



FINAL PROJECT REPORT

– Revised Version April 3rd, 2013 –

Please send this report ELECTRONICALLY to the Central Management Unit (CMU) as well as a copy to the National Contact Persons (NCPs) of the coordinator and project partners

The coordinator of the project must submit this report within 60 calendar days after the final date of the project, on behalf of the consortium.

***If you have any additional question,
please contact the AAL CMU at CMU@aal-europe.eu,
or your NCP (see details on www.aal-europe.eu/aal-ncp)***

Report date	3/4/2013
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PUBLISHABLE PROJECT INFORMATION (TO BE USED BY AALJP)

1A.PROJECT	
Project full title	Domestic Robot for Elderly Assistance
Project acronym	DOME0
Project No.	aal-2008-1-159
Project Website	http://www.aal-domeo.org
Project duration	•Starting date: 1/7/2009 •Termination date: 31/12/2012
Coordinator's name and details	Full name: Vincent DUPOURQUE E-mail address: vincent.dupourque@robosoft.com Telephone number: +33-559 415 360

1B. PROJECT PARTNERS					
No.	PARTNER ORGANISATION NAME	PARTNER ORG. ACRONYM	TYPE*	PROJECT COSTS: PUBLIC GRANT IN EURO	PROJECT COSTS: PARTNER OWN CONTRIBUTION IN EURO
1 (coord.)	ROBOSOFT	ROBO	SME	529 120 €	176 373 €
2	Institut des Systèmes Intelligents et de Robotique	ISIR	RTD	222 660 €	0€
3	Centre Hospitalier Universitaire de Toulouse	CHUT	RTD	429 921 €	0 €
4	Országos Orvosi Rehabilitációs Intézet	NIMR	END USER	175 862 €	0 €
5	Thales Alenia Space	TAS	Large	193 189 €	268 499 €
6	Vienna University of Technology, Institute "integrated study"	TUW	RTD	129 821 € ¹	43 274 €
7	Budapest University of Technology and Economics	BME	other	210 808 €	0 €
8	Meditech	MED	SME	102 984€ ²	30 172€ ²
*Please select one of these options: SMEs, Large, END USER, RTD, other					

¹⁾ Assumption, expected funding based on claimed costs

²⁾ Based on the following HUF/EUR exchange rate: 1 EUR = 290 HUF (Public grant in HUF 29.865.500 / Partner own contribution in HUF 8.749.916)

1C. PUBLISHABLE PROJECT RESULTS SUMMARY (1 PAGE)

In this section, please present the results of your project, including the following information:

Amendments in the revised version are underlined.

Below is a short selection of videos giving quick understanding of the project :

- DOMEQ project presented by Kompaï: <http://is.gd/md1Jdx>
- What Kompaï does: <http://is.gd/1rKsk5>
- Principle of home trials: <http://is.gd/50GkQS>

More videos are available in the video section of the DOMEQ website www.aal-domeq.eu

- what is your product/service (result of the AAL JP project work)

The main and more visible result of DOMEQ is a modular assistant robot to help dependent persons staying longer and safer at home. It has been evaluated, at different levels, in its cognitive and physical assistance versions. These robots are called Kompaï (means companion in Basque language, D4.0, D4.1, D4.2) and robuWALKER (D3.2), both born thanks to DOMEQ. The services around such devices have been implemented as prototypes and extensively tested with end users during the last year of the project

- what needs/problems does your product/service respond to

DOMEQ aims to give solution for the emerging problems of ageing Europe by providing a companion robot that is able to give cognitive support for elderly people with mild cognitive deficit (D1.4 p6-13). The Kompaï robot can bring the internet closer to the elderlies by a user-friendly interface while enhancing safety and allow remote assistance and doubt removing for relatives and caregivers.

- what are the target groups of users and payers

If such robots have been designed for dependent persons, most of them being elderlies, the exploitation analysis led to demonstrate that they will mainly be operated by call centers and geriatric organizations, hence secondary users will be professional caregivers as well as users of telemedicine service. The cost of the service including rent fee of the robots foreseen to be paid by public or private insurances plus out-of-the-pocket money. (D1.5 sections 2., 3., and 5.) Interesting to note that one of the Hungarian end user expressed wish of purchasing the robot right after the expiration of the test period. Finally the family bought a computer to the elderly user. (D7.3 p25)

- what is the technological innovation of your product/service (in terms of novelty of concept, approach to the development etc.)

The main technological innovation in DOMEQ is twofold : the design of robots and robot mediated services were accepted by final and secondary users during long-term experimentations with real people in real conditions (D7.2.1.3, D7.2.1.4, and D7.3). These experimentations are the first ones all over the world, while other projects are still at the research stage. Secondly, to help spreading the technology and keeping low costs both hardware and software architectures of the robot follows a modular, integration

platform strategy, a systems engineering feature that is available at all service robot solutions of Robosoft (D1.5 section 3 and 4). Modularity unlocks the possibility to create tailor made service customization to each individual user at low cost and fast delivery. Integration framework and open source control software unlock the easy interfacing with telecare systems and security and supervisory surveillance systems

- **what is the social innovation of your product/service (benefits to society and economic impact)**

The social innovation is tremendous: companion robots allow social link, by being available anywhere at any time in the home, and we demonstrated the acceptability (easy to use) by dependent persons, thanks to vocal and tactile interactions. DOME0 has clearly demonstrated the social benefits of companion robots, for elderlies but also care-givers and family. (D7.2.1.4 section V: telemedicine scenario, D7.3 section III: social link scenario)

- **which type of end-users have been involved in the project (how many and in which way)**
- robuWalker tests were conducted in France with 4 elderly people without cognitive or motor impairment aged 71 to 86; 9 patients with motor and cognitive impairment aged 80-96 (D.3.2 section 5).

Kompaï home deployment tests were conducted in France with 7 participants, 5 primary users out of them aged 66 to 98, and 2 secondary users out of them aged 19 and 23. (D7.2.1.3)

Users were recruited in Hungary in pensioner clubs and by asking relatives of the DOME0 staff. As a result, 8 elderly user, 7 women and 1 man (aged between 70 and 83 years) tried the Kompaï robot in their own homes between Sept 2011 and Dec 2012. Each of them tested the functions of the robot for about three months, resulting 744 testing days (with two robots altogether). All of the users were living alone. Half of them had never used a computer before. The users were well informed and signed the consent form. (D7.3)

- **what is the expected time to market and what are the main possible barriers**

We believe that the time to market ranges from 12 to 18 months (D1.5 sections 4, 5, and 7). DOME0 helped to clarify the needs, realize operational prototypes and experiment in real conditions. We can consider that there is no more conceptual barrier, the challenge being industrialization of the product, and set up of partnerships (manufacturer, installers, exploitation operators...). One of the main technical remaining challenges will be to reach a 24/7 operation of the equipment and associated services, to be able to provide a professional assistance. Overall dependability of the products should be improved and matched the high standard of white products, consumer electronics, medical devices, etc. Though the main mission of Kompaï was the cognitive assistance, a small payload (< 0,5 kg or < 1 kg) manipulator arm on board would have been welcomed by the subjects. This is the main technical conclusion of the 16-months trials.

CONFIDENTIAL PART OF THE REPORT

2. DELIVERABLES SUBMITTED AND MILESTONES ACHIEVED DURING THE PROJECT

In this section, please provide details in case your project deviated from the Description of Work (work plan) with respect to delivery dates, achievement of milestones or changes in planned outputs; please indicate whether and to whom (AAL NFA/NCP) the changes have been communicated.

An evolution of DoW has been made after the mid-term review, and accepted by AAL and NCPs. All deliverables have been submitted; milestones and the objectives of the revised workplan have been achieved. Deliverables D3.2, D4.3, D5.1, D5.2, D7.2.1.1, D7.2.1.2, D7.2.1.3, D7.2.1.4 were submitted later than planned partly because of extension of internal technical work (D3.2), or of delays caused by external reasons (delay of standard editing: D4.3, legal issues with ethics approval: D7.2.1.1, D7.2.1.2), or delayed compilation of the report (D5.1, D5.2, D7.2.1.3, D7.2.1.4). None of these delays led to adverse consequences in technical work either because these deliverables were the last reports of their work packages or were consecutive items in a series of reports.

Has the project been finalised in line with the Description of Work?

YES ☒

NO ☐

PARTLY ☐

IN CASE OF DEVIATION, PLEASE EXPLAIN:

SINCE REVISION OF DoW, NO MAJOR DEVIATIONS, ONLY DELAYED DELIVERABLES

Has the project achieved its expected results as described in the Description of Work?

YES ☐

NO ☐

PARTLY ☒

IN CASE OF DEVIATION, PLEASE EXPLAIN:

WE HAVE TO NOTE THE FOLLOWING INCOMPLETE RESULTS :

The 24/7 performance dependability of the robot was not adequate for long term autonomous operation in a home settings. This was an unexpected result not forecasted by factory, living lab and institutional tests. DOME0 has helped to understand the needs and to meet this fundamental challenge with the next product version.

3 A. PROJECT RESULTS - SCIENTIFIC/TECHNICAL PROJECT RESULTS

Provide a summary of the confidential results, including:

- **The progress per work-package**

WP0 : Project Management. The coordinator recognizes the weakness of project management during the first part of the project. In the DoW, partners committed to reduce travels, but we experienced technical problems during internet meetings. Several Management Board meetings took place

(physical and remote), but only a few meetings were organized by WP leaders, reflecting the lack of involvement to achieve common goals. At this stage of the project the delay of the robot prototypes presented major barrier to many work packages. National grant agreement and financial support anomalies were affected the work of Hungarian participants. But the Management Plan has been applied as described. The management of the project was reorganized after the MTR (December 2010), and kept a rigorous manner until the end of the project.

WP1 : Economic and Service Model

A complete economic model, based on a B2B approach, has been elaborated and detailed. This study shows that assistant robots need to be integrated in care provision environment to be efficient, and must be operated by organizations such as call centers. A theoretical business plan is proposed in D1.5. This DEL has been kept confidential.

WP2 : Field Test Methodology: The field test model was designed for both assistive robots of DOME0. Not only technical operation but administrative procedures like ethics approval, safety certification were considered. Test description model file was prepared.

WP3 : robuWALKER: a Smart-Walker called robuWALKER has been developed, based on the Kompaï's basic components. Because it has been declared as a "medical device" by ethical committees, we were not allowed to deploy it in real homes. In the latest DoW, we nevertheless decided to carry out site demonstrations, and were finally able to do more. Trials were completed with real patients, in hospital rehabilitation service, using force controlled walker. The development of robuWALKER was an iterative process, with the first testing campaign that led to a new version with haptic control.

WP4 : robuMATE. 5 robots have been built and made available at mid-term. 2 of them have been used by partners, for testing, evaluation, experimentation and development of advanced algorithms. The remaining 3 robots were delivered to the sites of the field test at the beginning also for testing, localization, customization. DOME0 has contributed to ongoing standardization activity in selected ISO/IEC working groups on non-medical and medical person care robots, Kompaï has also been used to verify the compliance with the requirements set out in draft ISO 13482 Robots and robotic devices -- Safety requirements for non-industrial robots -- Non-medical personal care robot.

WP5 : the concept of robuMASTER has been changed during the project execution. At the beginning the goal was to develop an independent computer and it turned into a piece of software running on the robots. Its main role is to interface (communicate) the home devices and the robot and send the collected data to the care center. This goal has been achieved. As the next step the integration of the medical devices (weight scale, blood pressure, ECG pad) were done. The solution has been tested successfully in many different scenarios and environment (lab, living lab, testfield). The data was sent smoothly from the medical devices to the care center.

WP6 : Communications

Detailed studies of communications issues and solutions for further deployment have been evaluated in this WP.

WP7 : Deployment in patient's homes. Deployment of the robots was done according to the ethical requirements in France and Hungary (with 1 and 2 robot respectively). While the main objective of the Hungarian field trial was to test the robot companion functions, the aim of the French field tests was also to test the telemedicine functions. Both field tests have concluded the acceptance and usefulness of the services of the Kompaï robot as home deployed care robot for single elderly. Invaluable knowledge – mainly for the robot manufacturer ROBOSOFT - has been capitalized on the long term real condition tests. Recommendations for product and service refinements have been concluded.

WP8 : Dissemination. Thanks to the visibility of such a device, and dynamism of both academic and industrial partners, the dissemination was very active: see specific section below.

- **The performance of the project consortium (added value of cooperation, added value and performance of each partner etc.)**

The lifetime of DOMEQ project can be broken down into two sharply different periods. The baseline described in the DoW at project kick-off was not entirely valid. We consider conditions such as the availability of ready to test/deploy robots, carefully revisited legal, ethical, and technical conditions of deploying an assisting robot to home and to institutional care environments, cultural and legislation differences in the European Union. It took a significant time until project participants found the way out of this situation. At project halftime the tasks were rearranged and project goals were clarified. In the second period including a 6-month extension with hard and collaborative work of each partner the revisited project objectives have been entirely completed. Among the original objectives only a few have been partly completed like the field test of the physical assistance robot, the integration of the DOMEQ service with institutional medical/telecare services, and omission of some smart robotic function for the sake of a reliable operation.

Even if results are quite good, we can regret that the consortium did not find common software tools, making selected academic developments not usable for the evaluation phase. The cross-capitalization between Hungarian and French trials has also been limited due to the difference in the availability of telemedicine services.

Added value and performance of each partner:

- ROBO: development of robots, and technical support to trials
- ISIR: development of advanced robotic functions, to prepare next generation of robots
- CHUT: contribution to steering of field test methodology, preparation for and execution of the field tests in France
- NIMR: steering of field test methodology, preparation for and execution of the field test in Hungary – active, timely and professional contributions
- TAS: development of communication architecture, and tests
- TUW: rigorous technical and usability testing of basic and advanced Kompaï functions – always critical and precise contributions
- BME: lab test, later development of the Kompaï robot and on site engineering support to field test, standardization expert – flexible in role and contributions, solidarity in financial support to other partner
- MED: provision of medical sensors both for Kompaï and robuWALKER, software interface, integration – professional and timely contribution

- **Scientific/technical achievements during the course of the project**

The main technical achievements are the robots themselves, including their software modules (navigation, Man-Machine Interface...). The voice and graphic interaction with the user has been improved all along the project to reach a good level of performance, validated during trials. he cognitive assistive robot Kompaï especially together with the advanced functions is quite ready for the market whereas the robuWALKER will need to undergo a refinement-test cycle. Both robots need improvements in product robustness and dependability.

- **End-user services developed during the course of the project**

Development of end user service per se was not among the objectives of the DOMEQ project. Field tests performed in WP7, however, substantially approximated of real elderly- and telecare scenarios.

- **Other confidential information**

(1 page maximum)

3 B. PROJECT RESULTS – BUSINESS MODELS & INDICATORS

Please insert here a short summary of the **business model** selected for your product/service (max. ½ page). If not explained in the publishable summary section, please describe:

The business model is detailed in D1.4 and D1.5 deliverables.

A majority of seniors want to keep living at home for as long as possible. In addition, staying at home is much cheaper than going into a nursing home - both alternatives require human daily assistance, but there are fewer and fewer workers compared to retired people, and shortage of caregivers is now a reality. Companion robots may contribute to bring solutions to this new societal problem, i.e., to help seniors staying at home while reducing long-term care costs. DOME0 is a robot companion project. It is able to move autonomously around the home, with remote control capabilities for caregivers, doctors and relatives, it also has cognitive and physical stimulation capabilities. The economic model behind DOME0 is a combination of robot sales and clouds of services for communities taking care of seniors: after selling the robots, virtually all people and organizations helping seniors may subscribe to web services to do their jobs thanks to the robots. The DOME0 project first target the European market health services but can target other markets later on. A list of opportunities and threats has been identified. Several business models can be considered, they are also presented in this document.

- What **product/service** will you offer?

Robots (for cognitive and physical assistance), autonomous and remotely controlled from a call center

- What main problem(s) does it solve or what **benefits** does it provide to the customer?

Staying longer and safer at home. Socialization of lonely dependent persons

- What is the **added value** of your product/service versus that of competitors and/or compared to existing solutions on the market? What is your **unique selling proposition**?

The main difference is technology which allows professional caregivers and family to be more efficient, and spend their time with the person rather than duties

- How will the product be sold? Who will **provide** products/services?

The robots will be mainly sold to call centers, which will dispatch and operate the robots. Care services will be done by professional caregivers, while local 3rd companies will provide technical services.

Please answer the questions below, if possible:	
What is the targeted range of manufacturing/service costs per product/service unit (€, € per month etc.)?	300 to 500 €/month
What is the estimated size of the targeted market in Europe for your product/service (in €)?	100 billions €
In your business model, who will pay for the product/service (you can tick more than one box): ☒ End user (older person) ☐ Informal carers ☐ Formal care providers ☒ Public subsidies ☒ Insurance ☐ Other (add if necessary) ☐ not yet decided	
In your business model, who will take the decision about purchase of the product/service (you can tick more than one box): ☒ End user (older person) ☐ Informal carers/family ☐ Formal care providers ☐ Public subsidies ☒ Insurance ☐ Other (add if necessary) ☐ not yet decided	
At what stage of development are you with your product/service (e.g. research, pilot, real life trial etc.)?	End of "proof of concept"
When will your product/service be ready for market ?	12 to 18 months
What type of further research/development is necessary to finalize the product (technical, adoption, market research etc.)?	Large scale pre-deployment
What further investments are necessary to launch product on the market?	3 to 5 M€
<i>Please insert here any other information related to the business model, such as:</i> - <i>what is the targeted market niche?</i> Dependent person staying at home, followed by call centers or living in institution - <i>do you need certification for your product/service before gaining access to the market?</i> Yes. - <i>what type of certification and from who?</i> Machinery Directive and ISO 13482 (evaluated during the project). In case of medical service the Medical Device Directive. - <i>do you need to perform reliability testing?</i> Yes. The key issue is to reach a robust long term (during several weeks) 24/7 operation. - <i>Any other information</i>	

3 C. PROJECT RESULTS – END USER INDICATORS

In the section below, please provide the information you have gathered during your project on primary, secondary and tertiary end-users¹ of your product/service. Note that secondary end-users can be formal and informal carers (see footnote). For the indicators cited below, please provide information if available; any other qualitative or quantitative information on beneficiaries can be provided instead.

Please provide your information on end-users here. This may include:

- Type of end-user (primary, formal and informal secondary, tertiary end-users)
- Total number of end-users involved (by type of end-user, gender etc.)
- Average age and age distribution of involved end-users
- Location of end-user (rural, town, large city etc.)
- Situation of end users (single household/family setting/etc., independence)
- Health status (disabilities, mobility, cognitive function etc.)
- Socio-economic background (education, income class etc.)
- Any other information

NIMR (Hungary – field test)

- Type of end-users: primary end-users
- Total number of end-users involved: 8 end-user (1 man, 7 women)
- Average age and age distribution of involved end-users: average age 77,125; between 70 and 83 years
- Location of end-user: private apartments in a large city (Budapest)
- Situation of end users: single household, living alone
- Cognitive function: MMSE 28-30
- Education: 2 of them: polytechnic; 2 of them: secondary school; 4 of them: college
- 4 users had computer or experience with computers, 4 users had none
- Approximated number of secondary end users: 40. The number is approximated because the secondary end users due to ethics reasons were not formally included in the study, the role of formal caregiver has been played by DOMEQ staff members. Based on scheduled and unscheduled visits, on log files, on skype contacts recorded the number of secondary end users can be quite precisely approximated.

CHUT (France – field test)

- Focus groups participants: 4 elderly residents with Alzheimer's disease (primary 1, secondary 2, university 1) aged 78-85, MMSE <5 to 16; 4 aged natural care givers (primary 1, secondary 1, university 2) aged 75-91; 4 professional caregivers (university 2, secondary 2) aged 30-57.
- Walker tests participants: → Robuwalker with button interaction: 4 elderly people without cognitive or motor impairment (4 university) aged 71 to 86; 5 patients with motor and cognitive impairment (2

¹ Definition of end-users in AAL Joint Programme:

- Primary end-user is the person who is actually using an AAL product or service, a single individual, "the well-being person". This group directly benefits from AAL by increased quality of life.
- Secondary end-users are persons or organisations directly being in contact with a primary end-user, such as formal and informal care persons, family members, friends, neighbours, care organisations and their representatives. This group benefits from AAL directly when using AAL products and services (at a primary end-user's home or remote) and indirectly when the care needs of primary end-users are reduced.
- Tertiary end-users are such institutions and private or public organisations that are not directly in contact with AAL products and services, but who somehow contribute in organizing, paying or enabling them. This group includes the public sector service organizers, social security systems, insurance companies. Common to these is that their benefit from AAL comes from increased efficiency and effectiveness which result in saving expenses or by not having to increase expenses in the mid and long term.

university, 2 secondary) aged 80-96, MMSE 17-26 → Robuwalker with haptic interaction: 4 patients with motor impairment (1 university, 1 secondary, 2 primary) aged 82-93, MMSE 12-26.

- Kompaï home deployment: 5 participants (4 university, 1 secondary) aged 66 to 98, MMSE in the two patients 19 and 23.

TUW (Austria – focus group study)

- Caritas Socialis Alzheimer day-care centre in Vienna, primary plus formal and informal secondary
- Group 1: The persons with dementia or the end users consisted of:
2 women, ages 83 and 85, with MMSE 26 and 27
1 man, age 81, MMSE 21
Visit the Daycare Centre 4 times, 2 times, 4 times respectively
- Group 2: The family carers/relatives of persons with dementia, intermediate users, consisted of:
2 men (a spouse and son), one woman (spouse)
all over 65 years of age
- Group 3: Caregivers at the Integrative Daycare Centre
It was not possible to recruit male caregivers at the Integrative Daycare Centre. Caring for persons with dementia is predominantly in hands of female employees.
The group consisted of three female employees, whose ages were 24, 38 and 39.

3 D. PROJECT RESULTS – OTHER INDICATORS

Patents, which are the direct result of the project work

ROBOSOFT has pending patents regarding some mechanical features of Kompaï (D1.5)

Collaboration to **standards**, which are the direct result from the project work

DOMEO has contributed to ongoing standardization activity in ISO TC/184 SC/2 WG/7 working on ISO 13482 Robots and robotic devices -- Safety requirements for non-industrial robots -- Non-medical personal care robot. This standard is in its 2nd balloting stage and likely will be published in 2013. (D4.3)
DOMEO has also contributed to joint working group of ISO TC/184 SC/2 and IEC TC/62 SC/62A JWG9 that evaluates Medical electrical equipment and systems using robotic technology. In case of positive decision a collateral standard (IEC 60601-2-x) will be developed in the family of Medical Electrical Equipment safety standards.

Publications (scientific or other) , which are the direct result from the project work (please provide details)	The consortium has been very active in dissemination : • 14 scientific publications • 40 project presentations They are all available at www.aal-domeo.eu in the dissemination section. Please login with name : reviewer pwd : domeo64
Other dissemination activities	See also videos and TV presentation in the video section of the website
Type and size of audience reached by dissemination activities	Thanks to TV and presentations, we have reached millions of people

4. FINANCIAL INFORMATION - OTHER COMMENTS

Please check appropriate box:

The financial part of the project ☒ is in line with (or) ☐ deviates from the partner's Grant Agreements & Work Packages plans (personal efforts, other costs, etc.)?

In case of deviation, please give a short explanation:

.....

Other comments related to financial part of the project:

TUW : Slight underspending in both effort and costs

5. AAL JP PROGRAMME

Please comment, using your AAL project experience, on the main advantages and disadvantages of AALJP projects.

The opinion of the consortium is that AAL scheme support to large scale and real trials removes a major barrier from the transfer of research results to marketable products/services: the deployments we made have shown serious differences between living (or research) labs and real homes. DOME0 is the very first project which deployed real assistant robots in real homes. Compared to engineering research or deployment in controlled environments, research in the home of the users is unveiling a wide range of issues that would affect commercial operation.