrid BCI interface created in the project. Additionally we have constructed specific tools that contribute to the objective: scenario modelling tool to create personalized virtual representations of the houses (see D4.3 *Audio-visual tools for self-expression and social networking*, D4.5 *VR environments and elements, final prototype* and D5.4 *VR Configuration APIs and Scenario Modelling Tool*) and the character customization to allow users to specify how they want to look in the virtual environment.

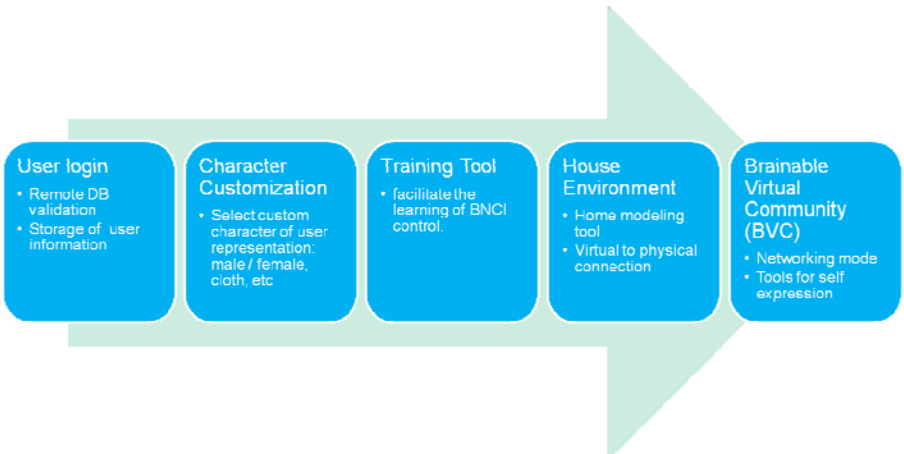


Figure 6: General scheme of BrainAble VR main components

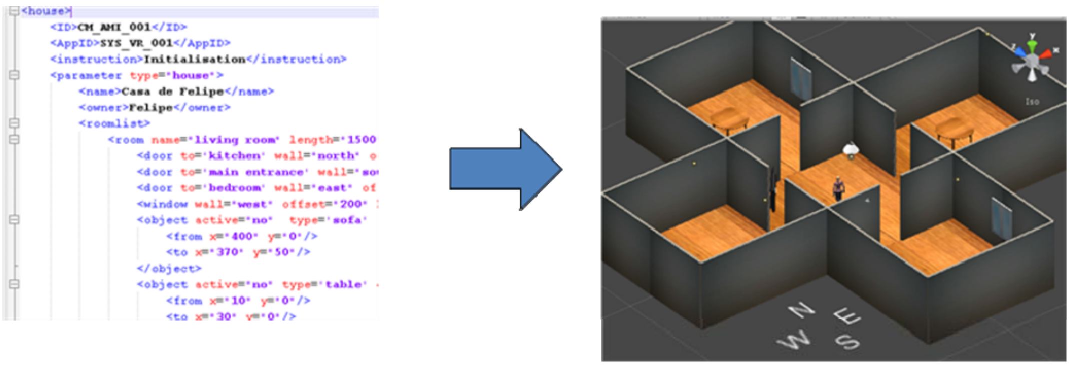


Figure 7: Scenario modelling tool. On the left the XML representation of the house description and on the right the automatic 3D representation generated from the file

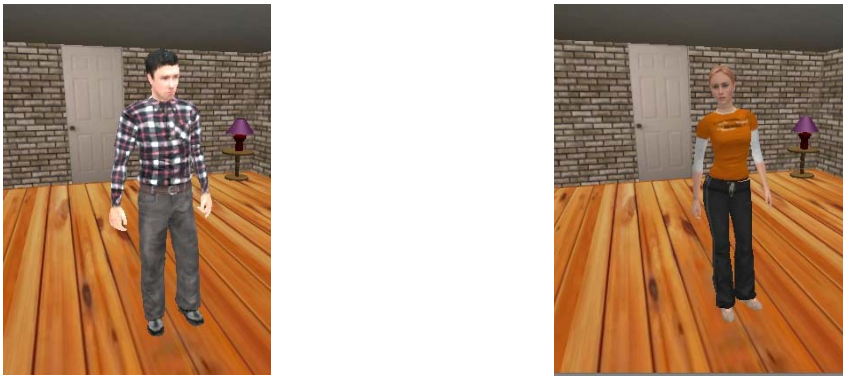


Figure 8: Character customization in home environment. Different genres and clothes can be chosen.

Figure 4.4: Visualization of the Smart home environment

<u>Deliverables</u>

D.4.1. *VR environments and elements, SoA*

D.4.2. *VR environments and elements, first prototype*

D.4.5. *VR environments and elements, final prototype*

Milestones

M.4 Second version of BrainAble system installed (M24)

M.6 Final version of BrainAble system installed (M30)

Objective 4.2: "Creating non-verbal audio-visual self-expression tools for social interaction"

WP4 has created tools to allow the expression of emotions in the BrainAble VR, using facial expressions, body postures, colours and music. The user selects the emotion using the BNCI interface, this message is transmitted to the AmI and finally to the VR. The VR maps this emotion to a value of valence and arousal that is mapped to a facial expression, a body gesture or a musical clip that express this emotion. A user connected to the BVC can easily perceive the state of the person by just looking into the environment. The avatars of the BVC are able to dynamically change the posture of their body based on the emotional tag they have in a particular moment in time. Users can express their affective state by modifying the animation of the character. This is an implementation of a paper published by UPF on emotion expression and body posture (Inderbitzin 2011) (***Figure 10***). The main argument of the investigation is that the bending of the body is dependent on the emotion described. Negative emotions are expressed with a higher bending, whereas positive emotions require an erect position of the back of the character. Following the dimensional model, the system is continuous and can be used to express very subtle differences in the affective.

Figure 9: Expression of emotions that affects colours and facial expression of the virtual environment

Figure 10: Variations of torso inclination based on valence and arousal of emotion in the VR environment.

Publications

Inderbitzin, M., Väljamäe, A., Calvo, J. M. B., Verschure, P. F. M. J., & Bernardet, U. (2011). Expression of Emotional States during Locomotion based on Canonical Parameters. EmoSPACE 2011 (pp. 809-814). IEEE. doi:10.1109/FG.2011.5771353.

Deliverables

D.4.3. *Audio-visual tools for self-expression and social networking* (M24, Prototype, Confidential)

Objective 4.3: "Networked 3D environment for community building and social interaction"

A multi-user network environment has been developed for social interaction and inclusion and integrated in the BrainAble architecture (See D5.5 *URC-enabled AmI Scenarios* section 4, Social Networking with Virtual Reality for technical details). Users can change from the inner VR (house environment) to the outside world (BVC) where they can go to a virtual community of users. In this world they navigate with their avatar representation and explore the world. They can also meet with others and chat (using text) or express their emotions using non-verbal communication (through facial expressions, postures and properties of the VR environment such as colours and sounds). As in the Inner VR, in the BVC the actions in this world are controlled from the BCI and allow the user to navigate, choose an emotion and select chat messages. In the future the BVC can be extended to multiple environments while the community of users increase, allowing different experiences based on user preferences.

Deliverables

D.4.3. *Audio-visual tools for self-expression and social networking*

Objective 4.4: "Tools for cognitive stimulation and mastering BNCI control"

Cognitive Stimulation

BrainAble's main objective is to improve the quality of life of people with disabilities by providing user-friendly BCI-based technology that will help them to develop autonomy and social inclusion. The use of audiovisual material in the context of BCI research raises interesting questions about cognitive stimulation and rehabilitation. In task 4.4 we developed a study focused on brain entrainment via auditory stimulation called binaural beat that stimulates arousal, focus and awareness, all fundamental components of consciousness. The aim of the experiment is to investigate the effect and impact of binaural beats on the cognitive states of patients with varying deficits of consciousness and healthy subjects. Binaural beats with a beating frequency of 6 and 10Hz at a base frequency of 440Hz can induce brainwave entrainment and stimulate the thalamo - cortical response in patients with varying deficits of consciousness.

Figure 11: The experimental setup for cognitive stimulation using gUSBamp, Gammabox hardware by G.tec

Mastering BNCI control

The training module scenario has been incorporated as a new module within the BrainAble VR. It provides a game that trains the users to control avatars in the virtual world using the BCI navigation tools.

The game that has been developed is an open space (without walls or physical barriers) where the avatar can walk freely (See ***Figure 12*** left). In the space there are objects in the form of gems that have to be collected, by simply passing through the gem (See ***Figure 12*** right). The objective is to collect the maximum number of gems in less time. A study to evaluate the effects of this training scenario for the performance in the BrainAble system was started and it's reported in D6.3.

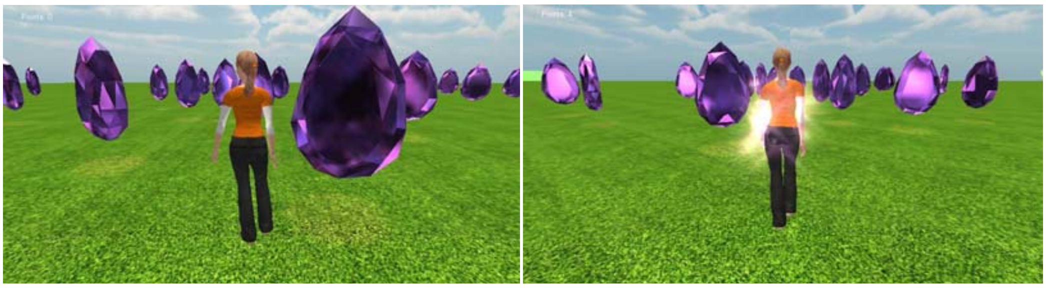


Figure 12: Avatars in game virtual world

Deliverables

D4.4. *VR and media based tools for cognitive stimulation and mastering BNCI control*

D6.3 *Evaluation of the individual components of BrainAble system*

3.II.5 WP5: Ambient Intelligence and social networks services

Interactive systems have been the dominant computing paradigm over recent years. This paradigm is characterized by the fact that human user and the system communicate and interact explicitly using different modalities. Observing humans interacting with each other and new possibilities given by emerging technologies indicate that a new interaction model is needed. In this setting, Ambient Intelligence is called to play an important role in this setting in which the system provides control to users with special needs adapting the system to their specificities.

BrainAble's WorkPackage5 (WP5) was committed to provide the service to assist the end-users in their daily life helping them to overcome the problems associated with their disability. To enhance the user experience, WP5 relied on the application of Ambient Intelligence techniques so that the system provides an adapted assistance to the user. The role of AmI is mainly to carry out the interaction with the real environment by performing the user's commands (e.g., to turn on a light) in an intelligent manner. The assistive scenario developed for this prototype consists of an unobtrusive network of pervasive devices acting to proactively manage emergency, security, comfort or energy-saving issues. For this purpose, AmI counts on the Context-Awareness feature which recognizes specific situations by means of the mentioned sensor network to subsequently perform the most suitable action.

The following figure illustrates the general architecture of BrainAble designed in this first year focused on the Ambient Intelligence block, output of the WP5.

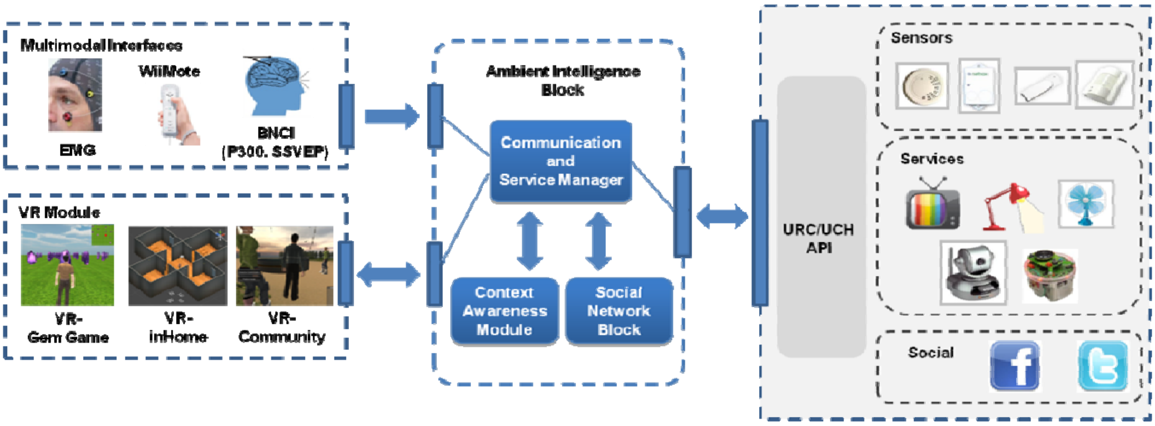


Figure 13: BrainAble architecture

Additionally, WP5 conceived and developed the social networking services to mitigate the isolation often suffered by the low-level dependent. Such services incorporate advanced features in order to enrich the communication with others, the self-expression tools, which provide, apart from the verbal communication (e.g. chat, voice), non-verbal communication such as emotional and postural expressions.

During first and second year, WP5 was dedicated to design the general architecture of the project together with developing the middleware architecture to connect all the modules (**Task 5.3**). As part of the functionalities of the middleware, this work included the design and implementation of the Virtual-To-Physical gateways (**Task 5.2**).

The **third year** of BrainAble was dedicated to consolidate the work performed during first and second years by both technical and non-technical counterparts. The work committed in WP5 in this third year was related to consolidate the deployment and installation procedures of the Smart Home services along with performing the different validation stages for the second and Final prototypes. As outcome of this validation stages, the end-user's reported issues arising from the conducted pilots, became a very valuable tool for the integration and enhancement of usability and usefulness of the platform as it was aligned with BrainAble's user-centred design.

The following figure illustrates the structure of Ambient Intelligence in BrainAble. The sources of information come from two sides: context which is corresponds to the immediate measurements of the surroundings (e.g. temperature, humidity, light) and the user habits, referred to the behaviour of the user (e.g. actions committed). This information is used as input by the Context-Awareness engine to provide as outcome a specific situation taking place which is lately used by a trained classifier to make a proper response to the user via in the form of a personalised adaption of the interface, the Context-dependent UI. This feature is capable of adapting the interface (i.e. suggestion actions to take) according to the context, the application of the envisaged Ambient Intelligence to the BrainAble prototype (**Task 5.1**).

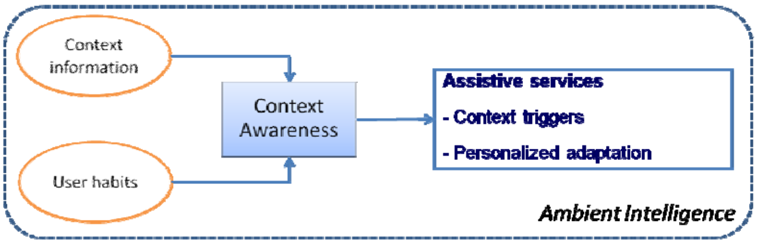


Figure 14: Ambient Intelligence

Finally, we put effort in the enhancement of the self-expression tools of the BrainAble Virtual Community to implement affective computing by means of the facial and behavioural emotions (**Task 5.4**). Indeed, the included self-expression tools were a requirement enriched the communication capabilities, which translated into the ability of communicating emotions. These emotions are enabled through two complementary means in the BrainAble Virtual Community (BVC): facial expression mechanisms and postural behaviour.

OBJECTIVES FOLLOW-UP

Objective 5.1: "Design and develop an AmI-based network of ubiquitous computing devices optimized by adaptive software components which work in concert to support people in carrying out their everyday life activities. Objects behavior will be refined according to the person needs, and even to the future needs by means of anticipation"

Ambient Intelligence (AmI) represents concepts related to Artificial Intelligence (AI) applied to Ubiquitous Computing devices. AmI consists of sensing the environment and performing the proper action as a consequence in an intelligent way. Hence, the first step in AmI systems is the perception of the environment obtained through the use of pervasive sensors processed by a Context-Awareness engine. The information provided by sensors processed by AI methodologies eventually provide decisions to act upon the environment through controllers and specialized HCI.

In BrainAble, the context is captured by a list of Boolean variables and numerical descriptors that are gathered via the sensors (e.g. temperature, humidity, luminosity, motion), the state of the services (e.g. light, TV, twitter login status, camera, HVAC) and the current time (day of the week, hour of the day, season). This sources of information are used as input by the Context-Awareness engine to determine the current situation taking place at a given instant of time. The following figure depicts the different elements that compose the context.

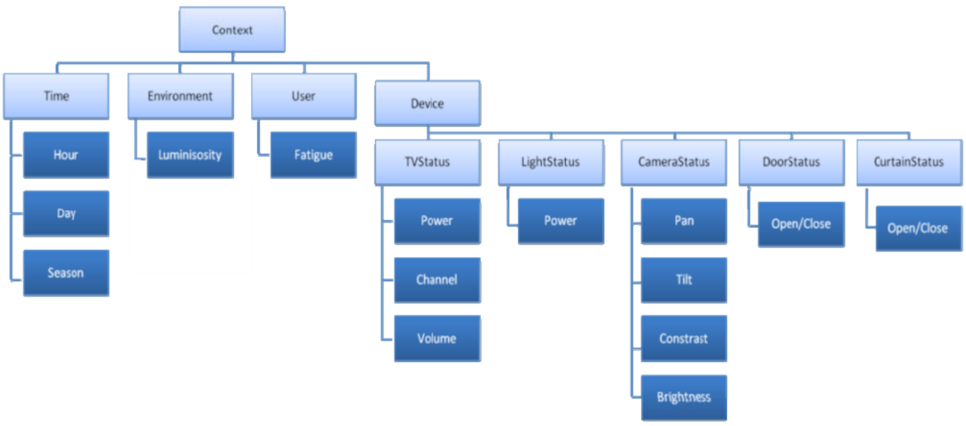


Figure 15: Definition of context in BrainAble

The AmI provides proactive responses to specific situations that take place in the user's home. This proactive response is translated into the so-called Context-dependent UI, an adaption of the user interface according to the needs of the user and the current context occurring. Indeed, the AmI engine is constantly monitoring the environment. When a suggestion needs to be done to the user, an update of the interface is performed suggesting the most likely options. The following figure illustrates such a process.

Figure 16: Context-dependent UI feature

Two different mechanisms have been developed in BrainAble to create the Context-dependent UI.

<u>Context Triggers:</u> Triggers are particular rules, hardcoded into the CA module, activated for a particular situation without an explicit request from the user. An example is the detection of a user sleeping with the room light on. As response, the light should be turned off by the system. Description of AmI systems are mostly based on knowledge representation mechanisms which imperatively need a formal methodology able to represent the knowledge acquired over time. The BTML (BrainAble Triggering Markup Language) helps to represent this knowledge, a human readable XML language helping to define this rules based on the RuleML standard language. The following is an extract of the BTML language codified.

BTML formatting for rule *"If the User is sleeping and Lamp is On then switch Lamp Off"*

```
<Implies>
          <Head>
            <And>
              <Atom>
                < State >Sleeping</ State >
                <UserVar>User</UserVer>
              </Atom>
              <Atom>
                < State >On</State >
                <EnvVar>Lamp</EnvVar>
              </Atom>
            </And>
          </Head>
          <Body>
            <Atom>
              < State>OFF</State>
                    <EnvVar>Lamp</EnvVar>
            </Atom>
          </Body>
</Implies>
```

<u>Personalised Adaption:</u> Personalization refers to the dynamic presentation of the most convenient options to select from the user interface based on the current context, while inference refers to the presentation of predicted options based on user's preferences under a determined context. In order to infer the context, the system is able to log all the interactions of the user with the system and the current context occurring at that time. All this information is processed by the Proactive Reasoning Core based on AdaBoost, with decision Stump as a weak algorithm. This engine is responsible to decide the most likely actions to be selected by the user.

Related Deliverables

D5.1 Ambient Intelligence in Assistive Environments

D5.2 Technical Specifications of Ambient Intelligence architecture

D5.3 *Deployed AmI scenarios final prototype*

D5.6 *URC-enabled AmI scenarios*

Objective 5. 2: "Provide Virtual-to-Physical gateways to enhance the interaction of disabled people and their living environment"

The Virtual Reality in the scope of BrainAble, provides the functionality of a virtual representation of end-user's home, by means of the Scenario Modelling Tool (SMT), with the final goal of providing the ability of navigating for those who have mobility impairments in their own home. In fact, SMT also allows to interact with the Smart Home appliances. For this purpose, the XML-based language HomeML is the format language designed to describe a customised virtual environment to have such conceptual representation. This language includes the description of size and location of the elements in the home, the passive elements, but also enumerates the different active elements with which the user can interact, the so-called active elements.

Finally, the VirtualReality of BrainAble includes the Virtual-To-Physical gateways functionality, which ensures an accurate synchronization between both virtual and physical worlds. That is, an action that takes place in the real world and has an effect on both virtual and real world (e.g. turn on/off the TV).

Related Deliverables: D5.4 *VR Configuration APIs and Scenario Modelling Tool*

Objective 5.3: "Design and deploy a modular, scalable and standard-based (URC standard) network architecture (using UCH middleware) to enable a fast and simplified integration and interoperation of devices into the environment"

The integration of the URC/UCH as proposed in BrainAble facilitates the integration of the home automation devices, sensors, actuators and social network applications. Furthermore, this integration provides an abstraction layer to the AmI and Social Network blocks allowing them to access and control all the integrated devices and services by using just one communication protocol. The usage of the URC/UCH technology also brings scalability and adaptability to BrainAble, allowing its future expansion by the development of APIs with "plug and play" capabilities based on the Target Adapter and Target Discovery Module concept. This expandability can allow the future integration of new home automation devices, new sensors, actuators and new services as new social networks applications or any other type of applications. The aim of this first year was to adopt this technology in the prototype and add extend the URC/UCH to interact with a commercial TV and a light.

The extension of the Smart Home services available for the BrainAble prototypes 2 and Final prototype has brought a broader view of the interoperability possibilities. The following services are included in the prototype:

- Light Control
- TV control in order to gain control over channel and volume
- HVAC access for managing the temperature
- IP Camera to control its heading and other functionalities such as resolution or contrast.
- Control of a robot

It is remarkable the smarthome functionalities devoted to provide telepresence features. Telepresence refers to a system able to enable a person to feel at another place than his true location. Indeed, the BrainAble platform enables the control of an affordable telerobotic platform, the ePuck robot. This feature seems to be very suitable for people in the predicaments of the end-users of BrainAble due to the mobility restrictions they suffer.

Related Deliverables:

D5.1 *Ambient Intelligence in Assistive Technologies*

D5.2 *Technical Specifications for BrainAble AmI architecture*

Objective 5.4: "Provide a personal communication framework based on social interaction capabilities by the integration of self-expression tools and advanced social networking services"

The use of Internet and related tools such as voice conference, text chat and e-mail opened a lot of new communication possibilities between patients and therapists. BrainAble aims at providing new ways of communication to disabled and giving them additional forms of sharing experiences with both disabled and non-disabled.

BrainAble has a subsystem, the Social Network Block (SNB), focused on offering the social functionalities to the user. This block allows social interaction granting access to the most popular social networking sites: Twitter and Facebook. The SBN translates the different actions that the user can do inside the social network to the URC/UCH block. The URC/UCH acts as a gateway to access the social networking servers of Facebook and Twitter and is the responsible for interacting with the social network and to get information to send to the user. The system offers connection to two of the most important social networks available online at the moment: Twitter and Facebook. With this integration we cover a great number of users, and functionalities. BrainAble incorporates intelligence to this SNB by giving it the ability to perform some social mining helping this interaction with others. As proof-of-concept, the SNB, by extent the AmIBlock, is able to suggest the user with an action to congratulate the anniversary of a contact via the *Context-dependent UI* feature.

The VR engine included in BrainAble also takes part in the social interaction due to its social networking capability based on a virtual world, the BrainAble Virtual Community (BVC). In this virtual world, the user is able to interact with others in similar predicaments with an avatar that can be customised to get a reliable representation of the user.

The role of the human body and face in perceiving emotions is highlighted by several studies that show that the perception of another person's actions involves activation of human brain circuits involved in the generation of such actions by the observer. To enhance the communication in the BVC, the user is able to make use of affective computing tools (e.g. sad, happy, angry) to transmit his/her emotional state to others via facial emotions transmitted by the avatar; and via postural behaviour since the avatar is able to modify its posture according to the emotion selected and through musical expression.

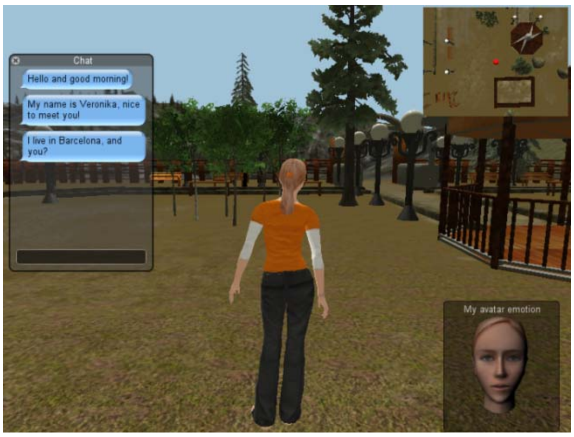


Figure 17: BrainAble Virtual Community

Related Deliverables

D5.4 - *VR Configuration APIs and Scenario Modelling Tool*

D5.5 - *Social Networking Infrastructure*

3.II.6 WP6: User-centred design, validation and research of impact on cognitive recovery

In the previous Periods, ANET and FPING developed the ethical framework, clinical definitions, the validation tests and user sample and developed an appropriate set of instruments and measures for evaluating the prototype. Deliverables D6.1 *Medical requirements in motor disabilities scenarios* and D6.2 *Identification of potential user groups and validation specifications* were submitted and contained a record of this work. UK ethical review for the research study and site was completed in October 2011. In the second half of 2011 and throughout whole 2012, FPING and ANET conducted different studies with groups of users and disseminated results to development teams. The following is a brief summary of the different studies by partner.

During Period-3, and relating to **task 6.4 Iterative evaluation for user-centred design**, BDCT and G.TEC worked together with Abilitynet and Guttmann to set up, install and test the Y2P BrainAble prototype in a permanent location for the prototype at Liverpool John Moores University (Y1P was installed in early June 2011) and the Institut Gutmann as per the revised plans.

Testing and dissemination of the results took place until autumn 2012. There were 2 further cycles of testing and development in the UK during 2012. The second prototype was tested both in the UK at the site at Liverpool John Moores University and at Guttmann in Spain in response to reviewers recommendations.

The second prototype was set up in the UK with the support of G.TEC who stayed for the first week of testing which took place during late May 2012. Data gathered included participant feedback on the system which included responses to developments and aspects of user interface and in addition a systematic protocol in order to test all the components available and to test input rates across a range of different inputs based on number of selections. All evaluations from users in both test sites was collated and disseminated amongst the developers and partners and resulted in incremental changes to the second prototype which led to a Final prototype, which was installed in both locations in November 2012 for the final tests.

The final prototype was validated intensively, both in the UK and in Spain during autumn with the support of G.TEC, BDCT and Tu-Graz. The functionalities and interfaces of the final version of those prototypes were evaluated and all the items of the Feedback Report given in full in the annex of 6.4.3 *Final Evaluation of the prototype for user-centred design* were checked.

A final record of results and dissemination was included in the deliverable 6.4.3 which was prepared jointly between FPING and ANET.

During the third year, same as in previous years, within the **Task 6.3. Evaluation of individual parts of BrainAble** several studies have been carried out. FPING has been mainly involved in the implementation of four different studies. Some of the studies had already started in the second year. The studies were the following:

- The first one was the *long-term P300 study*, after the results of the first year's study of P300 performance, a long-term study was agreed with G.TEC during the second year in order to assess accuracy and performance within a sequential number of sessions of P300 BCI with individuals with motor impairments.
- The second study was the *BNCI navigation control of avatar in BrainAble virtual environment*, this was designed with UPF during the first year, however due to several reasons the study was postponed until the last year. The objective of this study was to test usability of the BCI for navigation in disabled people and compare it to other, commercially available, assistive technology (i.e. The Grid 2, http://www.sensorysoftware.com/thegrid2.html).
- The third one was the *input study*. This study was planned to compare the different inputs in the BrainAble prototype in terms of accuracy and timing. A protocol was developed to compare the input signals. This was done with G.TEC.
- The last study was *ERD + Hex-o-Select*, this study was implemented together with TU-Graz. The objective was to investigate whether individuals with severe motor disabilities could attain 2-class ERD BCI control.

All the studies have been described in D6.3 *Evaluation of the individual components of BrainAble system*.

In addition, FPING worked in the **Task 6.5. Cognitive tasks and mastering BNCI**. The main objective of this task was to determine whether the different cognitive profile of patients with Brain Injury has an effect on the P300 BCI performance. To meet this objective, a study was designed and implemented during this final year. The deliverable D6.5 *Cognitive tasks and mastering BNCI* deeper describes the study.

OBJECTIVES FOLLOW-UP

Objective 6.1: "Establish ethical and practical framework for user involvement in project"

The BrainAble project's ethical framework drew upon current literature in the neuro-ethical debate, as well as conforming to the WMA Helsinki Declaration and other ethical guidance produced to aid researchers in ICT projects such as the EU's own ETICA and EGAIS projects and the general funding programme ethical guidelines on 'sensitive areas' of which 'implants and wearable computing' is one.

A subsequent review by the Future BNCI project of the programme of which BrainAble is a part has generated further guidelines drawing on more recent BCI and BNCI research and development. Both partners FPING and ANET directly obtained ethical consent from relevant authorities for their testing sites and practices, ANET from the UK National Research Committee and Guttmann from its own hospital ethics board.

Deliverables D6.1 *Medical requirements in motor disabilities scenarios* and D6.2 *Identification of potential user groups and validation specifications* were produced in the first year of the project to meet this objective as well and included exclusion and inclusion criteria, descriptions of consent forms and specific ethical issues. The International Classification of Functioning, Disability and Health (ICF) was used to build this practical framework for user testing in the project.

ANET produced significant material by March 2012: the participant information sheets produced for participants and other information to ensure potential participants were able to make an informed choice about participating in research in line with UK NHS ethical practice (those materials have been annexed in D6.4.3 *Final report on the Evaluation of the prototype for user-centred design*). A communication aid called 'speakbook' was also produced to enable participants with communication difficulties to gain more information during the recruitment and consent process. At the occasion of the project workshop, a final outcome was to give a paper at RAatE on ethical issues in the project from a UK perspective on the UK ethical review process.

Objective 6.2: "Evaluation and validation of the BrainAble prototype using a number of focused studies involving specific groups of patients"

Relating the UK site, the evaluation of the BrainAble prototype took place in with up to 8 disabled people with conditions of neurological origins (including MND, MS, Parkinsons and TBI) and 10 non-disabled people over 3 periods of testing from November 2011 – January 2012 and from late May 2012 to July 2012 and for a week in late November. In line with reviewers recommendations partner Guttmann also tested the 2nd prototype with a total of 7 patients with tetraparesia or tetraplegia from neurologic origin (TBI, MS, Guillain-Barre, SCI). Testing involved qualitative data collection on people's views of aspects of the system and measurements of specific tasks and specific system testing such as P300 classifier building and time taken to complete a preset number of selections using different inputs including BCI and which involved a set shared protocol.

In total, sixty-nine motor impaired participants have given written consent to participate in the different studies involving the evaluation and validation of the BrainAble prototype conducted both by ANET and FPING during 2012.

In this third year, the different studies (within tasks 6.3, 6.4 and 6.5) served to investigate the different components of the BrainAble prototype with specific groups of participants. Figure shows the studies and testing carried out during 2012.

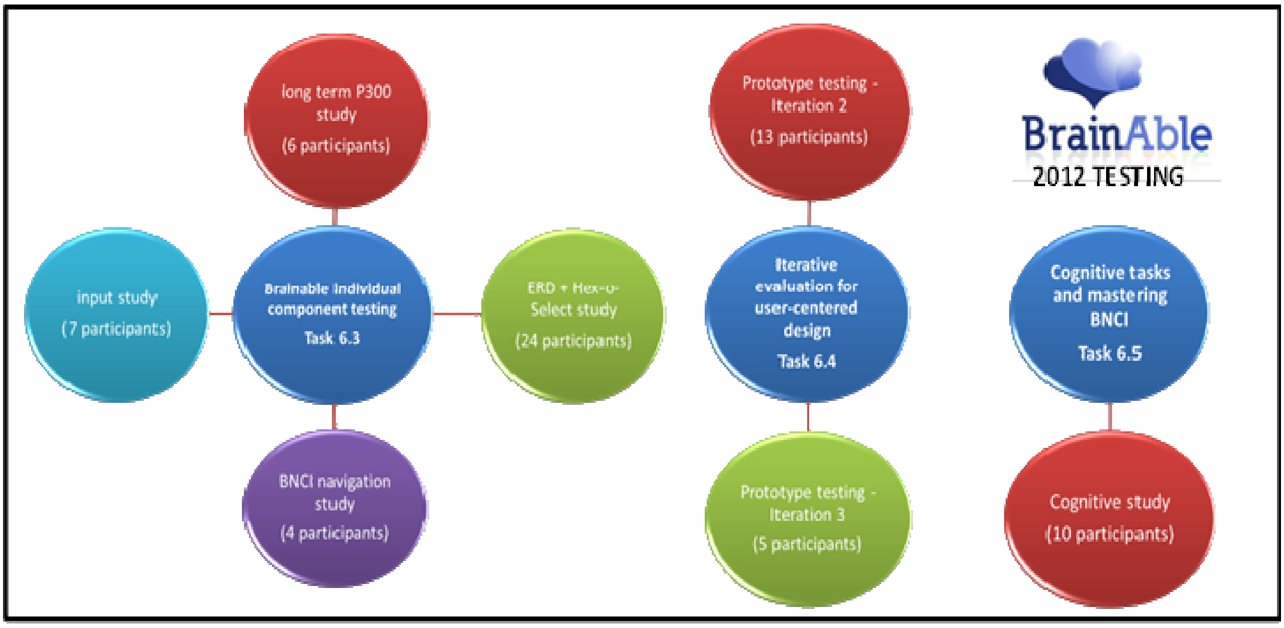


Figure 18: Detail of all the user testing of the BrainAble project in 2012

Objective 6.3: "Provide a Feedback about user experience and product effectiveness into the product cycle"

Feedback was provided through a variety of channels including through formal deliverable reports which included 6.4.1 (Dec 2011) and 6.4.2 (Feb-March) and included meetings, teleconferences, email and a shared spreadsheet which went through 24 draft states before finalization. Feedback included researcher observations and responses from the disabled and non-disabled people when engaged with the system. These participant evaluations were all collated into the spreadsheet which was included in the final report of all cycles of user testing 6.4.3.

Objective 6.4: "Create written and multimedia reports expressing user evaluation and testing to meet the needs of various stakeholders"

Two versions of the Evaluation Report were produced in early 2011 and during and after testing of the second prototype a spreadsheet of responses from all participants in both testing locations (FPING and ANET) was circulated between developers and partners to document changes to the system and potential directions for the prototype until incremental changes were finalised into a final prototype.

This final prototype was tested by one patient in Spain and by 4 in the UK. Measures and results were shared by direct involvement in the testing by G.TEC, BDCT and TU-Graz and were finally documented in a final version of 6.4.3 submitted in January 2013. Video and recordings of testing have also been shared in meetings and are available to the reviewers on-line.

Objective 6.5: "Compare and contrast impact of BCI product against traditional forms of assistive technologies to identify added value"

In the second iteration of testing a protocol was devised that was based on a set number of selections and participants were requested to make these selections with different inputs which included a Wii, EMG, EOG and ordinary mouse. Different BCI user interfaces were also compared, namely the matrix and Hex-O-Select interface. This enabled some comparisons and enabled us to obtain respondents views on the inputs but also to look at incorporating different inputs into the BrainAble prototype that could allow users to switch between inputs if required.

Formal evaluations of different kinds of headset have also been carried out at TuGraz with the emotive headset and showed that the BrainAble cap and set up was better. Developments in Eyegaze continued to be tested, and one of the participants in the UK observed that it had not worked for him whereas BCI had. Future development of BrainAble may include facility to incorporate and use other assistive technologies such as The Grid, a set of customisable grids and on-screen keyboards.

The BNCI navigation study (D6.3 *Evaluation of the individual components of BrainAble system*) precisely compares a BCI product against a commercial AT such as The Grid 2 (http://www.sensorysoftware.com/thegrid2.html).

Objective 6.6 "Identify further research required"

Areas of future research have been identified and include those that have potential ethical issues such as possible side effects from prolonged use of BCI systems and useful further developments to the system. Most users did not like the headset and gel electrodes and research into dry electrodes and wireless systems is required as well as research into how a device such as BrainAble is effected by being in a home rather than a controlled environment such as those in the BrainAble study.

This includes the effects of ventilators and other electrical devices and patterns of use of computer systems by participants who were found to like music or the TV on and to eat or talk when using the computer. Adaptive P300 was a promising development that mitigated one of the participant criticisms of the system being too slow and the input rate when using the speller to be too slow.

The adaptive BNCI enabled the system to change without intervention when P300 signals were strong so that the flash count was reduced. In addition research into using the BrainAble inputs combined with familiar or existing user interfaces such as the Grid Software would enable users to take advantage of features that were already developed such as word prediction and high levels of customisation and may improve overall rates of input and usability.

3.II.7 WP7: Service design, exploitation and dissemination

During the three years of BrainAble project implementation, a high number of dissemination activities have been undertaken by the entire Consortium. These activities included more than **thirty participations in national and international events** in areas related to Neuroscience, BCI, Ambient Assisted Living, Artificial Intelligence, Assistive Technologies, among others. Also, several project presentations were made, announcing the project to various key groups, mainly companies.

More **than 17 peer-review published results,** such as scientific papers and book articles, cited the BrainAble project.

In 2011, BrainAble was also present in the **1st edition of the Innovation Convention**, event organized by the European Commission in Brussels. A record of these activities was kept, and later summarized in the Dissemination Report of the Project's 2nd year (deliverable D7.2 *Dissemination Report year 2*). The project consortium was also invited to present results at the occasion of the **Conference on accessibility and participation** organised by the Danish Presidency of the Council of the European Union in cooperation with the **European Commission** on March 2012. The project form part of the main exhibit space built to show inspirational, technical and educational examples in the areas of accessibility and participation. BrainAble's booth, managed by Mr. Felip Miralles (project coordinator) and Mr. Juan M. Fernández both from Barcelona Digital, displayed Year 2 prototype and captured the attention and interest of most participants in the Conference, which were most important European stakeholders in the accessibility and disability arena.

Awareness rising of the BrainAble project with relevant stakeholders and general public was performed, following the actions defined in the Sponsoring Programme and Clustering Programme (see D7.7 *Sponsoring programme* and D7.8 *Project Cluster with sibling projects*). The BrainAble project has been highlighted in several TV showcasts as for instance in the satellite channel of Euronews, the main Spanish and Catalan TV channels (RTVE and TV3 respectively) and publications as Newsmedical, South China morning post, RTI magazine among others.

Last, but not least, the project consortium has significantly contributed to the **BNCI roadmap** issued by Future BNCI project on January 2012.

An initial analysis of the project-wide exploitation strategies was undertaken during the second year (see D7.4 *Intermediate Exploitation Plan*) in order to achieve an effective exploitation of the BrainAble project outcomes, and achieve proper social return of the investment in it. In the last year of the project implementation, the entire consortium worked in a more concrete exploitation plan much more quantitatively oriented, with projections for the main identified market segments per geographical region. As per result, a clear and quantified statement on use of results for each beneficiary was provided in D7.5 *Final Exploitation Plan*.

OBJECTIVES FOLLOW-UP

Objective 7.1: Prepare the rules for the management of IPRs and all other related property and knowledge issues, and fix them in a CA.

After the negotiation process, all the project beneficiaries signed, before the starting date of the project, a Consortium Agreement.

The signed agreement, based on DESCA model, established clear processes and responsibilities on governance structure but also, clear conditions on Access Rights to Foreground *for use* based on fair and reasonable conditions approach.

Relating to the access rights to Foreground, Background and Sideground *needed for the performance of the own work* of any party under the Project, provisions were on a royalty-free basis.

In Year 3 of the project implementation, partner METICUBE fail in bankruptcy. This unfortunate even, comes to set up that, some "protection" measures implemented in the CA as for instance the **special clauses on software access rights** (restricted to *Limited Source Code* Access, which in practice results in *Object Code* access), might result not only in the loss of a precious means to sort out the termination of a beneficiary contribution but essential tool to achieve integration processes without the need of additional effort for the developers in generating code already available. However, we strongly believe that, the disadvantages in terms of potential loss of Knowledge must not outweigh such potential benefits. This is the necessary approach to guarantee partners individual interests allowing proper collaboration dynamics.

According to what was defined in the Consortium Agreement, all partners, under supervision of the Coordinator, have been continuously monitoring the project's developments and evaluating their patentability and sensitivity regarding confidentiality and IPRs.

Objective 7.2: Disseminate the project efficiently and effectively, in the scientific community, healthcare, among the brain injured user community and industry.

An essential part of the project success was to efficiently and effectively disseminate the achieved results to researchers and therapists, among others, within and outside of the BrainAble network. Beside this, a major target of the project dissemination strategies was also to enable knowledge about the developed tools to the group of potential users (Task 7.3: Coordination and execution of the dissemination activities). During the whole period of the BrainAble project several activities were carried out and a large number of overview and specialised research-based presentations and publications were made by the entire consortium. The following graphic gives an overview about all publications with Framework Programme 7 (FP7) acknowledgment, produced within the whole project period.

Ten Journal Papers, 7 Books/Book Chapters, 25 Conference Papers, 19 Scientific Presentations and 21 Posters presented scientific achievements reached within the scope of the BrainAble project. The above numbers do not include papers that were submitted to journals/conferences and are currently under review. In addition the BrainAble consortium gave numerous presentations (conferences, workshops and congresses) announcing the project to various key groups in the scientific community and industry but also to healthcare and potential users. More details about the scientific dissemination and activities can be found in the deliverables D7.1 (by January 2011), D7.2 (by December 2011) and in the Final Dissemination Report (D7.3, by December 2012; M.9) or on the BrainAble web page (www.BrainAble.org).

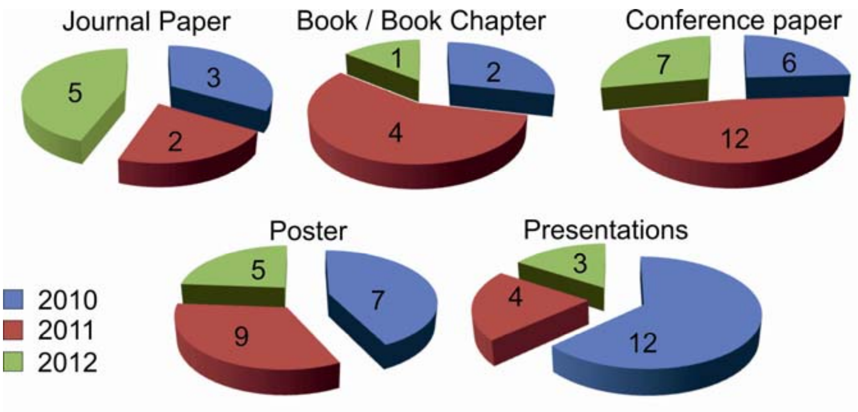


Figure 19: Overview of all published results and presentations during the whole project period

In order to reach a general proper visibility for the project, dissemination supported by mass media actions was used (newspapers, magazine article and eNews as well as project videos at YouTube and a Facebook representation; http://www.facebook.com/BrainAble).

In March 2012, the project form part of the main exhibit space in the **Conference on accessibility and participation** organised by the Danish Presidency of the Council of the European Union in cooperation with the European Commission. BrainAble's booth, managed by BDCT, displayed Year 2 prototype and captured the attention and interest of most participants in the Conference, which were most important European stakeholders in the accessibility and disability arena.

To enable knowledge about the developed tools to the group of potential users the BrainAble project was also present on special events, e.g. the **RAatE 2012**, which is the biggest UK conference focusing on the latest innovations in Assistive Technology. In the course of the conference the final prototype was presented to the general public. The BrainAble project consortium presented findings and developments from the research project (Figure 7) and showed the demonstrator of the BrainAble prototype. The BrainAble final prototype was running in the Exhibition Hall throughout the day (Figure 8). Multiple approaches were explored (e.g. ERD BNCI and P300 interface) in different demonstrations to control the services available in the prototype. The project organised a **workshop** during the afternoon session: *"Developing BNCI as an Assistive Technology Workshop BNCI Project"*. The project workshop introduced the audience to the BrainAble project, the EEG and ERD/s based BCIs -hybrid BCIs (slot conducted by Josef Faller from the Technical University of Graz, Austria), the BCI side of BrainAble prototype (G.TEC), the Ambient Intelligence, smart home control, social services and virtual reality (BDCT) and the iterations of users' testing and validation processes (ANET).

Figure 20: BrainAble exhibition space at the RAatE 2012

Figure 21: BrainAble final prototype showcast

Through the actions defined in deliverable D7.7 *Sponsoring Programme*, a network of Project Sponsors was set up (Task 7.4). The BrainAble project has greatly benefited during its implementation from the support of three companies (Telegesis, Netvox Technology Co. Ltd, and TEMCO CONTROLS Ltd). These Sponsors contributed to the project with hardware components which have been used in the research and development phase.

In accordance to activities defined in D7.8 (Clustering Programme) the BrainAble project was part of the BNCI FP7 cluster. Within the scope of clustering, BrainAble collaborated with ABC (EU project, 2011-2014; http://www.abc-project.eu/), BackHome (EU project, 2012-2015; http://www.backhome-fp7.eu/) and Tobi (EU project, 2008-2012; http://www.tobi-project.org/) to use synergies.

Objective 7.3: Study and conceive a feasible Exploitation Plan, including the research on patentability.

In the last twelve months of the project implementation, the entire consortium worked in a more concrete exploitation plan much more quantitatively oriented, with projections for the main identified market segments per geographical region. As per result, a clear and quantified statement on use of results for each beneficiary was provided in D7.5 *Final Exploitation Plan*.

The document lists possible exploitable products, details competitor analysis (BCI, assistive technology, smart home technologies), market size, pricing, sales forecast, distribution channels and a list of possible customers for Austria, Bavaria, Catalonia and the United Kingdom.

To explore ways to be anticipated in D7.5 further submitted, in October 2012, the project Coordinator assisted to the 2nd International Workshop on Exploitation of R&D results in the 7FP organised by Fit for Health. Among the networking activity carried out, interesting contact were made with venture capitalists.

At the time of this document submission**, 1 patent** and **2 Trademarks** are under application from **partner G.TEC.** The processes being at the priority fillings stage, no details are available.

4 Project management during the period

4.1. Management and coordination objectives and achievements

The objectives of the BrainAble project from a management perspective have been:

- ✓ Consolidation and enhancement of the **shared goal** within the different Consortium members.
- ✓ Maintenance of a **communication structure** able to combine the needs of daily work with long-term considerations, and adapted to the diverse work cultures within the Consortium.
- ✓ Promotion of an **efficient decision making process**, providing the appropriate decision makers with the required information at the appropriate time.
- ✓ Consolidation of the **project structure and roles within the Consortium**.
- ✓ Revision and upgrade of **management procedures** that will ensure efficient execution, including timely availability of deliverables and milestones assessment.
- ✓ **Timely administrative and financial management**

As described in the previous Periodic Reports, main managerial activities during the project implementation focused on a substantial amount of communication actions across the consortium, on the bringing together of different project strands, on the detailed definition of the joint RTD efforts within each of the technologies involved, and on the creation and the maintaining of the synergies among all the participants. The work was predominantly to maintain clearly this common ground, but also to enthuse partners about the work towards this **shared objective -** the consolidation of the BrainAble TEAM, bring huge benefit and significantly contribute to project success.

Because the project good dynamics were yet running, the major objective for Period 3 has been the settlement of an **efficient and continuous communication process** among all Consortium members. This communication has been carefully planned, and intensively monitored, and set-up tools were properly updated and maintained (shared workspace, email distribution lists, standardised messages of meeting notices, agendas and minutes distribution, intended publications, etc.) allowing transparent access to all relevant information and documentation of the project. Also in the dialog on purely technical issues and in the work with users, the Consortium succeeded in a **useful integration of the feedback received from the users in the development process** through continuous communication between the technological and end-users partners. The PMO, in addition, represented the Consortium and was in charge **of the liaison with the Project Officer** to ensure fluent and transparent project monitoring.

As a third key issue, the interrelations existing within the project mean that many decisions cannot be taken within a limited context but must consider the whole extent and duration of the project exploitability. Resources are however limited, making an **efficient decision making process** imperative in order to keep the project on track. The **definition of roles and project structure** while the start-up of the project has been key to sort out unexpected situations as the **bankruptcy of one of the partners has been**.

The **administrative and financial** workload in a Consortium should not be underestimated. Tasks such as budget planning and monitoring have been significantly management-intensive, especially in a consortium where some partners had only basic knowledge in the FP7 funding Programme.

As mentioned in previous Periodic reports, the progress of the project have generated excitement within the consortium, but they have also attracted the **attention of external stakeholders** as we were able to notice for example in the *Conference on accessibility and participation* (organised by the Danish Presidency of the Council or the European Union in cooperation with the European Commission) where BrainAble was invited. Combining efforts in management, exploitation and dissemination tasks has produced outstanding quantifiable results, like for instance **the high visibility of the project.**

One week before the submission of this document, the project has been invited to present results at the occasion of the *European Brain Research: Successes and Next Challenges* organised by the European Commission. The conference will see the participation of leaders in brain research and healthcare from around the globe, including industry and patient representatives, scientists and policymakers. This event is scheduled by the 14th of May 2013 in Brussels.

4.2. Project Structure

According with the DoW, the project maintained the structure shown in the diagram:

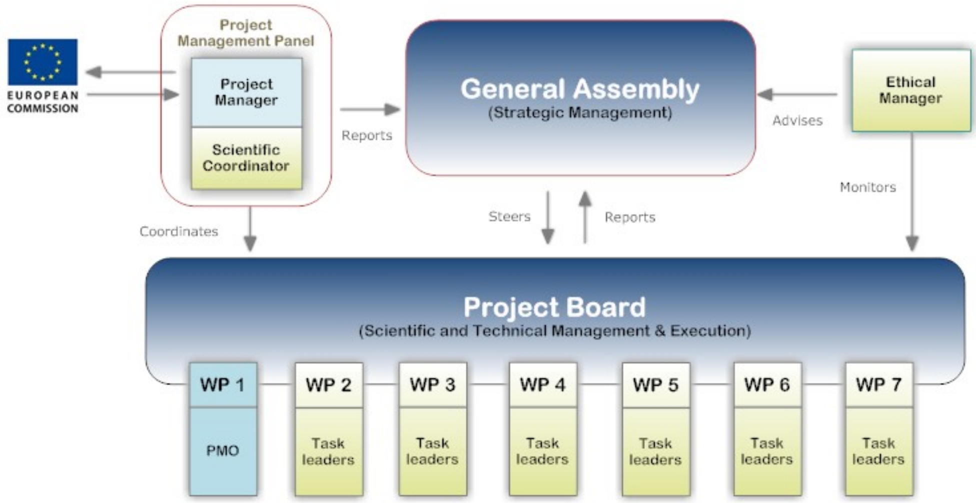
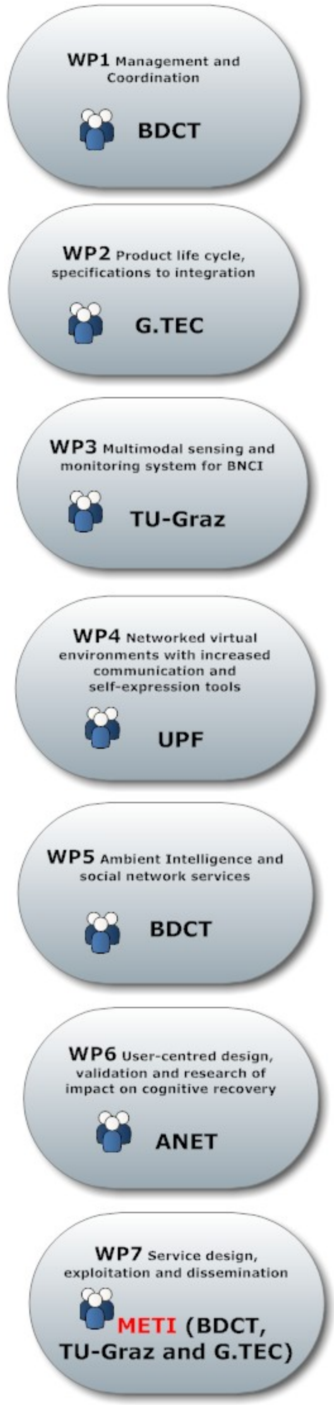


Figure 22: BrainAble project organisational structure



The overall and scientific coordination responsibility lies in the hands of the **Coordinator**, Felip Miralles, member of the project coordinator institution, BDCT. He chaired the General Assembly (GA) and is the executive director of the Work Packages Leaders Group (Project Board). The Coordinator steered the scientific work performed in the Project in order to ensure that the results achieved were of the maximum quality possible in scientific terms and are compliant with the objectives set for the Project. He was supported by the **Project Manager** responsible for the aspects relative to financial management and operational coordination and main liaison with the European Commission for the project.

The **General Assembly (GA)** has been the **highest authority** of the Project, mainly responsible for the overall review of the project progress, its resources and for decisions that affect its overall strategy and development and that may lead to contract amendments or modifications of plans that have impact on all the consortium, such as changes in the implementation plan, project scope and/or resource allocation between WPs and evolution of the partnership composition. Each partner is represented and has an equal vote.

The **Project Board (PB),** led by the Coordinator is composed of the Work Package Leaders and one representative of Medical Tasks in WP6 (FPING) has maintained executive decision-making power, supervised and conducted the execution of the implementation plan, as well as of any action approved by the GA, and solved any issue that does not require GA approval, as for instance the **resignation of partner METICUBE** was.

WPs Leaders are shown in the side figure.

This organisational structure has been indeed effective and has proven operability.
The failure of partner METICUBE by the second semester of 2012 has been efficiently dealt.

4.3. Beneficiaries / changes. Modifications in the Grant Agreement

Relating to G.A. modifications, during P3 a unique formal assessment took place: dated on 12th of December 2011, the Coordinator presented **an amendment (#2)** to the Grant Agreement due to the modification of **partner G.TEC legal name change** with date of effect April 2nd, 2010. **On January 26th 2012,** the **Commission agreed** to the request and the revised Part A.1 (overall budget breakdown for the project), A.2, A.3 and Part B1, B2, B3, B4, B5 (tables) of Annex I dated 12 December 2011 replaced any former version.

A critical issue rose during 2012: one of the project beneficiaries, **partner nº4 METICUBE**, experienced financial troubles during the summer period which collapsed in a **bankruptcy declaration by ~September 2012.**

Contingency measures were taken by the Coordinator in close liaison with the WP leaders to ensure proper hand-over of S&T aspects to minimise the impact of this unfortunate situation. The Coordinator also kept the EC Project Officer and financial services timely informed.

Earlier than the past week, the European Commission needed to go for an official declaration to be registered on the creditors' list. By registered letter dated February 1st, 2013, the European Commission has notified to METICUBE the decision to **terminate its participation in the Grant Agreement** relating to BrainAble project. This decision was taken with retro-active effect from 14/09/2012. As per EC request, BDCT as Coordinator has duly provided written statement on the EC financial contribution effectively transferred to METICUBE from the start of the project.

For the above mentioned reasons, partner METICUBE, currently under tutelage of an Insolvency Manager nominated by the Portuguese Administration, seemed not to be able to provide cost statement relating to Period 3. However, since the EC has formally terminated METICUBE participation, in case the tutelage manager proceeds as requested by the Commission -i.e. presenting through the Coordinator the justification of costs for Period-3- its subsequent assessment shall be treated separately from the cost claim of the Consortium.

Administrative and financial matters issued from partner METICUBE failure currently under the control of the European Commission services.

4.4. Project meetings

At the beginning of the project, the PMO scheduled and distributed to the partners a complete list of project regular meetings for the three years of the project duration. All the scheduled meetings for 2012 took place essentially as originally scheduled. The only exception was the Project Board meeting in September which was initially planned to be held by partner METI. This partner was not able to provide contribution to the project due to financial troubles described before that resulted in a bankruptcy declaration. BDCT took the responsibility of hosting this meeting.

Agendas were distributed at least 15 days before the meetings dates. Slots and sessions were detailed by specific responsible person who was in charge of a visual presentation (.ppt format). After meetings held, the Project Manager distributed preliminary minutes for the revision of the attendees together with the full presentations package. One week later and after revision, the final version of minutes with detailed actions list were timely generated.

In 2012, the most relevant meetings are listed below (face-to-face meetings were complemented with regular teleconferences):

- **General Assembly** (**GA3**, 16-17th February 2012, Barcelona, Spain): Third General Assembly of the project devoted to the second year outcomes internal appraisal and on the last year plans of the project execution with special focus on the prototyping outcomes and plans for the 2nd iteration testing, financial reporting and the preparation for the EC Review. Eleven (11) concrete actions were scheduled for the following 30 days .

- Project Board pre-review **(PB9,** 12th March 2012, Barcelona, Spain). Regular WP leaders meeting on overview of execution of the implementation plan, review and schedule of deliverables work and global discussion and assessment of the individual WPs activities. The meeting focused on the preparation of the EC Review for Period-2 and the internal appraisal of P2 implementation.
- **EC Review** (**REV-2**, 13th March 2012, Barcelona, Spain): **Review of second year implementation** (Jan-Dec 2011) of BrainAble project in particular to verify: the degree of fulfilment of the project work plan for the 2nd period and of the related deliverables, the expected potential impact in scientific, technologic, economic, competitive and social terms, and the plans for the use and dissemination of foreground and the assessment of the costs incurred by the beneficiaries during the period. The Review was conducted by Jan Komárek (EC Project Officer) assisted by three external reviewers. The full consortium was represented (a representative per WP plus FPING as clinical partner of WP6). Promoted by the EC and Reviewers and **updated work plan** was issued from the Review.
- **Plenary Technical teleconference** (**all the partners,** 3rd May 2012,) Post-review meeting devoted to final concrete plans set-up following the EC report issued from the Review process, specially those involving the delivering and installing of two full prototypes to ANET and FPING for the implementation of revised plans (also plans for resubmission of Deliverable D5.5): an unique additional iteration covering both aspects of the workplan foreseen: user's feedback requirements and validation on the basis of testing Y2P and incorporating changes and improvements into the Final prototype to be released at the end of the project.
- **Project Board** (**PB10**, teleconference 26th June 2012): regular WP leaders meeting on overview of execution of the implementation, review and schedule of deliverables work and global discussion and assessment of the individual WPs activities. The meeting focused on immediate plans towards 2nd prototype testing and interaction with developers as well as on the final workshop of the project, RAatE event was proposed as possible framework. The Project Manager presented the format, calendar and goals of the last intermediary financial report, aimed to the early check of financial plans and doubts solving.
- **Project Board** (**PB11**, 17-18 September 2012, Barcelona): Initially planned to be held by partner METI in Portugal, the meeting took place in Barcelona. As per its critical financial situation partner **METI was not able to attend, noticed formal resignation as WP7 Leader and anticipated that no further contribution would be expected from them due to financial constraints.**

  As per these last minute news, BDCT as coordinator took the responsibility for this leadership for the PB. The regular WP leaders meeting was initially aimed on perform overview of execution of the implementation plan towards Milestone 3 (BrainAble Y2P prototype users-developers iteration towards the final one), review and schedule of deliverables work and global discussion and assessment of the individual WPs activities. As per METI reversal news, the WP Leaders fixed actions to sort out the situation, mainly in the **pending WP7 tasks and outputs**. The Project Manager identified "available" budget and a **shift of responsibilities between BDCT, G.TEC and TU-Graz was decided.**

  The meeting served also to present expected contribution to the final workshop of the project in the framework of RAatE 2012 (Coventry, UK, November).
- **Final Plenary meeting (GA4-PB12,** 10-11th December 2012, Barcelona, Spain): 4th General Assembly and final WP leaders meeting on overview of execution of the implementation, review and schedule of deliverables work and global discussion and assessment of the individual WPs activities. The meeting focused on immediate plans and next steps for the assessment of final milestones of the project (User-centred design final iteration and DUP and final dissemination report). Concrete actions were scheduled to ensure timely release of the several technologies to be integrated and clear timeline for the releasing of the due deliverables.

All meetings have been organised and conducted in an executive way and the partners participated in a highly collaborative, constructive manner. These facts, added to the full consortium responsive attitude have indeed mitigated the impact of partner METI's failure

4.5. Corporate communication material

To provide a better and simpler understanding of the project's goals, reached results and undergoing activities, a description of BrainAble's Year 2 Prototype was made by the Coordinator in the form of **two videos**.

The first release, available for viewing on YouTube and embedded in the project's website since the end of May 2012, is 12'07'' long, with English audio and subtitles.

The second one, a shorter version, made public on the 10th September 2012, is 4'44'' long, also with English audio and subtitles.

YouTube provides a view counter for videos. By the 6th of February of 2013 and since its publication, the first released video **had already reached 690 views**, which means more than 80 views per month.

Video links: http://www.youtube.com/watch?v=P-UOxm0raYk

http://www.youtube.com/watch?v=Xsz0APmLzdQ

The video was recorded in CDs so that the project partners can distribute them if suitable in project presentations.

Figure 23: BrainAble Y2P video screenshot

BrainAble continues to attract the attention of the European Commission, who has invited the project to participate in the European Brain Research Conference (May 2013)

4.6. Mailing lists

Daily communication is heavily supported by e-mail. A comprehensive structure **and contact database was** created and has been continuously updated to guarantee that all relevant participants in each specific activity are appropriately informed of progress.

				@BrainAble.org									
BrainAble contacts		NAME, Surname	email	GA	PB	PMO	Admin_staff	WP2	WP3	WP4	WP5	WP6	all
bdigital	01 BDCT	**MIRALLES, Felip**	fmiralles@bdigital.org	X	X	X		X					X
		SANCHEZ, Maria	msanchez@bdigital.org	X	X	X	X					X	X
		CASALE, Pierluigi	plcasale@bdigital.org					X			X		X
		CECCARONI, Luigi	lceccaroni@bdigital.org										X
		FERNANDEZ, Juan Manuel	jmfernandez@bdigital.org					X			X		X
		TORRELLAS, Sergi	storrellas@bdigital.org		X			X		X	X		X
		VELICKOSVKI, Filip	fvelickovski@bdigital.org								X		X

From the very beginning of the project implementation, e-mail distributions were created to facilitate grouping communication. The Project Manager continued supervising and promoting its usage during the third period as well as doing the maintenance of the recipients.

Up to four versions of the contacts database and emailing have been generated during 2012; the main changes due to the staff rotation.

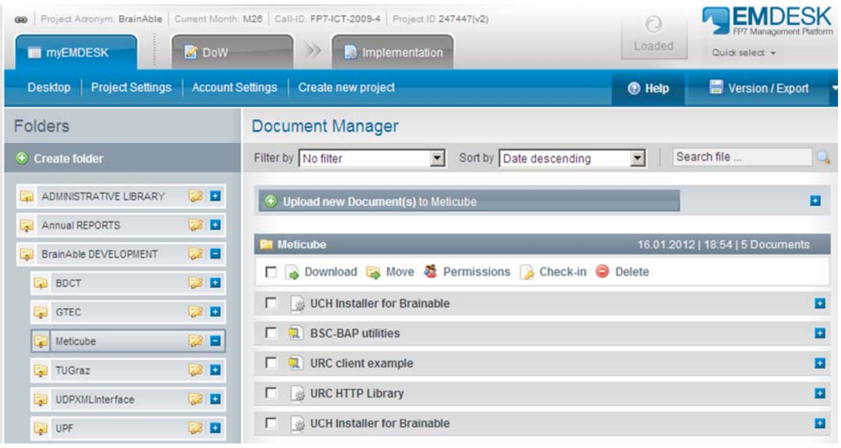
Everything worked well.

4.7. Shared online workspace

For the daily work a virtual shared workspace was implemented on March'10 using the Emdesk® platform.

During the project implementation the main use of the internal website has been as a shared documents repository, allowing transparent access to all relevant information.

After a negotiation with the supplier, the Management team succeeded in the implementation of new release on the second semester of 2011 providing a significant improvement with the inclusion a **restricted space devoted to the developers for the stock and exchange of software code.**



The space allowed an easy and secure communication between developers **via emailing groups**. Any modification in the folders or files is automatically sent to the involved developers for information.

Figure 24: Intranet "Developers area" screenshot

Though the EMDESK tool is not particularly adapted to the detailed project management implemented in BrainAble, the new feature for stock and exchange of software code was highly beneficial for collaboration.

4.8. Project website

The official project web site **www.BrainAble.org**, launched in March'10, is managed by the Project Manager. It is the most up-to-date and complete reference for the project related public information.

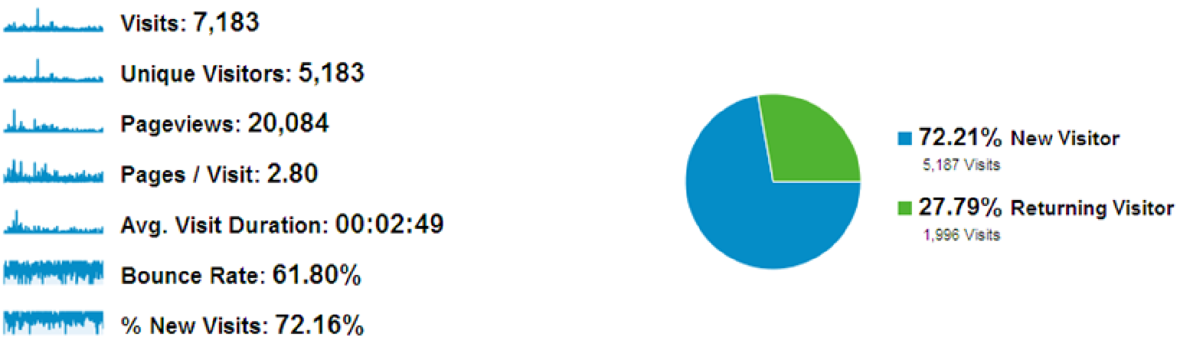
Partners contributed latest material, made reference to it on their public communications, and provided the Project Manager with news and latest facts such as complete information (date, place, media, source or reference, purpose, contents etc.) on publications, press releases, public communication, and presentations and similar.

The website has continued developing during this reporting period of the project to increase the amount of information included and therefore its role as a communication tool.

This developmental work has focused in particular on the expansion of content for the **news, dissemination materials, events** and the **refresh of the Home page** (including the videos with 2012 prototype results) and Consortium pages.

During the three years of the project implementation, the BrainAble website has collected, published and stored 32 detailed news with links to additional information sites, 95 interesting conferences and R&D *fora* briefly described, 24 press releases highlighting the project outcomes, and 22 publications issued from the project (which can be downloaded in PDF format).

Website statistics are being retrieved since May 2011. These statistics show, until January 31th, of 2013, that www.BrainAble.org **has received 7.183 visits**, more than 350 visits per month, since the service subscription.



Two major averages: time on site, ~3’’, and ~3 pages visited. Those seem to be good indicators of the website success. A three minute stay on a website is a long time for most scientific webs indicating that something is interesting general public. Unfortunately we have not yet been able to extract from the analytics why some pages apart from the Home page get most of the traffic (e.g. News). Still, this at least tells us what is of interest in our site. Using the website analytics and monitoring performance provide us with very valuable information enabling us **to ensure the project and the European Commission R&D programmes visibility and awareness** by making decisions based on statistics and measurements rather than intuition and guesswork.

Last but not least, from November'11, the website incorporates a **restricted area** devoted to the **EC Project Officer and Reviewers**. This secured space (protected by individual password) allows the Project Reviewers to timely access and download the project documentation to be reviewed: Deliverables for past and current periods, Annex I DoW, information about the Review venue, etc.

The project web site contents were frequently updated.

4.9. Conflict resolution and Risks Assessment

The good communication avoided conflict of interest. **No major disruption by conflicts of interest happened during 2012.** It is understood that they can be avoided through coordination of actions at all levels and in all areas of the project. By doing so, consensuses were reached at early stages.

An emergency procedure was detailed on Deliverable D1.1[1]: any event which shall jeopardise the overall completion date of the Project should be reported immediately to the Coordinator via the PMO. The Project Coordinator will endeavour to resolve the issue and may call an emergency Project Board or conference call.

Central to effective project management it is the active maintenance of a map of **project risks** together with a constantly-reviewed process of risk mitigation. The Coordinator-PMO had monitored to avoid risk situations and has scheduled meetings with the partners if necessary in order to mitigate potential conflicts and enable dialogue.

One unfortunate situation occurred during the third year of the project implementation: as explained in section 4.3, one of the project beneficiaries, **partner nº4 METICUBE**, experienced financial troubles during the summer period which collapsed in a **bankruptcy declaration by ~September'12.**
Contingency measures were taken by the Coordinator in close liaison with the WP leaders to ensure proper hand-over of S&T aspects to minimise the impact of this unfortunate situation. The Coordinator also kept the EC Project Officer and financial services timely informed.

[1] The Project Handbook (Deliverable D1.1) provided an overview of the management and administrative procedures designed to ensure efficient execution of the project and thus contribute to the production of **high quality project results**. This document covers administrative and technical project management, as well as the procedures for external communication, dissemination and exploitation.

Earlier than the past week, the European Commission needed to go for an official declaration to be registered on the creditors' list. By registered letter dated February 1st, 2013, the European Commission has notified to METICUBE the decision to **terminate its participation in the Grant Agreement** relating to BrainAble project. This decision was taken with retro-active effect from 14/09/2012. As per EC request, BDCT as Coordinator has duly provided written statement on the EC financial contribution effectively transferred to METICUBE from the start of the project.

The table below illustrates the **final status of the risk register,** with identified risk mitigation activities and the actions taken during the project implementation.

Identified Risks (description)	Mitigation actions
R.1.1: In the early stages of the project there is a higher risk of a delayed start-up due to possible staff recruitment, resource or communication problems.	The PMO checked allocated manpower is adequate and promoted an intermediary financial checked by PM06 and PM18. The communication structure was established as planned. ***RISK CLEARED***
R.1.2: Delay in the implementation or deployment of the necessary technologies emerging from other work packages.	Promotion of early establishment of communication between developers and integrators, and dynamic update of implementation and integration schedules were timely set-up. During the project implementation several **Technical Integration meetings took place.** Clear minutes and timelines were issued from those discussions. ***RISK CLEARED***
R.1.3: Consortium conflicts. Collaboration in a multidisciplinary team, spread all over Europe implies potential conflicts due to different approaches to work.	A precise definition of tasks, assignment of tasks based on competence and clear procedures on management and reporting have been set-up to avoid ambiguities and conflicts without overlaps in competence and responsibility. Also the commitment expressed by the partner and their agreement on the work plan and conditions are key for a smooth management. In case of conflicts, the Coordinator was expected to act as mediator and guide towards an acceptable solution. The Project Board (WP Leaders group) meet on **a quarterly basis to review and redesign when deemed necessary the tasks and workflow** for the next three months of the project implementation. ***RISK CLEARED***
R.1.4: Deficient or non-fulfilment of tasks by one or more partners	Useful clear and fair time limits for delivery of work were set; otherwise the Consortium Agreement (CA) foresees adequate consequences. The CA, signed before the start of the project and known to all partners also foresees provisions and contingencies in case of complete failure of delivery, withdrawal from a partner etc. ***BY PASSED***
R.1.5: Ethical or IPR risks	The consortium paid strong attention to all risks presented by the ethical, and legal/IPR implications emerged from the developments of BrainAble. It therefore was been tackled in the periodic reporting on WP level (Project Board meetings) and in the General Assembly. ***BY PASSED***

Identified Risks (description)	Mitigation actions
R.1.6: The integration of complex development performed by different partners throughout Europe implies a certain natural risks in order to actually get a complete and integrated system running, instead of insular solutions	The distribution of work already foresees a continuous surveillance on the development and integration of components and participation of all, but in particular the industrial partners in WP2 “from requirements to packaging”. To ensure coherence of work, the Project Board (WP Leaders group) meets on **a quarterly basis review and fixes workflow** for the next three months of the project implementation. After Year 2 Review, a workforce was jointly put in place to deploy a fully integrated Advanced Prototype (Y2P) in ANET and FPING and conduct a synchronized validation in both locations to collect feedback from end users and therapists targeted to improve usability, robustness and integration. This feedback was formally communicated to the development team and was key to get a fully integrated final Prototype. **Tutorial sessions on user testing requirements and forms** conducted by ANET and FPING were also held during the period of this gathering. ***IMPACT MITIGATED***
R.1.7: BrainAble strives for an actual boost in BCI technology, in integration with affective computing, VR and social networking throughout a user centred development. This certainly represents an innovative, multidisciplinary challenge with risks of failure.	The risk of not achieving the scientific and technological objectives of BrainAble exists but is reduced through the excellence and complimentarily of the partners, close cooperation and joint development and strict procedures for progress reporting and assessment. The Project Board (WP Leaders group) meets on **a quarterly basis review and fixes workflow** for the next three months of the project implementation. ***RISK CLEARED***
R.1.8. Staff rotation in the teams can result in project low performance and/or loss of knowledge	During Period-3 (2012) project implementation, **several of the teams involved in the project have experienced changes in their staff.** This has been the case for UPF-SPECS (Mr. Le Groux to Mr. Omedas) and G.TEC (Mrs Veronika Putz to Mr Espinosa) and indeed, the failure of partner METICUBE. **The Coordinator assisted by the Project Manager played essential role to help ensure the smooth transition** and handover organising bilateral meetings. The **internal communication tools and support documentation repositories well organised** (shared workspace) facilitated the quick awareness of new comers. In some of the cases, additional effort has needed to be provided for the reintegration to the project of some “lost” software code already existent which was no longer updateable. ***IMPACT MITIGATED***
R.2.1: Interfacing between different technologies must be defined correctly otherwise the data exchange will not work. Technologies must be available in time otherwise the prototype setup can not be done in time.	Design document for the interfacing have been defined (D2.1, D2.3 and D2.4). Technology developments were monitored carefully to have prototypes in time. Developments of interfacing technology of other European projects such as SM4all are monitored to solve the task successfully. The Project Board (WP Leaders group) meet on **a quarterly basis top review and redesign when deemed necessary the tasks and workflow** for the next three months of the project implementation. ***RISK CLEARED***

Identified Risks (description)	Mitigation actions
R.2.2. Delays in the integration and/or deployment of the prototype could potentially delay the user's validation processes and hence the whole workplan .	After Period 1, and due to the high ambitious requirements for prototype 1, both from the technical and the user perspective, the technological partners of the consortium took extra time in the final steps of the integration and deployment of a single solution and its installation in Liverpool for the 1st iteration process with the UK users lead by ANET. During the project Review of Period 2, the point was set up and the project consortium has been requested to submit clear plans on the integration of Y2P. Additionally, the contingency plan agreed by P.O. and the Reviewers will involve an unique additional iteration covering both aspects of the workplan foreseen: users' feedback requirements and validation on the basis of testing Y2P and incorporating changes and improvements into the Final prototype which was released at the end of the project. ***IMPACT MITIGATED***
R.3.1: The BCNI system does not work for all users.	To ensure that the BNCI system is reliable for different users, all three major concepts (P300, SSVEP and ERD) are integrated into the BrainAble system. Within the BCI field, research is seeking answers to how BCI works best and who it works best for. There are issues around whether it works at all for people who are in a completely locked in state and how it performs for people with different disabilities. BCI illiteracy is still not understood and current research is exploring physiological causes and also exploring psychosocial factors such as 'motivation', and 'self efficacy'. As described in Deliverable D6.4.1 and D6.4.3, BrainAble design methodology is therefore based on an approach that takes into consideration **not just how the prototype performs and measures of this but on gaining a broader understanding of our participant's based on both physiological and psychosocial factors**. The current critical steps are ensuring that this information is communicated to the developers/designers and that there can be shared discussion and interpretation between all parties perhaps aided with 'scenarios' and or 'personas'. We finally complete the loop by bringing the results of this joint effort back to the potential users of the system with a prototype that has visibly incorporated their feedback. ***RISK CLEARED***
R.3.2: "No effective way to use the signal acquired from the heart (HR), eyes (EOG), muscle (EMG) and skin in combination with a BCI is found." This risk is notably different from Risk 1 above for 2 reasons: it reflects only a failure of multisignal combination, and it focuses only on the combination of a BCI and another physiological signal.	As noted in section 1.2.2 of the DoW, one way to effectively combine BCI with HR was already found and validated in TU-Graz (Scherer et al., 2008). We see no obstacles to extending the approach validated in that study to practical tasks within BrainAble. However, it is possible that the combination of a BCI and another physiological signal will prove less effective than a BCI combined with another BCI. It would instead reflect a successful research outcome; we explored different hybrid BCI approaches and found the best one. In reality, we expect different results across subjects. One of the most consistent outcomes of any BCI research study is inconsistency; users show considerable inter-subject variability. This further underscores the importance of flexibility in deciding the best combination of signals for individual users. ***RISK CLEARED***

Identified Risks (description)	Mitigation actions
R.4.1. Low user acceptance and difficulties to use virtual environments by the target end user group	The user-centred prototyping of VR elements and environments and its early testing using control and patient groups in WP6 (tasks 6.1, 6.3 and 6.4) ensured its optimal design within BrainAble system for its usability in clinical and home environments. ***BY PASSED***
R.5.1: Availability of URC-enabled electronic devices suitable for BCI operation and adapted to the target user needs arisen from medical requirements analysis.	Joint analysis of medical and technological state of the art established a first draft of URC proven devices. Prototypes Y1P and Y2P already incorporated suitable URC-enabled electronic devices such us the Dreambox TV controller set and the d-link dcs-5220 IP surveillance camera. ***RISK CLEARED***
R.6.1: Though developed with best technology and intentions, high technology products and services can be rejected by users if the offered solution does not reflect the user's actual needs and is not user-friendly in learning and handling the tool.	User acceptance tests are planned through the lifetime of the project for early identification of both technical and personal barriers to uptake. **Deliverables D6.4.1, D6.4.2 and D6.4.3 report on these points.** Current critical steps **were ensuring that this information was communicated to the developers/designers** and that there was shared discussion and interpretation between all the actors. User acceptance was satisfactory in the validation process. ***RISK CLEARED***
R.6.2: Persons with disabilities unwilling to take part in trials	Users were identified with the support of representative organisations and associations to reduce the fear of involvement in trials. The recruitment processes made by ANET and FPING were successfully closed with a suitable number of volunteers and cases represented. ***RISK CLEARED***
R.6.3. Key staff unavailable for trials	Training programme for testing and trial procedure was developed to ensure that a span of team members is available to support the testing process. ***RISK CLEARED***
R.6.4. Levels of researcher intervention invalidate outcomes due to acquired dependency amongst users.	Repeated testing and longitudinal intervention is built into the study with a graduated process of reduction of researcher direction. ***RISK CLEARED***
NEW RISK IDENTIFIED R.6.5. Ethical Approval could potentially delay the work plan.	Despite the efforts made by the partner to speed up the process, **Abilitynet** needed to obtain ethical approval from a REC[2] prior to their user testing, as this is accepted practice for the **testing of CE marked medical devices on vulnerable persons**. The UK requires that research on human subjects and the use of medical devices must be reviewed by independent ethics committees that consider several issues. The Ethical Approval Process in the UK required extensive documentation for scrutiny

[2] Research Ethics Committee http://www.nres.npsa.nhs.uk/

Identified Risks (description)	Mitigation actions
	by the UK NHS Ethical Review Board with a board meeting of 16 members. However, partner previously gained guidance from the PEAK team[3] on this. Following the installation of Y1P, documents were prepared and submitted the account is created online in IRAS9F[4]. Finally, on the 9th of September 2011 the UK Ethical board called partner Abilitynet (represented by Clare Carmichael, *Ethics Manager*) for the review and assessment of the approval submission. Partner took advantage of this situation to initiate the recruitment process and upgrade processes and consent form according with the feedback obtained during the process. For the Y2P iteration ANET obtained updated permission in time. ***IMPACT MITIGATED***
R.7.1: Market uptake of a highly innovative product developed for a specific target group, such as the case in BrainAble, depends on numerous external factors.	Major concern for Period-3 (2012). Awareness and interest of 'early adopters' is one key aspect, which have been responded by the consortium through active communication, presentation and positioning in the market through the planned dissemination activities for scientific, industry and end-user audience. Another critical aspect for feasibility of exploitation was a forth looking strategic planning to identify and explore mainstream applications for a broader audience and therefore commercial target group. Exploitation planning, the detailed identification and assessment of such risks **have been surveyed and documented in WP7 and shall path the way to successful and sustainable exploitation. (see deliverable D7.5 and D7.6)** ***RISK CLEARED***
R.7.2: Project partners are retaining know-how developed / acquired in the scope of the project, in order to protect their individual IPRs.	The early agreed Consortium Agreement is very detailed and clear on specifying the rules of knowledge sharing and IPR. It settles clear rules for Access Rights to Foreground developed during the project for further use and exploitation activities of the partners together or individually. The Consortium Agreement is drafted in a spirit of fostering exploitation, promoting licensing and providing already by default fair and reasonable compensation to co-owners of IP. ***BY PASSED***
R.7.3: Productisation of the BrainAble system is not feasible in a short-term period that would allow for an immediate return-on-invest.	Major concern for Period-3 (2012). The Consortium monitored and evaluated the readiness of the addressed market(s) for absorbing a BrainAble product constantly along the whole project duration (D7.5 *Final Exploitation Plan* and D7.6 *Dissemination and Use Plan*). ***RISK CLEARED***
R.7.4: Sponsorship programme is not accepted in the desired scope.	During 2011 BrainAble project succeeded in the entry of three project sponsors (Netvox from Taiwan, Telegesis form U.K. and Temco Control from the U.S.A.) which become potential future strong allies. ***RISK CLEARED***

[3] Centre for Professional Ethics, http://www.keele.ac.uk/ethics/

[4] Integrated Research Application System, the single system for applying for the permissions and approvals for health and social care / community care research in the UK https://www.myresearchproject.org.uk/

4.10. Financial Management

Effort has been made in ensuring that partners have been well-informed of their contractual obligations as well as they have been familiar with the use of the ECAS-NEF tool. At both of the main General Assembly Meetings, **a major section was included covering financial and contractual issues** and, additionally, a presentation on financial guidelines specific to the BrainAble project was distributed to all partners and made available via the shared workspace. Reporting tasks, both financial and procedural, have all been **standardised by the introduction of upgraded documented templates.**

Extra effort has been required from the Project Manager to ensure that the Final Report herein contains an appropriate level of information conveyed in a concise and effective manner. However, the application of this centralised effort is considered to be beneficial both to the project and the partners, as it means that **major reporting questions have been dealt with efficiently.** Partners who previously lacked experience in European Projects have reported particular benefits as the learning processes have been developed in line with this central guidance.

The key financial activities that have taken place during the third and last reporting period are now summarised below:

- **Implementation of the intermediary internal financial report by PM30** aimed to guide the consortium with FP7 financial rules, early identify mismatches or under/over spending situations to take corrective actions and to check the accuracy of the work provided and the resources consumed.
- The **collection of the data and generation of the Cost Claim description for Period 3**. Detailed description of resources use is given in the section 6.

The Project Manager has found it helpful to make use of the EC-financed projects IPR-Helpdesk and Finance-Helpdesk for assistance with the resolution of questions.

The use of project resources is well aligned with the work plan and in balance with the overall budget.

4.11. Ethical issues

Ethical issues are first expressed and assessed at WP level and within the WP leader groups. All assessment tools and protocols used within BrainAble are verified by the project General Assembly with regard to their impact on end users' well being prior to use. The two main partners involved in user testing were FPING and ANET.

4.I.1 Abilitynet

ANET needed to obtain ethical approval from a REC7F[5] prior to their user testing, as this is accepted practice for the **testing of CE marked medical devices on vulnerable persons**. The UK requires that research on human subjects and the use of medical devices must be reviewed by independent ethics committees that consider several issues

The Ethical Approval Process in the UK required extensive documentation for scrutiny by the UK NHS Ethical Review Board with a board meeting of 16 members. However, partner previously gained guidance from the PEAK team8F[6] on this.

Following the installation of the prototype, documents were prepared and submitted the account is created online in IRAS9F[7]. Finally, on the 9th of September 2011 the UK Ethical board called partner Abilitynet (represented by Clare Carmichael, *Ethics Manager*) for the review and assessment of the approval submission.

---

[5] Research Ethics Committee http://www.nres.npsa.nhs.uk/

[6] Centre for Professional Ethics, http://www.keele.ac.uk/ethics/

The NHS reviewers raised a number of important issues which had impact not only on the research design but also on the actual conduct of the research and testing.

- The extent to which disabled people are ‘vulnerable’, and the ways in which their needs and ‘vulnerability’ might change over the course of an extended project was highlighted
- Particular care was required in obtaining informed consent from participants with severe communication difficulties – carers were particularly important in confirming their intentions and consent
- The ethics board was clear in their view that the prototypical nature of the system should be made very evident to manage expectations of participants and to ensure that they understood that there was little chance of their immediately benefitting from the technologies they were testing.
- It was very useful that the components and system was all CE marked and marketed by gTEC and that G.TEC provides a very clear account on their website and materials.
- The committee was also concerned that the researcher should have an appropriate support structure for dealing with the difficult issues around complex progressive conditions.
- **The Board was impressed by the participatory nature of the design and wished to be kept informed.** They liked **the research design and that participation was encouraged rather than being subjects.** They also liked the different modes of consent.

Site specific information needed to be presented (Liverpool John Moores University) although in our case the letter from the Ethics Board extends, as far as all the required conditions are complied with NHS research arrangements, the permission for a multi-site testing in case potential users aren’t able to travel.

Ethical approval (for the UK testing purposes) for the 2nd prototype was straightforward and consisted of requesting a substantial amendment to the original research proposal based on the developments to the Y2P prototype and how this could differently effect the users during testing sessions compared to the 1st iteration. It also included a request to revise and extend the time scale of the user testing.

A subcommittee gave the project consortium (represented by ANET) permission to continue the study at the same site prior to installation of the 2nd prototype and the successful amendment was based on the detailed information that the development teams were able to give to ANET in advance of the installation and proposed user testing.

Dated from **21st of October 2011**, the **National Research Ethics Service gave favourable ethical for the BrainAble study** and allowed to starting with the testing phase. A copy of the issued certificate was annexed to deliverable D1.5 *Periodic report Year-2.*

At the occasion of the final workshop within RAatE 2012 (Coventry, UK), lead by Mrs Clare Carmichael - Research Analyst – Abilitynet / Honorary senior research fellow Liverpool John Moores University, a paper and a session on ***“Ethical Issues in BNCI and Participatory Research in the BrainAble Project”*** was conducted.

The presentation described **current thinking about ethical issues in relation to BCI/BNCI research** both generally and in relation to this particular project, and the **patterns of ethical practice** that have been developed both within the multidisciplinary research team and with participants. “*BCI/BNCI research involves novel and emergent technologies and their as yet undetermined potential for use as assistive technologies (rather than medical devices or gaming interfaces) means that the project's ethical framework has had to be flexible, responsive and participatory. A further challenge has been presented by rapidly increasing public awareness of BCI/BNCI systems as potential means of addressing 'Locked-In Sydrome' which itself remains a*

[7] Integrated Research Application System, the single system for applying for the permissions and approvals for health and social care / community care research in the UK https://www.myresearchproject.org.uk/

problematic concept. This has meant that participant expectations of what the technologies can actually achieve have had to be carefully managed".

The paper concluded with a discussion of some findings from the project in which participants shared their views of the project prototypes, of the potential of BCI/BNCI systems as an assistive technology, and of their other possible applications. This draws attention to the importance of ethical practice in projects where high expectations of technologies and representations of 'ideal types' of disabled users may reinforce stereotypes or drown out participant 'voices'.

4.I.2 Guttmann

During the first year of the project implementation, **FPING** generated and validated by all the members of the consortium the protocols. In addition, both user requirements and inclusion/exclusion criteria were defined (deliverable D6.1: *Medical requirements in motor disabilities scenarios*).

One month later this release, the team involved in BrainAble project generated all the documentation to the attention of the Ethics Committee including **informative sheet, questionnaire to ensure understanding** of the study and the **informed consent**. Moreover the circuit to recruit patients and responsible person was established and presented to the Committee.

Documents (available in Spanish) summarise that the agreement to take part in research should be made without being subjected to coercion, undue influence, inducement, or intimidation, enough time should be given as is needed to make a decision (including time for consultation with family members), and investigator must then ensure the participant has understood the information and give them the opportunity to ask questions. A summary sheet was created addressing how the Data Protection Spanish Directive 15/1999[8] governs the processing and transfer of personal data and how these its requirements affect BrainAble study avoiding potential identification of someone.

Dated form **26th of September 2010**, the **Ethics Committee approved the BrainAble study** and allowed to starting with the testing processes. A copy of the issued certificate was annexed to deliverable D1.4 *Periodic report Year-1.*

4.I.3 Data protection

On admission to the research participants, each user is identified by a "subject number" recorded on its contact details. Only the contact form and consent forms have the participants' names. Only these documents will be able to correlate information on the participants. **All the information collected during the study is kept under the same rules and regulations for any of Abilitynet's client records**.

The research team have access to information and photos of the participants where participant consent has been obtained. The paper based data is stored in a lockable filing cabinet and information on the web is shared through HT Access requiring a user name and secure password.

The ethical issues are well controlled and are completely respected in daily work.

[8] Issued in accordance with Data Protection Directive 95/46/EC

4.12. Key performance indicators

A set of Key Performance Indicators was developed during the first quarter of Period-3 and submitted to the approval of the Project Board held on June; the process carefully considered the expected results and the EC expectations, according with similar R&D initiatives.

The table below reports on these indicators to assess that the all-encompassing process of providing evidence that we performed effectively quality-related activities in the project or, when necessary, we implemented corrective actions.

Type	Description	Target	Final Results
Management	**max %** of deliverables for which the EC requests resubmission following project reviews	15 %	Periods 1 and 2 have seen the release of 30 deliverables (including both Period Reports). Three of them (D2.1, D5.1 and D5.5) were requested for revision. This means **10%** of the written outputs submitted to the EC. Furthermore, the rationale of the *resubmission request* related to **minor changes restricted to specific sections or issues** and no major concerns were set up.
	max % of deviation from original resources assignment	20 %	Relating to monetary resources, **no deviation was set up during the project implementation**. However, as it has been reported, some partners needed to involve more effort (**in PMs terms**) than initially foreseen due to the unavailability of planned senior profiles: the staff involved in the project being less experienced required more time to achieve the expected results. The global deviation for the three years of the project implementation is **of 25%.**
	max number of days of delay in submitting deliverables (per Period)	30	Period 1: Deliverable D4.1 was delayed as per **three weeks** from the initial planned date Period 2: Deliverable D6.4.1 was delayed as per four **months** from the initial planned date. The initial planned iteration and testing processes were rescheduled due to **prototyping delays** which additionally resulted in troubles to obtain ethical approval on time. Once the testing process was able to be performed, partner ANET delivered two (instead of one) reports on the testing results by October and December 2011. Period 3: **minor deviation** of some days (less than 30) from the revised work plan.

Type	Description	Target	Final Results
Concertation / clustering	**number** of concertation meetings (within existing conferences and workshops) which the project commits to help organise/participate in	5	Above any expectations: **~10**, the BrainAble consortium has actively participate in several events as three **Tobi** Workshop, **Decoder** project meeting and three BCI conventions organised by **Future BNCI project**. Furthermore, the BrainAble project has contributed in concertation *fora* organised by the European Commission as for instance the **2011 Innovation Convention** and the **2012 EU Conference on Accessibility.** Last but not least, the BrainAble consortium has provided strong contribution to the ***Future BNCI roadmap***, coordinated by Dr. Brendan Allison. This roadmap was developed by the Future BNCI Project and researchers from other **BNCI Research Cluster projects** co-financed by DG Information Society and Media (Directorate "ICT Addressing Societal Challenges", Unit "ICT for Inclusion") under the Seventh Framework Programme [FP7/2007-2013] of the European Union. The publication addresses the next five years of Brain/Neuronal Computer Interaction Research. This roadmap reflects two years of development with contributions from stakeholders around the world. **Future BNCI** was a Coordination and Support Action under the ICT Theme of FP7.
	number of project publications in highly regarded journals	3	The project consortium has issued **more than 20 peer-reviewed publications** during the three years of the project implementation. As per exigent quality criteria we indicated, the consortium is happy to confirm that we managed to disseminate results and findings through FIVE *highly regarded journals* (ranked in the JCR® - Journal Citation Report[9]): the ***International Journal of Psychophysiology*****,** the ***Journal of Neuroscience Methods*****,** the ***Journal on Neural Engineering***, the ***IEEE Transactions on Neural Systems and Rehabilitation Engineering*** and the ***Journal of Clinical EEG and Neuroscience*****.** Furthermore, several book chapters on BCI issues have been published by the BrainAble team among other well known editors: **Springer** and **the Frontiers collection.**

[9] ISI Web of Knowledge, JCR - 2011 , http://wokinfo.com/products_tools/analytical/jcr/

Type	Description	Target	Final Results
Dissemination impact	**number** of BCI workshops showing BrainAble technology	5	Above any expectations: **>10**, the BrainAble consortium has actively participate in several events as three **Tobi** Workshop, **Decoder** project meeting and three BCI conventions organised by **Future BNCI project**. Furthermore, the BrainAble project has been shown in European initiatives organised by the European Commission as for instance the **2011 Innovation Convention** and the **2012 EU Conference on Accessibility.** As foreseen in the work plan, **a final project workshop** was organised in the framework of RAatE 2012 (Coventry, UK). At this occasion, the **BrainAble final prototype was running in the Exhibition Hall** throughout the day. An **ERD BNCI demonstration** took place over the lunch break. Additionally, lead by Mrs Clare Carmichael - Research Analyst - Abilitynet/Honorary senior research fellow Liverpool John Moores University, the project conducted a **workshop** during the afternoon session: **"Developing BNCI as an Assistive Technology Workshop BNCI Project".** Furthermore, the project has been recently invited to participate in the conference **European Brain Research: Successes and Next Challenges**, organised by the European Commission that will take place on May 14th, 2013 in Brussels. Invited by the organisation, the BrainAble project coordinator, Felip Miralles (BDCT) will participate along with other leaders in brain research and healthcare from around the globe.
user feedback	**number** of end users involved in the trials	20	The prototypes were tested with small groups of users exclusively recruited for this study at **ANET** (all prototypes) and **FPING** (individual components, 2nd and final prototypes). Mixed methods approaches were used to build demographic profiles, trajectories of computer use and alternative assistive technologies that either were used or could be used. As per result of the added efforts in recruitment, BrainAble system has been tested for R&D purposes by **8 able bodied people** (Physiotherapists, Clinicians and Occupational Therapists) and more than **75 disabled people**. These have provided direct feedback to the developers for the iterative development of the prototype and to create real case studies of potential BCI users which were then used to inform subsequent development. More than **100 concrete inputs from the users** were registered and treated (furthermore, 40-50 additional inputs were obtained from the Therapists conducting the trials). The prototype testing was informed in terms of usability, user development, user perceptions and qualitative feedback. From the inputs received, the development team **"solved" the 80% of the improvements-modifications suggested**. A large majority of "non-solved" issues needing additional resources
	number of issues reported **by the users** serving to the improvement of the system	60	
	% of reported issues "solved"	60 %	

5 Deliverables and milestones status

5.1. Deliverables table

Del. nº	Deliverable name	Version	WP nº	Leads	Nature	Dissemination level[10]	Delivery date Annex I	Actual / Forecast date	Status	Contractual	Comments
PERIOD 1 (2010)											
D1.1	Project Management Handbook	v.1.0	WP1	BDCT	O	CO	M02	25/02/10	Approved	YES	Approved by the EC (REV-1)
D1.2	Shared Workspace set up	v.1.2	WP1	BDCT	O	CO	M02	29/03/10	Approved	*	* As per EC agreement, delivery dates of D1.2 and D1.3 were interchanged Approved by the EC (REV-1)
D1.3	Project website online	v.1.3	WP1	BDCT	O	CO	M03	23/02/10	Approved		
D4.1	VR environments and elements, SOA	v.1.1	WP4	UPF	R	PU	M03	26/04/10	Approved	**	** Slightly delay reported to the EC Approved by the EC (REV-1)
D5.1	Ambient Intelligence in Assistive Technologies, SOA	v.1.1 v.1.3	WP5	BDCT	R	PU	M04 M18	29/04/10 16/06/11	Re-submitted	YES	Available on the public web site Deliverable resubmitted after REV-1, on the 15TH June 2011 Approved by the EC (REV-2)
D2.1	Requirements specification	v.1.3 v.1.4	WP2	G.TEC	R	CO	M06 M18	28/06/10 15/06/11	Re-submitted	YES	Deliverable resubmitted after REV-1, on the 15TH June 2011 Approved by the EC (REV-2)
D3.1	State of the Art Analysis: BCI and BNCI systems	v.1.0	WP3	TU-Graz	R	PU	M06	28/06/10	Approved	YES	Available on the public web site Approved by the EC (REV-1)
D3.2	State of the Art Analysis: Sensors, signals and signal processing	v.1.2	WP3	TU-Graz	R	PU	M06	29/06/10	Approved	YES	Available on the public web site Approved by the EC (REV-1)

10 **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).

5.1. Deliverables table

Del. nº	Deliverable name	Version	WP nº	Leads	Nature	Dissemination level[10]	Delivery date Annex I	Actual / Forecast date	Status	Contractual	Comments
D6.1	Medical requirements in motor disabilities scenarios	v.3.0	WP6	ANET	R	CO	M06	29/06/10	Approved	YES	Approved by the EC (REV-1)
D6.2	Identification of potential user groups and validation specifications	v.1.2	WP6	ANET	R	CO	M06	25/06/10	Approved	YES	Approved by the EC (REV-1)
D5.2	Technical Specifications for BrainAble AmI Architecture	v.1.0	WP5	BDCT	R	CO	M07	29/07/10	Approved	YES	Approved by the EC (REV-1)
D2.2	Human computer interaction interfaces	v.2.0	WP2	G.TEC	R	CO	M09	30/09/10	Approved	YES	Approved by the EC (REV-1)
D2.3	Interfacing of technologies	v.1.0	WP2	G.TEC	P	CO	M12	30/12/10	Approved	YES	See also the 1st global prototype Description document delivered on the 29th of December 2011 by BDCT. Approved by the EC (REV-1)
D3.3	First BCI system available	v.1.0	WP3	TU-Graz	P	CO	M12	29/12/10	Approved	YES	
D4.2	VR environments and elements, first prototype	v.1.1	WP4	UPF	P	CO	M12	29/12/10	Approved	YES	
D7.7	Sponsoring Programme	v.1.1	WP7	METI	O	PU	M12	29/12/10	Approved	YES	Available on the public web site Approved by the EC (REV-1)
D7.8	Project Cluster with sibling projects	v.1.1	WP7	METI	O	PU	M12	29/12/10	Approved	YES	Available on the public web site Approved by the EC (REV-1)
PERIOD 2 (2011)											
D5.1	Ambient Intelligence in Assistive Technologies, SOA	v.1.1 v.1.3	WP5	BDCT	R	PU	M04 M18	29/04/10 16/06/11	Approved	YES	Available on the public web site Deliverable resubmitted after REV-1, on the 15TH June 2011 Approved by the EC (REV-2)
D2.1	Requirements specification	v.1.3 v.1.4	WP2	G.TEC	R	CO	M06 M18	28/06/10 15/06/11	Approved	YES	Deliverable resubmitted after REV-1, on the 15TH June 2011 Approved by the EC (REV-2)
D7.1	Dissemination Report Year 1	v.1.0	WP7	METI	R	PU	M13	31/01/11	Approved	YES	Available on the public web site Approved by the EC (REV-2)

5.1. Deliverables table

Del. nº	Deliverable name	Version	WP nº	Leads	Nature	Dissemination level[10]	Delivery date Annex I	Actual / Forecast date	Status	Contractual	Comments
D7.4	Intermediate Exploitation Plan	v.1.0	WP7	METI	R	CO	M16	29/04/11	Approved	YES	Approved by the EC (REV-2) *with comments*
D6.4.1	Evaluation of the prototype for user-centred design	v.2.0	WP6	ANET	R	CO	M18	31/10/11 30/12/11	Approved	*	* As per EC agreement, delivery date was delayed. Approved by the EC (REV-2)
D5.3	Deployed AmI Scenarios, final prototype	v.2.3	WP5	BDCT	P	CO	M20	29/08/11	Approved	YES	Approved by the EC (REV-2)
D2.4	Technology packaged 2nd prototype	v.1.0	WP2	G.TEC	P	CO	M24	30/12/11	Approved	YES	Approved by the EC (REV-2)
D3.4	Second BCI system available	v.1.0	WP3	TU-Graz	P	CO	M24	29/12/11	Approved	YES	Approved by the EC (REV-2)
D4.3	Audio-visual tools for self-expression and social networking	v.1.0	WP4	UPF	P	CO	M24	30/12/11	Approved	YES	Approved by the EC (REV-2)
D4.4	VR and media based tools for cognitive stimulation and mastering BNCI control	v.1.0	WP4	UPF	P	CO	M24	30/12/11	Approved	YES	Approved by the EC (REV-2)
D5.4	VR Configuration APIs and Scenario Modelling Tool	v.1	WP5	BDCT	P	CO	M24	29/12/11	Approved	YES	Approved by the EC (REV-2)
D5.5	Social Networking Infrastructure for patient-patient interaction, final prototype	v.1.0 v.1.1	WP5	BDCT	P	CO	M24	29/12/11 29/06/12	Re-submitted	YES	Deliverable resubmitted after REV-2, on the 15^{TH} June 2011
D7.2	Dissemination Report Year 2	v.1	WP7	METI	R	PU	M24	28/12/11	Approved	YES	Approved by the EC (REV-2)
PERIOD 3 (2012)											
D5.5	Social Networking Infrastructure for patient-patient interaction, final prototype	v.1.0 v.1.1	WP5	BDCT	P	CO	M24	29/12/11 29/06/12	Re-submitted	YES	Deliverable resubmitted after REV-2, on the 15^{TH} June 2011
D6.4.2	*Evaluation of the prototype for user-centred design*	*N.A.*	*WP6*	*ANET*	*R*	*CO*	*M27*	*As per EC agreement, delivery date on 6.4 was merged (6.4.2 and 6.4.3)and rescheduled according with revised plans for Year-3*			
D2.5	Technology packaged	v.1.0	WP2	G.TEC	P	CO	M30	05/07/12	Submitted	YES	

5.1. Deliverables table

Del. nº	Deliverable name	Version	WP nº	Leads	Nature	Dissemination level[10]	Delivery date Annex I	Actual / Forecast date	Status	Contractual	Comments
D3.5	Report on complete system	v.1.0	WP3	TU-Graz	R	CO	M30	05/07/12	Submitted	YES	
D4.5	VR environments and elements, final prototype	v.1.0	WP4	UPF	P	CO	M30	04/07/12	Submitted	YES	
D5.6	URC-enabled AmI Scenarios	v.1.0	WP5	BDCT	P	CO	M30	04/07/12	Submitted	YES	
D6.3	Evaluation of the individual components of BrainAble system	v.4.0	WP6	ANET	R	CO	M33	31/12/12	Submitted	**	** Expected delay informed to the EC prior to the deadline. Plans on user feedback were fully revised for Year-3.
D6.4.3	Evaluation of the prototype for user-centred design	v.5.1	WP6	ANET	R	CO	M34	23/01/12	Submitted	*	* As per EC agreement, delivery date on 6.4 was rescheduled according with revised plans for Year-3
D7.5	Final Exploitation Plan	v.1.0	WP7	G.TEC	R	CO	M34	02/01/13	Submitted	**	** Expected delay informed to the EC due to METI failure
D6.5	Clinical validation of BrainAble components over cognitive state and mastering BNCI control	v.6.1	WP6	ANET	R	CO	M36	07/01/13	Submitted	YES	
D7.3	Final Dissemination Report	v.1.0	WP7	TU-Graz	R	PU	M36	30/11/12	Submitted	YES	Available on the public web site
D7.6	Dissemination and Use Plan	v.2.0	WP7	BDCT	R	RE	M36	12/01/13	Submitted	YES	

5.2. Milestones table

Milestone Nº	Milestone name	Work packages nº	Leads	Delivery date from Annex I	Achieved Yes/No	Actual / Forecast achievement date	Comments
M.1	System requirements available and rapid prototyping environment distributed	WP2, WP3	G.TEC	M06	YES	M06	Reached. Annex I stated: Means of verification: D2.1. Delivered.
M.2	First prototypes installed	WP2, WP3	G.TEC	M12	YES	M12	Reached. Annex I stated: Means of verification D2.3 and D3.3. Delivered. Other related outcomes have been D4.2 and 1st year prototype global description
M.3	User-centred design and validation, iteration one	WP6	ANET	M18	YES	M22	Reached. * As per EC agreement, delivery date was delayed.
M.4	Second version of BrainAble system installed	WP2, WP3,WP 4, WP5	G.TEC	M24	YES	M24	Reached. Annex I stated: Means of verification D2.3 and D3.3. Delivered. Other related outcomes have been D4.2 and 1st year prototype global description
M.5	User-centred design and validation, iteration two	WP6	ANET	M27	YES	M36	As per the updated work-plan agreed during the 2nd Period Review, Milestones 5, 6 and 7 converged into a last by the end of the project. The agreed working plan involved the installation and testing of two prototypes, both in ANET and FPING to maximise the development towards the final system. No formal amendment was deemed necessary by the P.O. Means of verification are D6.4.3, D6.3 and D6.5
M.6	Final version of BrainAble system installed	WP2, WP4, WP5	G.TEC	M30	YES		
M.7	User-centred design and validation, iteration three	WP6	ANET	M34	YES		
M.8	Final Exploitation Plan	WP7	G.TEC	M34	YES	M34	Reached. Annex I stated: Means of verification: D7.5. Delivered with informed delay due to METI failure
M.9	DUP and Final Dissemination Report	WP7	BDCT	M36	YES	M36	Reached. Annex I stated: Means of verification: D7.6. Delivered.

6 Financial Report

6.1. Introduction

According to new regulation within FP7, the financial statements have to be provided within the Research Participant Portal in the FORMs C (Annex VI of the Grant Agreement) by each beneficiary. Therefore, the *Explanation of use of resources* requested in the Grant Agreement for personnel costs, subcontracting, any major costs and indirect costs, has been done within those Forms in the Participant Portal.

However, since the tool does not allow the inclusion of informed data at consortium level, we intentionally **kept this section as it was structured** to share with the European Commission our **analysis, findings and conclusions** relating to **the use of resources invested by the European Commission** for the project implementation[11].

In order to guarantee that the budget assigned to each partner is well-matched to BrainAble's needs for the final period, the PMO requested partners to submit at PM30 position statements including estimates for the closing cost claims. This process facilitated the identification of potentially unused budget needing to be reassigned and also highlighted tasks that might be at risk due to recruitment difficulties. As a result, **the** profile of expenditure for this final 12-month period and the global expenditure substantially matches the expected figures detailed in the indicative cost breakdown for each partner.

As explained in previous sections, a critical issue rose during 2012: one of the project beneficiaries, **partner nº4 METICUBE**, experienced financial troubles form the beginning of the second semester which collapsed in a **bankruptcy declaration by ~September'12.** Earlier than the past week, the European Commission notified to METICUBE the decision to **terminate its participation in the Grant Agreement** relating to BrainAble project with retro-active effect from 14/09/2012[12].

Relating to the pure impact in the work plan, by September 2012, **METI notified formal resignation as WP7 Leader** and anticipated that **no further contribution** would be expected from them **due to financial constraints.** Informed by the Coordinator, the **Project Board body**, composed by the WPs Leaders**,** agreed in necessary actions to sort out the situation, mainly relating to the pending WP7 tasks and outputs: following the identification of "available" budget it was decided and agreed a **shift of responsibilities** as per the following distribution:

- **BDCT** (additional budget of **15.000** €), responsible for tasks 7.1 and 7.5 (IPR policies and scientific results management) and leading deliverable D7.6 *Dissemination and use Plan*.
- **TU-Graz** (additional budget of **10.000** €), responsible for task 7.3 and 7.5 (Coordination of Dissemination activities) and leading deliverable D7.3 *Final Dissemination Report*.
- **G.TEC** (additional budget of **15.000** €), responsible for task 7.2 (Exploitation) and leading deliverable D7.5 *Final Exploitation Plan*.

This current financial report refers to the final year of the project **(from January 2012 to December 2012)** and it contains assessed figures for a **Period-3** final, exception made of one of the consortium members[12].

Note: minor mismatches could exist (less than 1 € per partner) between the figures presented in the report and those of the on-line Form C due to the **automatic rounding down applied by the NEF tool.**

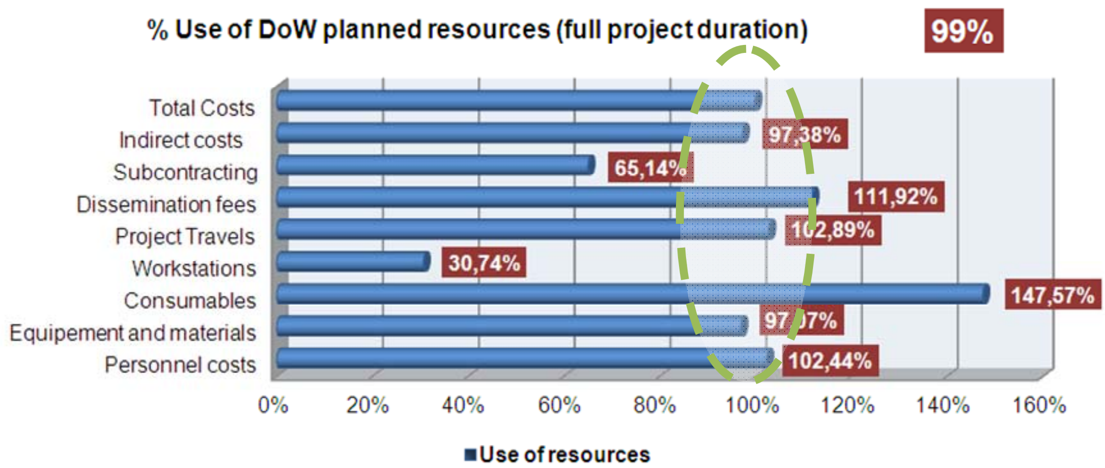
[11] This section aimed to provide explanatory inputs and overview to the EC, it is understood in case of inconsistency in the figures detailed herein and those reported by the beneficiaries in the Forms C, the last ones, reported by the partners in the Research Participant Portal, shall prevail.

[12] METICUBE, currently under tutelage of an Insolvency Manager nominated by the Portuguese Administration, seems not to be able to provided cost statement relating to Period 3. However, since the EC has formally terminated METI's participation, in case the Insolvency Manager proceeds as requested by the Commission -presenting through the Coordinator justification of costs for Period 3-, its subsequent assessment shall be treated separately from the cost claim of the Consortium.

6.2. Justification of major cost items and resources

TYPE of EXPENDITURE	TOTAL BUDGET (DoW)	ACTUAL COSTS			% of budget used
		2010 (P1)	2011 (P2)	2012 (P3)	
Effort (Person-month)	340,00	123,78	170,77	118,57	122%
Personnel costs	*1.580.534 €*	525.634 €	575.631 €	517.846 €	102%
Equipment / workstations	*129.979 €*	41.037 €	40.794 €	35.779 €	98%
Consumables	*8.000 €*	301 €	2.697 €	8.808 €	148%
Project Travels	*85.600 €*	35.078 €	31.376 €	21.621 €	103%
Dissemination activities	*57.880 €*	14.680 €	21.769 €	28.330 €	112%
Subcontracting	*32.220 €*	11.457 €	4.799 €	4.733 €	65%
Indirect costs	*1.081.287 €*	355.810 €	373.840 €	323.360 €	97%
TOTAL	*2.975.500 €*	983.997 €	1.050.904 €	940.478 €	99%

The above table compares Consortium actual costs and resources to the estimated budget for the full project duration. As a result, **the profile of expenditure for the three years substantially matches the expected figures detailed in the indicative DoW cost breakdown** for the full consortium.



As it was for Periods 1 and 2, in 2012 for all partners the **major costs have been devoted to research personnel**, and their associated **indirect costs** in carrying out the Research and the Management of the project. Up to 42 people (including those providing only partial inputs) have participated in the implementation of BrainAble tasks. Detail on staff profiles is to be found in the individual tables following this introductory section.

The **equipment** charged to the project corresponds to the BCI full system (7) that G.TEC provides to the consortium partners, some PCs (3) and monitors (2) devoted to the system, software as SDK research edition, components for VR Infrastructure and related materials. Where applicable, these costs are charged to the project in accordance with depreciation and dedication FP7 financial rules.

Travel costs are divided into two sub-categories: ***project meetings***, as listed and described in section *4.4 Project meetings* and includes for some partners the participation in extraordinary installation meetings that could not be anticipated when budgets were set up (prototype installation at Guttmann, for example). The second category, ***Dissemination fees***, is used by the project partners for the attendance and participation in the selected international events to disseminate the project (details of the presentations made by the project partners are available in Deliverable D7.3 *Final Dissemination Report*).

Finally, the **subcontracting** expenses refer to a minor amount spent by BDCT (outsourcing of emails distributions lists) and the two due Certificates on Financial Statements (TU-Graz and UPF).

6.3. Efforts used

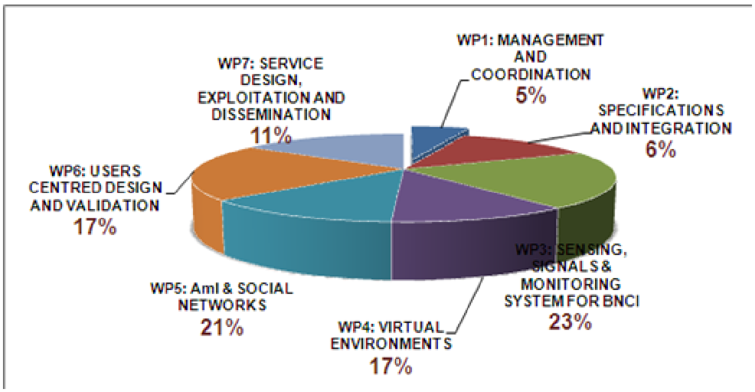
Efforts used show accurate consumption of efforts for the majority of Work Packages. More detailed explanation on the specific Work Packages tasks deployed is to be found in the Activity Annual Report section 3. Period-3 consumed a total number of **~130 person-month** distributed among the work-packages. The majority of partners **have used more PM than initially planned in the Annex I**, Description of Work (TU-Graz, UPF, G.TEC, BDCT and slightly FPING). This is due to the fact that the profiles initially planned were not available and most of the work has been carried out by PhD instead of Postdoctoral positions that required more labour time through a lower cost to reach the planned results.

WPs	*Dow ALLOCATION*	*2012 Efforts*	*% of use (cumulate 3 years)*
WP1: *MANAGEMENT AND COORDINATION*	30,00	*7,24*	90%
WP2: *SPECIFICATIONS AND INTEGRATION*	46,00	*16,59*	108%
WP3: *SENSING, SIGNALS & MONITORING SYSTEM FOR BNCI*	52,00	*27,41*	180%
WP4: *VIRTUAL ENVIRONMENTS*	53,00	*15,26*	125%
WP5: *AmI & SOCIAL NETWORKS*	52,25	*17,15*	129%
WP6: *USERS CENTRED DESIGN AND VALIDATION*	58,25	*27,34*	121%
WP7: *SERVICE DESIGN, EXPLOITATION AND DISSEMINATION*	48,50	*19,92*	105%
Total Person-month	**340,00**	*130,91*	125%

As expected, the **WP1 *Management and Coordination*** of the project **consumed similar effort than in Period-2.** It is normal since the highest involvement of the Management team is foreseeable for the starting-up of the project. For Period-3 the effort mainly focused in the proper delivery and achievement of Milestones and Deliverables, partner METI bankruptcy situation and consequent split of tasks and remaining budget as well as for the overall financial management (including support on the certificate on financial statement) and the current Final Project Report.

WP2 increased the intensity of effort needed due to the renewed plans in the iterative testing and development in both "pilot" sites. The **transversal *technologies*** (**WP3** *BNCI*, **WP4** *Virtual Reality* and **WP5** *Ambient Intelligence)* concentrated significant effort **during this Period 3: ~48%** of the Human resources devoted to the BrainAble project. As per result of the requirements defined during the user's testing iterations, these WPs have been involved in the development of the technologies and, indeed on the integration of all of them into the final prototype.

The involvement of the users in the project, slightly delayed from the initial workplan during P1 and P2, has been crucial during 2012: **WP6** *Users-centred design and validation* needed a significant 22% of the full effort provided during this final Period.



Finally, **WP7** *Dissemination and Exploitation* kept efforts aligned with the workplan. Again, several dissemination activities were undertaken by the entire Consortium. These activities included 15 participations in national and international events and several project presentations. BrainAble was also present in the **RAatE** conference, the **EU Conference on Accessibility**. Although an initial analysis of the project-wide exploitation strategies was made, relevant effort were reserved to achieve an effective exploitation plan of the BrainAble project outcomes beyond the project implementation [details available in Deliverables D7.*5 Final Exploitation Plan* and D7.6 *Dissemination and Use Plan*].

6.4. Work performed by each beneficiary and Costs Claim details

01 Barcelona Digital Centre Tecnològic (BDCT)

BDCT leads the BrainAble scientific coordination and is in charge of the Project Management Office (PMO) for the management of legal, financial and administrative issues, both tasks grouped in WP1 (Project Management and Coordination). The PMO organised, coordinated, held and minuted five major internal meetings mentioned above and managed the final intermediary financial check aimed to support partners with FP7 procedures and potential deviations from the planned use of resources. Non planned effort was devoted also to sort out the bankruptcy of partner nº4 METICUBE to minimise its impact to the project.

In close relation with the management activities, BDCT was responsible for the up-to-date and maintenance of the corporate dissemination and communication tools (BrainAble website and shared workspace Emdesk platform), and has strongly contributed (more than planned for the above mentioned reasons) in the WP7 deliverables D7.3, D7.5 and D7.6 Final Dissemination Report, Exploitation Plan and Dissemination and Use Plan respectively.

As scientific coordinator, BDCT steered the scientific work performed in the project in order to ensure that results achieved are of the maximum quality possible in scientific terms and are compliant with the objectives set for the project. The scientific coordinator is in charge of the final approval of the 11 issued deliverables for the period (includes D5.5 deliverable resubmission) and chaired the Project Board (WPs Leaders group) and General Assemblies meetings.

As a part of the dissemination tasks in WP7, BDCT authored two videos on Year-2 results published by May (long and short versions) and also enhanced and coordinated the participation of the project in major events as for instance the Presidency Conference held in Copenhagen on March, and, in close interaction with partner ANET, the final workshop of the project at RAatE 2012.

As WP5 leader, the major technical contribution of BDCT focused on the development of the Ambient Intelligence (AmI), which includes the machine learning algorithms to provide adapted and personalised assistance. This development also entailed the design of the Context-Awareness engine, a software development able to understand the happening taking place. The third year of BrainAble was dedicated to design and implement the Context-dependent UI. This feature allows the system to adapt and configure the BNCI interface by suggesting the most likely options according to the context. Indeed, the Ambient Intelligence algorithms generate a new interface whenever the engine detects a potential need of the user with two different approaches: Context triggers and Personalised Adaption. BDCT authored D5.5 revision and D5.6 *URC-enabled scenarios* deliverables.The enhacement of the self-expression tools of the BrainAble Virtual Community were also tackled during this third year. Indeed, this feature enables the users to enrich the communication by transmiting emotions. These emotions are enabled with two separated means in the BrainAble Virtual Community (BVC), facial expression mechanisms and postural behaviour. Also in WP4, BDCT played an important role in the development of the BrainAble Virtual Community mainly in the definition of the protocols between the AmI block and the VR module.

Finally, BDCT also played an important role in WP2 and WP6, providing "helpdesk support" and coordination in the iterative processes of the user testing and the developments and upgrades of the final system reached.

- Formed part of: *General Assembly, Project Board* and *Project Management Office*

➲ Financial reporting essential data (25-36PM):

	Full Budget (as per DoW)	2012 Costs (€)		Cumulate Y1-Y2-Y3	
		2012 Actual Costs	%	In €	%
Management	*250.280 €*	*67.828 €*	*27 %*	*242.545 €*	*97 %*
R&D	*417.790 € (*)*	*181.340 €*	*42 %*	*429.507 €*	*103 %*
Total (global)	**665.630 € (*)**	**249.168 €**	**%**	**672.052 €**	**101 %**

Notes: Minor mismatch (less than 1 €) between BDCT figures presented in the report and those of the on-line Form C due to the **automatic rounding down applied by the NEF tool.**
(*) Additional allocation of 15.000 received for the achievement of WP 7 tasks

➲ **Specific costs issues** and **details on costs items:**

PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEM FOR BENEFICIARY 1 (Coordinator) FOR THE PERIOD		
Item description	Amount	Explanations
Personnel Direct Costs	142.124 €	Staff costs as per 36,98 PMs: 7,24 PMs in WP1, 2,39 PMs in WP2, 4,12 PMs in WP4, 14,95 PMs in WP5, 1,57 PMs in WP6 and 6,71 PMs in WP7 tasks. (RTD) The R&D team devoted to the project tasks during P3 was composed by 1 Principal Investigator (Senior Scientist) , 1 Post-doc, 2 senior Engineers, 2 developers, 1 Head of Communication and 2 Technicians (MMT) The MMT has been provided by 1 senior Project Manager
Equipment and Workstations	369 €	(RTD) Depreciation costs of 1 PC HP Probook (BrainAble prototype). These costs are charged to the project in accordance with depreciation and dedication to the project as per FP7 financial rules.
Other materials (fungibles)	4.968 €	(RTD) Expenses incurred for the purchase of small furniture, pieces and devices needed for the prototype/s. The list includes but it is not limited to: SRV drive motor, sandisks, switches, sensors, fibre plaques, cables, electrodes, gel, epuck robot pack, interrupters, etc. These materials are registered as consumables since they form part of the prototype itself and they have not value outside the project utilisation (BrainAble system). (RTD) The category includes also the monthly fees form the hosting of the BrainAble website.
Project meetings / Travels	2.515 €	(MMT) The costs relates to the coffee break services and lunch services relating the hosting of the three BrainAble plenary meetings in Barcelona (2 project meetings on February and November en the EC Review on March); Dinner aren't charged to the project.
Dissemination fees	5.677 €	(RTD) Registration and travel fees for the attendance to the following three events: • *Presidency Conference on accessibility and participation,* Copenhagen/Denmark, 5-6 March 2012 (2 attendees), • *Fit For Health project International Valorisation Workshop*, Paris/France, 17 October 2012 –on which the project coordinator booked individual support time on BrainAble exploitation issues- (2 attendees) and • *RAatE Conference 2012* Warwick/U.K. 26 November 2012 (3 attendees, final project workshop). (RTD) The category includes registration costs (273,81 €) for the publication of the paper: *Prunning AdaBoost for Continous Sensors Mining Applications,* Poster-proceedings at Ubiquitous Data Mining Workshop in conjunction with 20th European Conference of Artificial Intelligence, Montpellier/France 17-21 August 2012 ECAI 2012
Subcontracting	123 €	(MMT category) exclusively relate the outsourcing of the emailing lists distribution.
Indirect Costs	*93.392 €*	*(Specific Flat Rate of 60%)*
TOTAL COSTS	*249.168 €*	*Comments:*

02 Technische Universitaet Graz (TU-Graz)

TUG

TU-Graz leads WP3 (Sensing and monitoring system for BNCI). In 2012, TU-Graz continued to intensively test and validate the adaptive ERD BCI and the EEG-based workload detection system. Following the user-centred design principles, we implemented and integrated changes based on end-user and care-giver feedback. We fully integrated i all our up-to-date methods and systems into the final prototype. Additionally, we performed extensive offline analyses (e.g. Hidden Markov Models) and research for improving self-paced operation.

Most importantly, in cooperation with our clinical partner FPING in Spain and the end-user experts ANET in the UK, we successfully validated the adaptive ERD BCI feature of the final prototype in 24 severely disabled users.

In addition to the technical work and research, TU-Graz was very active with dissemination (WP7): Most work has already been presented in a peer-reviewed conferences or peer-reviewed journal articles. Additionally the partner collaborates in the set-up and demo running during the final workshop in RAatE 2012 exhibition.

Finally, TU-Graz has been responsible author of D3.5 *Report on complete System*, which describes the progress made towards the final BNCI prototype.

- Formed part of: *General Assembly* and *Project Board*

➲ Financial reporting essential data (25-36PM):

	Full Budget (as per DoW)	2012 Costs (€)		Cumulate Y1-Y2-Y3	
		2012 Actual Costs	%	In €	%
Total	**565.711 € (*)**	***186.456,30 €***	**33 %**	**601.309 €**	**108 %**

Notes: Minor mismatch (less than 1 €) between TU-Graz figures presented in the report and those of the on-line Form C due to the **automatic rounding down applied by the NEF tool.**
(*) Additional allocation of 10.000 received for the achievement of WP 7 tasks

➲ **Specific costs issues** and **details on costs items:**

PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEM FOR BENEFICIARY 2 FOR THE PERIOD TUG		
Item description	Amount	Explanations
Personnel Direct Costs	100.258,05€	Staff costs as per 22,44 PMs: 3,09 PMs in WP2, 16,89 PMs in WP3, 0,34 PMs in WP6 and 2,12 PMs in WP7 tasks. The R&D team devoted to the project tasks during P3 was composed by 1 Principal Investigator, 2 Senior Scientists and 2 Post-docs
Equipment and Workstations	1.062,90€	Depreciation of Equipment: Demotion Gaming PC, Lenovo Thinkpad, Color Monitor. These costs are charged to the project in accordance with depreciation and dedication to the project as per FP7 financial rules.
Other materials - consumables	81,45€	Electrode gel, remuneration for participants
Project meetings / Travels	6.402,96 €	Travel and accommodation for BrainAble plenary meetings Barcelona (3 meetings on February, March and November); After the prototyping, travels and accommodation expenses for the final installation and testing support in both planned locations: Liverpool (ANET testing) and Barcelona (FPING testing).
Dissemination fees	5736,41 €	Registration and travel fees for the attendance to the following conferences: Orange County, USA, 29.2.-10.3.2012, Lecture NSF Center f. Sensorimotor Neural Engineering & VR2012 Meeting (1 attendee), Würzburg, 20.-22.3.2012 TOBI Workshop III (2 attendees), San Diego, 30.8.-3.9.2012, 34th Annual International Conference of the IEEE EMBS (1 attendee), Berlin, 19.-29.9.2012, BBCI Workshop and Summer School (1 attendee) and Warwick/Liverpool, England, 25.-28.11.2012, RAatE Conference 2012 (1 attendee).
Other Direct Costs	1.118,42	Cleaning of laundry, express mail service, representation
Subcontracting (RTD)	3.000,00€	Costs of the Certificate on the Financial Statement (CFS)
Indirect Costs	*68.796,11€*	*(Specific Flat Rate of 60%)*
TOTAL COSTS	*186.456,30€*	*Comments:* N.A.

03 Universitat Pompeu Fabra, Institute of Audiovisual Studies (UPF)

During Period 3 UPF have developed activities across different work packages of the BrainAble project.

As WP4 leader has coordinated the research and development activities in this work package and related activities in WP3, WP5, WP6 and WP7. In WP4 we have coordinated the development of *D4.5 VR environments and elements, final prototype* that describes the final prototype of the Virtual Reality (VR) and the latest development since the latest reporting period (M24) for the networking environment and the self-expression tools like expression through music, postures and facial expressions in avatars.

Additionally in WP4 UPF has provided technical support for the integration of the VR with the BrainAble prototype in the clinical partners ANET and FPING, incorporating new features based on user's feedback and solving bugs in the prototype.

On WP3 UPF performed a study for emotional composition of non-symbolic shapes and animations in Virtual Reality described in *D3.5 Report on complete system*. On WP5 UPF implemented social network tools in the Virtual Reality as part of task 5.4.

On WP6 which was very centric this last year UPF provided support for incorporating users feedback into the VR prototype and leaded *D6.3 Evaluation of the individual components of BrainAble system* which describes experiments that validates individual components of the BrainAble architecture. In particular UPF described in this deliverable three experiments that were performed during the last year: 1) A study about emotional composition of non-symbolic shapes and animation in Virtual Environments 2) Cognitive stimulation through Binaural Beas and 3) a study in cooperation with clinical partner FPING about BNCI navigation control of avatars in the BrainAble Virtual Environment. Studies 1) and 2) were the master thesis of two students in UPF supervised by Dr. Sylvain Le Groux and Dr. Paul Verschure.

- Formed part of: *General Assembly* and *Project Board*

➲ Financial reporting essential data (25-36PM):

	Full Budget (as per DoW)	2012 Costs (€)		Cumulate Y1-Y2-Y3	
		2012 Actual Costs	%	In €	%
Total	**588.324 €**	**150.428 €**	**26 %**	**590.270 €**	**101 %**

Notes: Minor mismatch (less than 1 €) between UPF-SPECS figures presented in the report and those of the on-line Form C due to the **automatic rounding down applied by the NEF tool.**

➲ **Specific costs issues** and **details on costs items:**

PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEM FOR BENEFICIARY 3 FOR THE PERIOD		
Item description	Amount	Explanations
Personnel Direct Costs	85.538 €	Staff costs as per 29,10 PMs: 5 PMs in WP3, 10,50 PMs in WP4, 2 PMs in WP5, 10,10 PMs in WP6 and 1,50 PMs in WP7 tasks. The R&D team devoted to the project tasks during P3 was composed by 1 Principal Investigator, 3 Post-doc researchers, 1 PhD student and 3 Technicians (technical support staff).
Equipment and Workstations	1.437 €	Software: SDK research edition, avatars pictures of facial affect. These costs are charged to the project in accordance with depreciation and dedication to the project as per FP7 financial rules.
Other materials (fungibles)	249 €	Physiolab material : Gamma Gel, electrodes, batteries
Dissemination fees	5.787 €	Registration and travel fees for the attendance to the following conferences: Monte Verita Workshop on Music in Neuroscience – Ascona, Switzerland – 18-23 March; CMMR2012 – London –19-22 June; BCBT2012 – Barcelona – 3-14 September; ICNR2012 – Toledo –14-16 November
Subcontracting (MMT)	1.610 €	Certificate of Financial Statement (MMT costs)
Indirect Costs	*55.807 €*	*(Specific Flat Rate of 60%)*
TOTAL COSTS	*150.428 €*	*Comments: In relation to the use of Person Months (PM) UPF reports a deviation compared to the projection due to two reasons: (i) the effort originally planned to be able to meet the project activities were underestimated, and (ii) there has been a change in the WP4 leadership and the composition of the UPF research / technical team in comparison to team originally planned during the proposal development and subsequent contract negotiation (i.e. Post Docs, Technical staff and PhD students). UPF deviation is only in terms of used PMs related to originally planned PMs, but that there are no deviations in UPF's budget execution versus originally planned budget.*

04 Meticube Sistemas de Informação, Comunicação e Multimedia, Lda. (METI)

METICUBE, currently under tutelage of an Insolvency Manager nominated by the Portuguese Administration, seems not being able to provided cost statement relating to Period 3.

*However, since the EC has formally terminated METICUBE participation, in case the Insolvency Manager proceeds as requested by the Commission -presenting through the Coordinator justification of costs for Period 3-, **its subsequent assessment shall be treated separately from the present cost claim of the Consortium.***

05 Guger Technologies OEG (G.TEC)

G.TEC leads WP2 (Development life cycle, from user-oriented specifications to integration) and has made major contributions in the rest of transversal technical work-packages: WP3, WP6 and WP7. In WP2 partner integrated components of UPF, TU-Graz, BDCT and METI into the Y2P and tested it. Furthermore the system was re-designed according to user feedback and error corrections were performed.

In WP3 G.TEC was working on different input devices for controlling the system and performed experiments with the P300 and SSVEP BCI systems, including zero class. In WP6 G.TEC performed measurements with patients to test the BCI system and in WP7 g.tec was involved in dissemination and exploitation activities as well as cluster meetings.

G.TEC has been responsible for the deliverable D2.5 *Technology packaged and D7.5 Final Exploitation Plan.*

- Formed part of: *General Assembly* and *Project Board*

➲ Financial reporting essential data (25-36PM):

	Full Budget (as per DoW)	2012 Costs (€)		Cumulate Y1-Y2-Y3	
		2012 Actual Costs	%	In €	%
Total	572.145 €	208.218 €	36 %	592.503 €	104 %

Notes: Minor mismatch (less than 1 €) between G.TEC figures presented in the report and those of the on-line Form C due to the **automatic rounding down applied by the NEF tool.**
(*) Additional allocation of 15.000 received for the achievement of WP 7 tasks

➲ **Specific costs issues** and **details on costs items:**

PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEM FOR BENEFICIARY 5 FOR THE PERIOD		
Item description	Amount	Explanations
Personnel Direct Costs	92.680 €	Staff costs as per 20,85 PMs: 11,11 PMs in WP2, 5,52 PMs in WP3 and 4,22 PMs in WP7 tasks. The R&D team devoted to the project tasks during P3 was composed by 8 people: 1 CEO (pay through salary), 4 Researchers, 2 Developers and 1 Project Manager
Equipment and Workstations	31.549 €	Seven (7) BCI systems provide to the consortium partners (3rd year depreciation). These costs are charged to the project in accordance with depreciation and dedication to the project as per FP7 financial rules
Other materials (fungibles)	1.587 €	PC, notebook and software tools. These costs are charged to the project in accordance with depreciation and dedication to the project as per FP7 financial rules.
Project meetings / Travels	7.199 €	Travel and accommodation for BrainAble plenary meetings Barcelona (3 meetings on February, March and November); After the prototyping, travels and accommodation expenses for the final installation in both planned locations: Liverpool (ANET testing) and Barcelona (FPING testing).
Dissemination fees	10.584 €	Relates to registration fees, travel and accommodation for the participation to the: *BNCI Workshop* (Schieldberg, Austria, January), *Workshop Tour* (Zaragoza, Valladolid and Madrid, Spain, April), *SSCN - BCI Special Session on Challenges in Neuroengineering* (Barcelona, October), *SFN-2012* (New Orleans, USA, October), the *International Conference on Neurorehabilitation* (Toledo, Spain, November) and the *BrainAble final workshop at RAatE* in Coventry (UK, November).
Indirect Costs	*64.619 €*	*(actual indirect costs)*
TOTAL COSTS	*208.218 €*	*Comments: G.TEC overspends in total the budget by about 6% mostly because of the need of more equipment for all the partners and higher travel costs.*

06 Abilitynet (ANET)

As lead partner for WP6 (user-centred design, validation and research into impact) Abilitynet (ANET) has helped coordinate user testing and data analysis in relation to the BrainAble prototype system. Major activities and outcomes have included: the development and validation of a comprehensive, battery of research instruments based on existing high quality research into assistive technologies but adapted and extended for multi-method BCI research, development and evaluation; the successful application for UK NHS research ethics approval; and 3 cycles of testing of the prototype with up to 10 non-disabled people and 8 disabled participants with a range of disabilities and progressive medical conditions. Abilitynet has gathered evaluation data and given feedback to the developers and then back to participants who have evaluated new developments to the prototypes. Abilitynet has produced the deliverable 6.4.3 (and 2 previous drafts) with partner Guttmann.

Engaging individual participants has involved close working with some of the key stakeholder organisations and networks that will be key to successful dissemination with a more developed prototype in particular the MNDA. The assistive technology research community has also been made aware of project activities through BrainAble project news updates on the ANET website, a workshop on World Disability Day (2011) in Liverpool John Moores University and a workshop and a paper on ethical issues in the project at the UK AT conference RAATE, the paper has been accepted for publication in a special issue for the international Journal Disability and Rehabilitation.

The need to establish close working relationships between researchers, developers, stakeholder groups and other interested parties has also informed a range of activities under WP7, including the development of web based case studies and a BNCI fact sheet for publication on the Abilitynet website. These will, in the first instance be of primary use within the Assistive technology community but their future role will be to contribute to a wider public awareness and training of technologists and health and disability professionals. Work on WP7 has included desk research on the AT market in Europe.

ANET has been the responsible author of D6.2 and D6.4.1-3 and has contributed to reports in WP7.

- Formed part of: *General Assembly* and *Project Board*

➲ *Financial reporting essential data (25-36PM):*

	Full Budget (as per	***2012 Costs (€)***		***Cumulate Y1-Y2-Y3***	
		2012 Actual	***%***	***In €***	***%***
Total	***161.339 €***	***67.591 €***	***42 %***	***173.609 €***	***108***

Notes: Minor mismatch (less than 1 €) between ANET figures presented in the report and those of the on-line Form C due to the **automatic rounding down applied by the NEF tool.**

➲ **Specific costs issues** and **details on costs items:**

PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEM FOR BENEFICIARY 6 FOR THE PERIOD AbilityNet		
Item description	Amount	Explanations
Personnel Direct Costs	48.354 €	Staff costs as per 9,20 PMs: 0,20 PMs in WP5, 4 PMs in WP6 and 5 PMs in WP7 tasks. The R&D team devoted to the project tasks during the last year was composed by 1 Research Analyst and 1 member of the Senior Management team.
User's testing fees	1.923 €	Nominal allowance paid to individual testers for attendance at user tests at Liverpool John Moores University
Project meetings / Travels	5.504 €	Travel and accommodation for BrainAble plenary meetings Barcelona (3 meetings on February, March and December); After the prototyping, travels and accommodation expenses for the testing process at Liverpool.
Dissemination fees	545 €	RAatE conference costs (final project workshop, November 2012). Includes subsistence costs for BrainAble project members' group dinner 25 November 2012 (9 people)
Indirect Costs	*11.265 €*	*(Flat Rate of 20%)*
TOTAL COSTS	*67 .591 €*	*Comments: The R&D team devoted to the project tasks during the last year was composed of a Research Analyst (Clare Carmichael) at AbilityNet with prior experience as an assessor and trainer for Assistive technologies with a specialism in complex and progressive disorders. In addition the Analyst is a qualified teacher with an MA in IT and Education and has experience of research and evaluation in a number of settings.* *The project is overseen by a member of the Senior Management Team (Dianne Cockburn) within AbilityNet who has extensive management experience in a variety of roles and has delivered projects for AbilityNet since 2003, having built on project management experience with their Prince 2 training.* *They have lead staff groups to meet organisational delivery and operational requirements through developing partnerships, working jointly, to deliver projects with different organisations, working across Government, Voluntary and Corporate sectors. They also have specialist knowledge of disability across all age groups and have experience of individual case management within large contracts.*

07 Fundació Privada Institut de Rehabilitació Guttmann (FPING)

FPING is mainly involved in WP6 (User-centred design, validation and research impact on cognitive recovery). During this third year, FPING has worked in tasks 6.3, 6.4 and 6.5. This implied user testing in FPING with more than 50 individuals with motor disabilities and/or cognitive impairment.

Within the **Task 6.3 Evaluation of individual components of BrainAble**, FPING has conducted four studies together with different technological partners. First was *long-term P300* study with G.TEC, second was *BNCI navigation study* with UPF, third was *input study* with G.TEC and the last one, *ERD + Hex-o-Select study*, with TU-Graz. All of them are described in D6.3.

During this third year, FPING was also responsible of the **Task 6.5 Cognitive tasks and mastering BNCI**. This task aimed to determine the relation between cognitive profile of individuals with brain injuries and their BCI performance. A study was designed and developed during the third year. The deliverable D6.5 describes this study.

Additionally, FPING was requested (during Y2 Review) to actively contribute in the BrainAble prototype testing. Therefore FPING did also recruit and participate in testing with disabled users of the entire system in iterations 2 (June 2012) and 3 (December 2012). This was within the **Task 6.4 Iterative evaluation for user-centered design**. The deliverable D6.4.3 describes the user testing for this last year of the BrainAble project.

- Formed part of: *General Assembly* and *Project Board*

➲ Financial reporting essential data (25-36PM):

	Full Budget (as per DoW)	2012 Costs (€)		Cumulate Y1-Y2-Y3	
		2012 Actual Costs	%	In €	%
Total	172.560 €	78.606 €	46 %	193.090 €	112 %

Notes: Minor mismatch (less than 1 €) between ANET figures presented in the report and those of the on-line Form C due to the **automatic rounding down applied by the NEF tool.**

➲ **Specific costs issues** and **details on costs items:**

PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEM FOR BENEFICIARY 7 FOR THE PERIOD		
Item description	Amount	Explanations
Personnel Direct Costs	48.892 €	Staff costs as per 12,34 PMs: 0,64 PMs in WP4, 11,33 PMs in WP6 and 0,37 PMs in WP7 tasks. The R&D team devoted to the project tasks during the last year was composed by 1 Research coordinator, 2 Heads of Clinical Dpts., 2 Clinicians, 1 Therapist, 5 Physiotherapists and 1 Engineer.
Equipment and Workstations	243 €	PC depreciation 3rd year. These costs are charged to the project in accordance with depreciation and dedication to the project as per FP7 financial rules.
Indirect Costs	*29.481 €*	*(Specific Flat Rate of 60%)*
TOTAL COSTS	*78.616 €*	*Comments: Partner FPING has been requested to provide additional contribution to the project: the testing of the full prototype, initially planned solely in the UK site was also conducted in their Centre. This extra effort in human resources has been possible by the split and moving to Personnel Costs of "unused" budget as for instance some travel expenses planned for the project meetings that finally took place in Barcelona or the production of audit certificate which is not necessary since the amount claimed by the partner to the EC remains is 375.000 €*

6.5. Distribution of the Community's Contribution

The Coordinator, Barcelona Digital Centre Tecnològic, certifies that no interests have been earned from the amount received in the BDCT account through EC Pre-Financing originated by the European project BrainAble (Grant Agreement: 247447). The Coordinator has timely distributed the amounts received from the EC in the 10 days following there reception according with the below table:

- **Pre-financing amount** of 1.111.667 €

- **Period-1 costs claims assessment**, EC payment calculation for an amount of 765.274 €

- **Recovering balance** from the partners having received up to 90% ceiling of EC Funding to ensure project cash flow (transfers received from partners UPF, G.TEC and FPING to the coordinator's account)

- **Period-2 costs claims assessment**, EC payment calculation for an amount of 78.059 €

FUNDING EC (per partner)			BDCT	TU Graz	UPF	METI	G.TEC	ANET	FPING	Total	BrainAble
			551.623,04	418.033,16	441.868,00	218.092,50	418.459,20	121.754,10	130.170,00	2.300.000,00	
160%	of linear annual	a) 1st pre-financing	294.199 €	222.951 €	235.663 €	116.316 €	223.178 €	64.936 €	69.424 €	1.226.667 €	
5%	of total funding (Guarantee Funds)	b) Guarantee Funds	27.581 €	20.902 €	22.093 €	10.905 €	20.923 €	6.088 €	6.509 €	115.000 €	
	(a-b)	1st transfer amount (~January-February	266.618 €	202.049 €	213.570 €	105.411 €	202.255 €	58.848 €	62.916 €	1.111.667 €	RECEIVED from the EC
		Data of transfers	27-ene-10	27-ene-10	27-ene-10	27-ene-10	27-ene-10	27-ene-10	27-ene-10		
Y1 assessment amount (up to 90% cumulated amount)		2nd transfert amount (~May-June 2011)	189.914 €	126.321 €	164.584 €	29.764 €	166.566 €	37.263 €	50.862 €	765.274 €	Costs assessed
(up to 90% cumulated amount)			N.A.	N.A.	yes!	N.A.	yes!	N.A.	yes!	765.274 €	RECEIVED from the EC
		Data of transfers	23-jun-11	21-jun-11	22-jun-11	23-jun-11	23-jun-11	23-jun-11	23-jun-11	765.274 €	Amount transferred
		Cumulate	484.113 €	349.272 €	400.247 €	146.080 €	389.744 €	102.199 €	120.286 €	1.991.941 €	Up to the ceiling
Received form partners / balance normalisation (May 2012)					2.566 €		13.131 €		3.133 €	16.264 €	Received from the partners
		Data of reception	N.A.	N.A.	1-jul-12	N.A.	15-may-12	N.A.	14-may-12		
Y2 assessment amount		Form C Cost claimed	170.927 €	184.818 €	165.297 €	84.639 €	121.647 €	42.250 €	34.992 €	804.570 €	Costs assessed
(up to 90% cumulated amount)		3rd transfert amount (~May-June 2012)	12.348 €	26.958 €	0 €	50.203 €	0 €	7.380 €	- €	78.059 €	RECEIVED from the EC
		Data of transfers		29-may-12		29-may-12		29-may-12		96.889 €	Amount transferred

At the date of the submission of this deliverable, **the Commission has formally initiated the process to recover non justified funds transferred to our ex-partner METICUBE**. Actually, since the company is formally in bankruptcy, the European Commission has needed to go for an official declaration to be registered on the list of creditors.

Subsequently, the Commission has decided to terminate the participation of METICUBE in the Grant Agreement relating to BrainAble project with retro-active effect from 14/09/2012.

Following EC request, the Coordinator formalised by written the amount of the financial contribution effectively transferred from the start of the project to METICUBE (letter sent to the attention of Mr. Paul Timmers dated February 1st, 2013) as per the below detail:

- Dated from the 27/01/2010 un amount of **105.411,38 €** - **Pre-financing minus 5%** retained in the guarantee funds
- Dated from the 23/06/2011 un amount of **29.764,00 €** - **Y1 Cost assessment**
- Dated from the 29/05/2012 un amount of **50.203,00 €** - **Y2 Cost assessment capped to 90%** of individual cumulate funding (**METICUBE assessed a higher amount for Y2** = 84.639 € were requested for funding)

7 List of Key Words/Abbreviations

ALS	Amyotrophic Lateral Sclerosis
AmI	Ambient Intelligence
AT	Assistive Technologies
BCI	Brain Computer Interface
BNCI	Brain-Neural Computer Interface
BVC	BrainAble Virtual Community
CA	Consortium Agreement
DoW	Description of Work (Annex I of the Grant Agreement)
EC	European Commission
EDA	Electro Dermal Activity
EEG	Electroencephalography
EMG	Electromyography
EOG	ElectroOculoGraphy
ERD	Event Related Desynchronisation
GA	General Assembly (in some contexts, used for Grant Agreement)
GUI	Graphical User Interface
HCI	Human Computer Interface
HOS	Hex-O-Select
ICF	International classification functioning, disability and health
MND	Motor neurone diseases
PB	Project Board
PMO	Project Management Office
SCI	Spinal Chord Injury
SoA	State of the Art
SSVEP	Steady State Visually Evoked Potentials
TBI	Traumatic Brain Injury
UCD	User Centred Design
UCH	Universal Control Hub
UDP	User Datagram Protocol
URC	Universal Remote Controller
VR	Virtual Reality
WHO	World Health Organisation
WP	Work Package
XML	Extensible Markup Language
Y1P	Year 1 Prototype
Y2P	Year 2 Prototype

Annex 1 – Use and Dissemination of Foreground

(In word version document, **double-click on the image to open the file**)

G.A.247447
Collaborative Project of the 7th Framework Programme


SEVENTH FRAMEWORK PROGRAMME

BrainAble

WP 7
Service design, Exploitation, and Dissemination

D7.6: Dissemination and Use Plan

Barcelona Digital Centre Tecnològic [BDCT]
V 2.0

11.01.2013

www.BrainAble.org

Annex 2 – Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

I. General Information

(completed automatically when **Grant Agreement number** is entered.

Grant Agreement Number:	247447
Title of Project:	**BrainAble**: *Autonomy and social inclusion through mixed reality Brain-Computer Interfaces: Connecting the disabled to their physical and social world*
Name and Title of Coordinator:	**Fundació Privada Barcelona Digital Centre Tecnològic** **Felip Miralles Barrachina** fmiralles@bdigital.org PMO_BrainAble@bdigital.org

II. Ethics

Did your project undergo an Ethics Review (and/or Screening)? • If Yes: have you described the progress of compliance with the relevant Ethics? **YES,** relevant information has been reported through section 4 of the Periodic Reports issued	***YES***
Please indicate whether your project involved any of the following issues (tick box) :	
RESEARCH ON HUMANS	
• Did the project involve children?	
• Did the project involve patients?	
• Did the project involve persons not able to give consent?	
• Did the project involve adult healthy volunteers?	**YES**
• Did the project involve Human genetic material?	
• Did the project involve Human biological samples?	
• Did the project involve Human data collection?	**YES**
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	
• Did the project involve Human Foetal Tissue / Cells?	
• Did the project involve Human Embryonic Stem Cells (hESCs)?	
• Did the project on human Embryonic Stem Cells involve cells in culture?	
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	**YES**
• Did the project involve tracking the location or observation of people?	**YES**
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	
• Were those animals transgenic small laboratory animals?	
• Were those animals transgenic farm animals?	
• Were those animals cloned farm animals?	
• Were those animals non-human primates?	
RESEARCH INVOLVING DEVELOPING COUNTRIES	
• Did the project involve the use of local resources (genetic, animal, plant etc)?	
• Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	
DUAL USE	
• Research having direct military use	
• Research having the potential for terrorist abuse	

III. Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	-	1
Work package leaders	3 (BDCT, ANET and G.TEC)	12
Experienced researchers (i.e. PhD holders)	-	5
PhD Students	-	8
Other	3	5

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	
Of which, indicate the number of men:	
BDCT	2
G.TEC	2

IV. Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project?	**YES**

6. Which of the following actions did you carry out and how effective were they?

		Not at all effective				Very effective
☒	Design and implement an equal opportunity policy	○	○	√	√	○
☒	Set targets to achieve a gender balance in the workforce	○	○	√	√	○
☒	Organise conferences and workshops on gender	○	○	√	√	○
☒	Actions to improve work-life balance	○	○	√	○	√

☒ Other:

Tu-GRAZ: Women in Engineering Mentoring, Equal pay project, Project Gender & Diversity, Child care. Definitely: Not only does TUG obey to the gender equality laws, it also has a number of gender equality policies in place, and there is a number of projects that deal with the topic:
http://portal.tugraz.at/portal/page/portal/TU_Graz/Services/3552/
http://portal.tugraz.at/portal/page/portal/TU_Graz/Gleichstellung
Tu-GRAZ does have equal opportunity policies in place. In addition there is a number of other programs and projects to improve diversity and gender equality. On a scale where 1 is Not at all effective and 5 is very effective, we would score the efficacy of our policies at a 4. While the number of women in our project did not exceed 50%, we did have female colleagues in key positions (including PI and head of the institute) in our team (Lisa Friedrich. Isabella Wagner, Prof. Christa Neuper). The rate of females is higher in other projects of our workgroup.

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please specify

☒ No

V. Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

☑ Yes- please specify

☐ No

ARS Electronica Museum (G.TEC): the Museum of Future in Linz, Austria, is a unique facility with 3.000 m² exhibition space. One main part of the exhibition is the BrainLab. Here the visitors have the chance to make a journey through the fascinating world of the human brain. Visitors even have the chance to interact with computers only with the power of their minds with so called brain-computer interfaces. This devices were provided by g.tec medical engineering GmbH. With g.tec's biosignal amplifier g.MOBIlab+ and its analyzing software, the visitor can use brain-computer applications like the "Speller", the "Smart Home" and a "Robot Control via SSVEP".

TU-Graz BCI institute and specifically project was supporting a number of student projects, bachelor thesis and master thesis. In addition our project contributed to our institutes open lab night to get students and the public in touch with current scientific research. At numerous occasions we spend a significant amount of time presenting our institute to school classes. We show them around at the institute and explain everything to them.

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

☑ Yes- please specify

☐ No

- **ARS Electronica Museum (G.TEC)**
- **Materials for classes** to Master Students **(FPING)**
- Three **videos on BrainAble system** for the general public **(BDCT)**
- **Internal wikipedia site** that **TU-Graz** students working with the institute can use for educational purposes. For numerous occasions we spent a significant amount of time creating flyers, large posters and other material used to explain our research to students, pupils and the general public.

VI. Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

☑ Main discipline[13]:
3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

☑	Associated discipline[13]: **1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]**	○	Associated discipline[13]:

Question F-10: Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

FIELDS OF SCIENCE AND TECHNOLOGY

1. NATURAL SCIENCES
1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]
1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)
1.3 Chemical sciences (chemistry, other allied subjects)
1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)
1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2 ENGINEERING AND TECHNOLOGY
2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)
2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]
2.3. Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES
3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)
3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)
3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES
4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)
4.2 Veterinary medicine

5. SOCIAL SCIENCES
5.1 Psychology
5.2 Economics
5.3 Educational sciences (education and training and other allied subjects)
5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary , methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

[13] Insert number from list below (Frascati Manual).

VII. Engaging with Civil society and policy makers

11a Did your project engage with societal actors beyond the research community? *(if 'No', go to Question 14)*	☑ ☐	Yes No

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

- ☐ No
- ☑ Yes- in determining what research should be performed
- ☑ Yes - in implementing the research
- ☑ Yes, in communicating /disseminating / using the results of the project

ANET is an organized civil society (NGO); **Abilitynet** has a lot of contact to patients. So does the Guttmann Institute. **TU-Graz** was in very close collaboration with both of them.

11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	☑ ☐	Yes No

12. Did you engage with government / public bodies or policy makers (including international organisations)

- ☐ No
- ☐ Yes- in framing the research agenda
- ☐ Yes - in implementing the research agenda
- ☑ Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- ○ Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ☑ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

Agriculture Audiovisual and Media Budget Competition Consumers Culture Customs Development Economic and Monetary Affairs Education, Training, Youth Employment and Social Affairs		Energy Enlargement Enterprise Environment External Relations External Trade Fisheries and Maritime Affairs Food Safety Foreign and Security Policy Fraud Humanitarian aid		Human rights ☑ **Information Society** Institutional affairs Internal Market Justice, freedom and security ☑ **Public Health** Regional Policy ☑ **Research and Innovation** Space Taxation Transport	

13c If Yes, at which level?

- ○ Local / regional levels
- ☑ **National level**
- ☑ **European level**
- ☑ **International level**

VIII. Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?		10
To how many of these is open access[14] provided?		5
How many of these are published in open access journals?		5
How many of these are published in open repositories?		-
To how many of these is open access not provided?		5
Please check all applicable reasons for not providing open access:		
☑ publisher's licensing agreement would not permit publishing in a repository ❑ no suitable repository available ❑ no suitable open access journal available ❑ no funds available to publish in an open access journal ❑ lack of time and resources ❑ lack of information on open access ❑ other[15]: ……………		
15. How many new patent applications ('priority filings') have been made? *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).*		1 (G.TEC)
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	2 (G.TEC)
	Registered design	-
	Other	-
17. How many spin-off companies were created / are planned as a direct result of the project?		1
Indicate the approximate number of additional jobs in these companies:		2

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

☑	Increase in employment, or	☑	In small & medium-sized enterprises
❑	Safeguard employment, or	❑	In large companies
❑	Decrease in employment,	❑	None of the above / not relevant to the project
❑	Difficult to estimate / not possible to quantify		

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:* 4

[14] Open Access is defined as free of charge access for anyone via Internet.
[15] For instance: classification for security project.

IX. Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?

○ Yes ☑ No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?

○ Yes ☑ No

22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?

☑	2Press Release	☑	Coverage in specialist press
☑	1Media briefing	☑	Coverage in general (non-specialist) press
☑	2TV coverage / report	☑	Coverage in national press
☑	Radio coverage / report	☑	Coverage in international press
☑	1Brochures /posters / flyers	☑	Website for the general public / internet
☑	1DVD /Film /Multimedia	☑	Event targeting general public (festival, conference, exhibition, science café)

23 In which languages are the information products for the general public produced?

☑	Language of the coordinator	☑	English
☑	Other language(s) **SPANISH and CATALAN**		