SEVENTH FRAMEWORK PROGRAMME

ICT – Challenge 2
Cognitive Systems, Interaction, Robots

Collaborative project

Annex I - "Description of Work"

*** SHORT Version, for information only***

Project acronym: *SERA*

Project full title: Social Engagement with Robots and Agents

Grant agreement no.: *231868*

List of Beneficiaries

Beneficiary Number	Beneficiary name	Beneficiary short name	Country	Date enter project	Date exit project
1 (coordinator)	Österreichische Studiengesellschaft für Kybernetik	OFAI	AT	1	24
2	University of Sheffield	USFD	UK	1	24
3	University of Twente	UT	NL	1	24
4	University Duisburg-Essen	UDE	DE	1	24

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Part A

A 1. Budget breakdown and project summary

A 1.1 Overall budget breakdown for the project

Participant	RTD/ Innovation (A)	Demonstration (B)	Management (C)	Other (D)	Total (A+B+C+D)	Total receipts	Requested EC contribution
OFAI	299,840.00	0.00	40,676.00	50,420.00	390,936.00	0.00	315,976.00
USFD	468,683.00	0.00	4,787.00	5,600.00	479,070.00	0.00	361,899.00
UT	383,762.00	0.00	12,232.00	12,232.00	408,226.00	0.00	312,285.00
UDE	187,520.00	0.00	11,200.00	8,000.00	206,720.00	0.00	159,840.00
Total	1,339,805.00	0.00	68,895.00	76,252.00	1,484,952.00	0.00	1,150,000.00

A 1.2 Project summary

The project SERA (Social Engagement with Robots and Agents) aims to advance science in the field of social acceptability of verbally interactive robots and agents, with a view to their applications especially in assistive technologies (companions, virtual butlers). To this aim, the project will undertake a field study in three iterations to collect data of real-life, long-term and open-ended relationships of (fully consenting and healthy adult) subjects with robotic devices. The three iterations test different conditions (functionalities) of the equipment, which will consist of a room equipped with sensors at the subjects' home, a computer and a simple robotic device (the Nabaztag) as the front-end for interaction. The project partners will analyse the collected audio and video data in parallel, using different, mainly qualitative, methods. Data analysis will be prepared and accompanied by theoretical and methodological research in order to a) take into account the state of the art and b) ensure quality of the field study. The project will use findings from the field study to specify, build and implement a reference architecture for social engagement, and use it for developing a showcase system of combined speech based service applications with relevance to the target field and audience.

Part B

B 1. Concept and objectives, progress beyond state-of-the-art, S/T methodology and work plan

B 1.1 Concepts and objectives

B 1.1.1 Concepts and approach

Much research and development is dedicated to virtual (agents) and embodied (robots) devices that serve as assistive technology especially to elderly or homebound people. There are already some ongoing EU-funded projects around this issue (Companions, LIREC, Semaine and others).

Practical experiences with today's conversational interactive systems however show the deep gap between the utopian "companion" and today's clumsy attempts. Interaction is invariably disappointing or boring, if not outright irritating. A majority of users do not wish to use such systems again, and many feel growing aggressiveness leading to verbal or physical "abuse" of the machine [Walker et al, 2002 and De Angeli et al, 2005, 2006].

Getting people to engage with robotic and virtual artifacts is easy, but keeping them engaged over time is hard. Yet, artifacts that are supposed to take long-term assistive, coaching, mediating or educational roles in people's everyday lives have to blend into these lives, i.e. they have to be sociable.

The problems addressed and the approach taken by SERA are summarized in the following table:

Problems addressed	**SERA hypotheses**
Problem Area 1: Knowledge of real-life human-robot relationships	
Time limits, lab settings, and pre-defined tasks are an inappropriate basis for studying how social relationships evolve between humans and interactive artifacts. Analysis of the data gained from such experiments mostly serves specific research and development interests.	The research community needs knowledge about long-term, open-ended[1] social relationships between humans and robots/agents. There is a need for open-ended, explorative analysis of data from human-artifact interaction.
Problem Area 2: Holistic view of sociability	
The specialized and focused study of individual behavioural phenomena (such as gaze, gesture, language) will not by itself add	Sociability involves perceptiveness of and responsiveness to individuals' and groups' needs, moods, habits, idiosyncrasies, changing

[1] In the present context, we take "long-term" to mean a relationship that lasts long enough for any novelty effect to wear off (estimated at one week). "open-ended" means that the interaction goal and nature of the relationship is set by the user within the limits of the artifact's functionality.

up to complex social behaviour.	macro- and micro-situations, cultural background, social norms and conventions. Sociability is therefore a complex whole, and much more than its (behavioural) parts. Sociability with artifacts has to be studied as a whole. Social engagement has to be addressed directly in its complexity and on sound interdisciplinary theoretical foundations.
Problem Area 3: Social-emotional architectures	
To be sociable, robots and agents will ultimately need a representation of users, their social and cultural background, and of interaction situations and contexts.	This representation (in the broadest sense) has to integrate theory of mind and emotionality, situational awareness and general behavioural patterns. A key element is the capacity to be aware of and to manage social-emotional relationships.

B 1.1.2 Objectives, output and criteria of success

The project will work onwards from these three hypotheses, with the following objectives:

> *OBJECTIVE 1. To generate new and much-needed knowledge about social relationships between users and robots*

Project activities pertaining to this objective are laid out in detail in the descriptions of WP 2 (Field Study) and WP 1, task 1.3 (Data analysis).

Output: ***Video corpus on real-life long-term human-robot relationship; analysis results gained through the application of different (qualitative) and inter-subjectively/theoretically validated methods.***

> *OBJECTIVE 2. To make progress in the methodology with which social engagement between robots/agents and humans can be studied, tested and evaluated*
>
> *OBJECTIVE 3. To contribute to the development of theoretical foundations of human-robot/agent social relationships*

Project activities pertaining to these objectives are laid out in detail in the description of WP 1.

Output: Theory and methodology survey and critical review (released for easy public access, e.g. as Wiki), coordinated publications and presentations targeted at the research community; a blueprint for the architecture.

> *OBJECTIVE 4. To develop, on theoretical grounds and empirical results, a social-emotional reference architecture for interactive robots and agents, and to implement it to a proof-of-concept state.*

Project activities pertaining to this objective are laid out in detail in the description of WP 3.

Output: Architecture specification and its proof-of-concept implementation, as an open access research platform.

OBJECTIVE 5. To develop and test a portable showcase of intertwined service applications in this architecture

Project activities related to this objective are laid down in detail in the description of WP 4.

Output: Interactive portable showcase system of an assistive robot front-end, intertwining two or more services relevant to the target users.

OBJECTIVE 6. To actively promote scientific debate and networking with the goal of advancing European research in this broad and important domain.

Project activities related to this objective are laid out in detail in the description of WP 5.

Output: In addition to online resources, presentations and publications: a topical symposium, and a joint peer-reviewed publication (journal special issue).

Indicators of goal achievement	*Expected results*
Data collection*: Quantity of collected data: number of subjects, duration of recording.*	*Iteration 1: 3 subjects;* *iteration 2: 6 subjects of which 3 new;* *iteration 3: 9 subjects of which 3 new;* *(= 9 subjects total).* *Minimum recording duration:* *1,5 hours (voluntary) video recording per dataset (= 27 hrs total),* *5 hours audio recording per dataset (= 90 hrs total).*
Data collection*: Technical quality of collected data: rate of intelligible/transcribable data = rate of data usable for analysis.*	*Minimum: 50 % usable data.*
Analysis*: Generation of significant and inter-subjectively validated (investigator and method triangulated) analytical categories.*	*Tokens for each category are found in more than one data set. Categories are confirmed by triangulation.*
Theory*: Definition of the necessary and sufficient indicators (observable phenomena) of sociability in artifacts.*	*Necessary and sufficient input to task 3.1 (design guidelines) and task 2.2.*
Methodology: Critical dimensions of data collection and analysis, credibility, transferability and confirmability of methods.	*Theoretically founded coding categories (= hypotheses) for subsequent quantitative analyses (= hypotheses testing).*
Reference architecture: Advance beyond state of the art.	*Documented progress wrt. the review of state-of-the-art (task 3.1).*
Reference architecture: Implementability & respect of design guidelines (classified as core/additional/optional).	*Successful implementation;* *at least core requirements are all met.*
Field study setup: Progress in social engagement as measured by the qualitative criteria developed in the project, plus	*Observable behavioural differences in the collected data from iteration 2 and 3 as compared to iteration 1, from "new" or*

(probably) quantitative aspects such as e.g. frequency and length of interactions, proportion of user-initiated interactions, success rate of interactions, user satisfaction.	*"old" subjects or both; improvement in sociability as evaluated by the indicators developed in WP 1.*
Showcase system: Functionality corresponds to scenario specifications (classified as core/additional/optional).	*At least core requirements are met.*
Showcase system: User test results: questionnaires, observation, interviews.	*Survey with at least 6 test subjects*
Dissemination: Website & repository visits, audience reached, response to the Symposium Call.	*Minimum outreach: Hits >100, Downloads of resources > 30, Audience > 150, Submissions > 10*

B 1.2 Progress beyond the state-of-the-art

The SERA project is intended to identify exactly what is the state-of-the-art (task 1.1, task 2.3 iteration 1) and then provide the theoretical basis for the next generation of research. The aim is to build on the lessons learnt in the EU FP6 Network of Excellence HUMAINE, one of which is that there is much we do not know about "really natural language processing". Progress beyond the state of the art can be summarised as follows:

State of the Art	Progress beyond it
Theory of pervasive emotions and more	
Starting from a focus on distinctive emotional episodes [Scherer 2001], HUMAINE researchers have increasingly turned their attention to "pervasive emotions" [Cowie 2006]. What is needed now is some unifying theory of the role of these pervasive emotions in human-machine interaction. Some sociological theories, e.g. Affect Control Theory [Heise 2002, 2004, McKinnock 1997] have made advances in connecting the concept of social identities to affective meanings and identity-confirming modes of behaviour, but these models remain far too abstract and coarse-grained to e.g. describe conversation- and turn-level verbal and nonverbal behaviour.	SERA will show how notions such as affect and social identity influence human-machine interaction, and demonstrate how such notions are relevant to the implementation of working systems.
Robots in our space rather than robots with an interface	
In classic HCI research, the user "attends to" the task at hand and hence is paying attention to the computer interface. This is one type of interaction that one might have with a robot, but robots of the near future will also act autonomously, near humans, without attention being paid in either direction. We know very little about how machines might manage the attention of humans in a shared physical and social space. We know humans sometimes treat computers as social actors, but how and when does that change?	SERA will explore the ways in which a robot might attract attention without being annoying, how it can recognise human interest with a minimal set of sensors, and the role of paying attention more generally in social relations.
An alternative methodological approach	
In a recent special issue on speech based interactive systems research [*Speech Communication*, 50:8-9, 2008] McTear classified research as either "objective" = involving statistical analysis of large corpora, or "subjective" = involving	SERA will apply ethnomethodologically inspired techniques to data from genuine human-machine interactions. Rather than attempting to test hypotheses that are based on often dubious theory, the aim is to develop theory that is grounded in genuine and realistic data. The

questionnaires and surveys of users and their experience. This engineers' focus on quantitative data contrasts with research on virtual characters in which lab experiments have prevailed to date—mainly for technical reasons, but also because of the predominance of psychologists and their focus on hypothesis testing. After nearly 20 years of looking at corpora, some researchers are looking for new ways to look at the problems of "really natural language processing". HUMAINE has brought together researchers with an interest in emotion, and those with a background in psychology brought with them the tools of the lab experiment. Also into the mix have come researchers with an interest in sociology bringing with them the tools of anthropology.	resulting theory might be tested in controlled experiments, but in SERA it will be assessed for its enabling role in the engineering of more successful robot systems.
System rather than component evaluation	
It is often far easier to measure the performance of a sub-component than to measure the utility of a functional system; therefore the state of the art tends to focus on components. This leads to misguided assessments of usefulness [Sparck-Jones and Galliers]. Search engines, for example, have very poor performance in terms of recall and precision, but are certainly useful. For speech interfaces, the state of the art tends to focus on word recognition error rates or on "coverage" of grammatical constructs in a standard evaluation corpus. Although it might take another 50 years for machines to hear as well as humans [R.K.Moore'07], is the technology useful *now*?	SERA has been set up to have people using existing technology to address a genuine need. Like search engines, we are expecting that, firstly, system components compensate for each other—computers have infallible memory but poor language understanding—and secondly that the user will adapt his or her behaviour to the system. The set-ups and methodology are intended to capture the details of how and when this happens.

B 1.3 S/T methodology and associated work plan

B 1.3.1 Overall strategy

The project will undertake a field study to collect data of real-life, long-term (see footnote 1, page 5) and open-ended relationships of (fully consenting and healthy adult) subjects with robotic devices. The field study will be undertaken in three iterations, each involving both "old" subjects (from previous iterations) and "new" ones. The three iterations test different conditions (functionalities) of the robot. The project partners will analyse these data in parallel, using different methods in which they have expertise.

The first iteration will produce behavioural data for an individual interacting with a commercial off-the-shelf product, the Nabaztag, set up to provide life-style reassurance. The expected outcome is that the user will find the system annoying. The second iteration will integrate the robot interface with ambient sensing equipment to provide timely information, and with some form of question and answer spoken language interface. The expected outcome is that the user will overestimate the capabilities of the system. The third iteration will integrate our "social engagement architecture" (developed in WP 3) to provide a socially aware robot that can manage expectations and that can operate seamlessly in the user's physical and social space. The field study is described in more detail in WP 2.

Finally, a showcase system will be extracted and re-assembled (WP 4) that basically reflects the set-up from iteration three, with some fine tuning, and which is not tied to a subject's home. The purpose of the showcase is to provide a tool for academic and educational presentations, and to show how the theoretical developments in the project are grounded in implementation issues.

At the start of the project, WP 1 will proceed to a review of literature on theory and methodology of the study of social engagement with robots and agents. Data from iteration 1 are distributed and submitted to a first round of parallel analyses, the results of which will feed into theory and methodology development. We do not expect sensational new insights from this first set of data given the state-of-the-art setup, but the analysis will be relevant nonetheless: a) for progress in methodology, and b) as a baseline against which we can evaluate the later results. Such review of results, in turn, will be the basis for developing design guidelines for the reference architecture (WP 3). The cycle of data collection and parallel analysis (task 1.3) will be repeated for iterations 2 and 3.

Development and implementation of the architecture (WP 3) and of the portable showcase (WP 4) will be driven to a state which allows for taking their results into account in iteration 3 of the field study. The showcase system will also be tested independently late in the project, and the reference architecture will be brought to a state where it can be made available to the research community.

All work packages will contribute to the theory, methodology and technology integration that the project aims at (see section B 1.1 Concepts and objectives).

The plan for dissemination and networking activities will be set up early in the project (task 5.1), specifying further the orientation given in section B3.2 in accordance with the progress made in scientific and technical WPs. Dissemination activities will be carried out in such a way that the lasting impact of the project becomes, as far as possible, already visible during the lifetime of the project.

The following diagram (Figure 1) shows the interdependencies of the four RTD work packages:

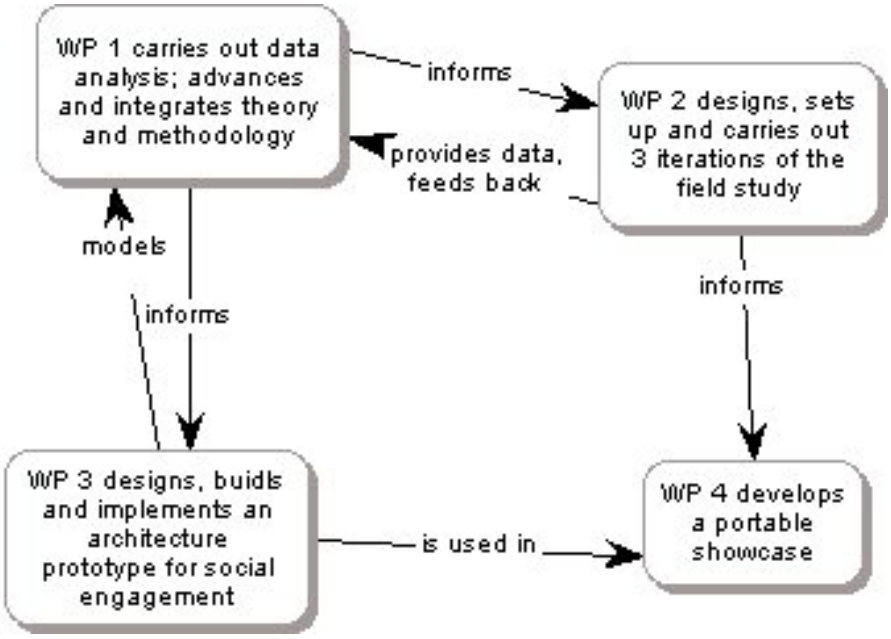

Figure 1: SERA: Connection of RTD work packages

B 1.3.2 Timing of activities (Gantt chart)

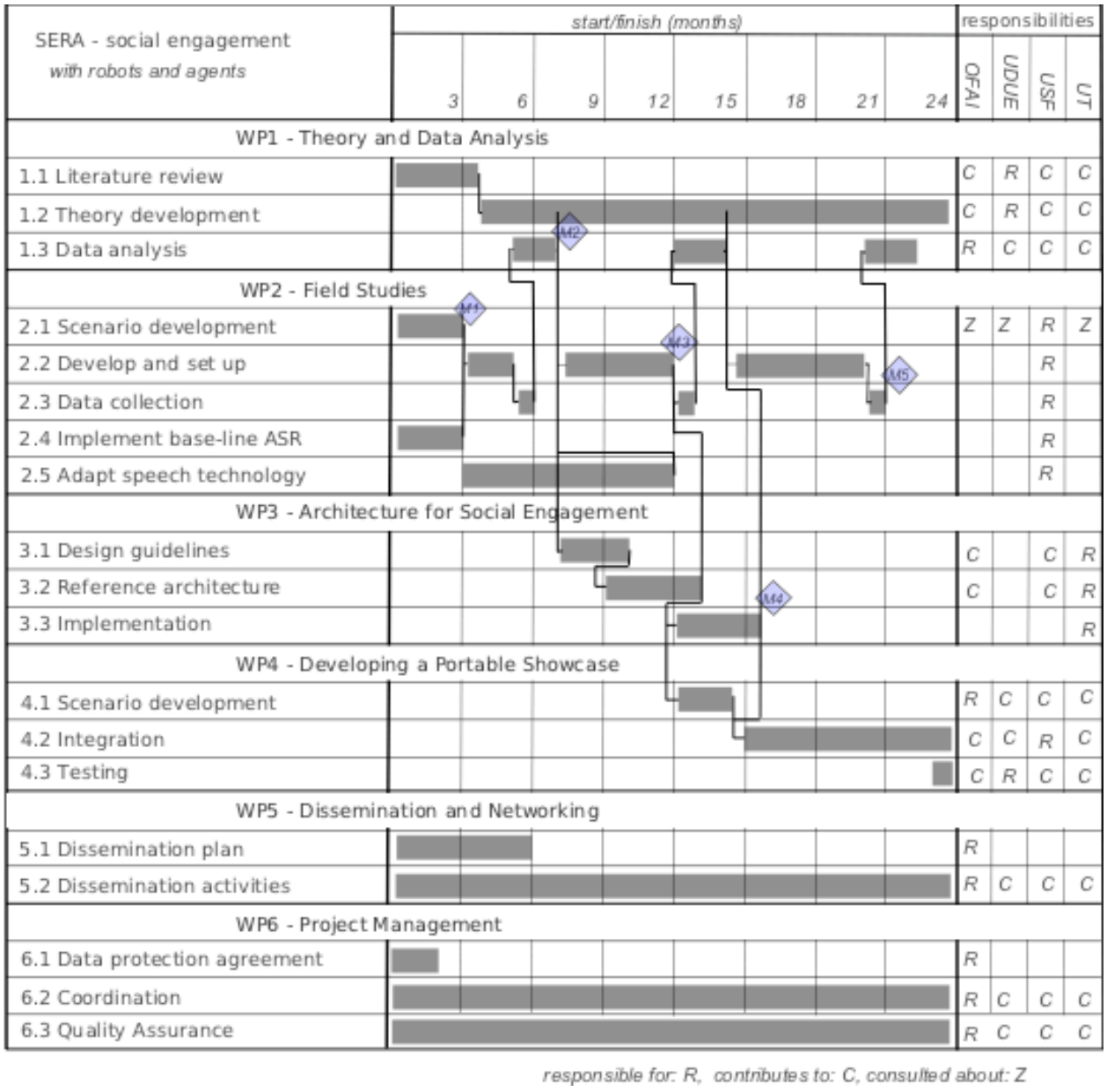

Figure 2: Gantt Chart

B 1.3.3 Work package list

Work package No	Work package title	Type of activity	Lead partic. no.	Lead partic. short name	Person-months	Start month	End month
WP 1	Theory and data analysis	RTD	4	UDE	40	1	24
WP 2	Field studies	RTD	2	USFD	31	1	21
WP 3	Architecture for social engagement	RTD	3	UT	25	7	16
WP 4	Developing a portable showcase	RTD	2	USFD	29	13	24
WP 5	Dissemination and Networking	O	1	OFAI	8	1	24
WP 6	Project Management	MGT	1	OFAI	9	1	24
	TOTAL				**142**		

B 1.3.4 List of deliverables

Del. no.	Deliverable name	WP	Lead bene-ficiary	*Estima-ted indi-cative person-months*	Nature[2]	Dissemi-nation level[3]	Delivery date[4]
6.1	Data protection agreement	6	OFAI	0,5	R	CO	2
2.1	Scenario for field study	2	USFD	4	R	PU	3
2.4	ASR baseline implementation	2	USFD	3	O	CO	3
6.3a	Self-assessment checklist	6	OFAI	0,5	R	PU	3
1.1	Literature review	1	UDE	6	R	PU	4
5.1	Dissemination and networking plan	5	OFAI	1	R	CO	5
2.2a	Description of set-up for iteration 1	2	USFD	1	R	CO	6
3.1	Requirements analysis for architecture design	3	UT	9	R	PU	10
1.2a	SERA theory framework	1	UDE	7	R	PU	11
3.2	Initial design of the SERA architecture	3	UT	7	R	PU	12
6.2a	Management report on first project year	6	OFAI	3	R	CO	12
2.2b	Summary of development in iteration 1 and description of setup for iteration 2	2	USFD	6	R	CO	12
2.5	Adapted spoken language interface	2	USFD	9	O, R	PU	12
4.1	Showcase scenario description	4	USFD	6	R	PU	15
1.3a	Minutes of data analysis workshop	1	UDE	9	R	PU	15
5.2a	Proceedings of dissemination event	5	OFAI	4	R	PU	15
3.3	Implementation of the SERA core architecture	3	UT	9	P, R	PU	16
2.2c	Summary of development in iteration 2 and description of setup for iteration 3	2	USFD	6	R	CO	20
2.3	Corpus description	2	USFD	2	R	PU	21
1.3b	Data analysis results	1	UDE	7	R	PU	23
4.2	Showcase and video	4	USFD	21	P, O	PU	24
1.2b	Revised journal papers	1	UDE	13	R	PU	24
6.2b, 6.3b	Final management report including self-assessment results	6	OFAI	3	R	CO	24
4.3	Showcase test report	4	USFD	2	R	PU	24
5.2b	Final dissemination and networking report	5	OFAI	3	R	CO	24
	TOTAL	**142**					

[2] **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

[3] **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)

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

B 1.3.5 Work package descriptions

Work package number	**1**	**Start date or starting event:**		month 1		
Work package title	Theory and analysis					
Activity type	RTD					
Participant number	1	2	3	**4**			
Participant short name	OFAI	USFD	UT	**UDE**			
Person-months per participant	10	6	6	18			

Objectives

- ***To make progress in the methodology with which social engagement between robots/agents and humans can be studied, tested and evaluated***
- ***To develop a sound theoretical foundation for implementing and analysing human-robot/agent social relationships***
- ***To generate knowledge about human-robot relationship through both theoretical and empirical research***

Description of work

Advances in the theory of human-machine social engagement will be made starting out from a survey of the state-of-the-art and through adopting an explorative data-driven approach to data analysis.

Literature review (task 1.1): The literature search and review focuses on theories and aspects of human-machine social engagement and on relevant theories of human-human social interaction from different disciplines (such as linguistics, paralinguistics, psychology, sociology). It will take into account specific insights concerning the projected domain of application (i.e., interactive assistive technologies, "virtual butlers")

Development of a theoretical framework (task 1.2): Based on the literature review, we will provide a careful analysis of the different theories of human-machine social engagement in order to identify theoretical frameworks which represent potential approaches to achieving the project's objectives (e.g. theory of mind concept). The inter-disciplinarity of the consortium allows making advances in theory beyond restrictive disciplinary boundaries. Simultaneously, experiments done and methods used to date in studies of human-machine social interaction will be first surveyed and critically reviewed with regard to their benefits and shortcomings. The critical discussion will help to identify optimal methodological approaches. The quality of the literature review and the derived framework will be assured by submitting it to high-quality peer-reviewed journals and conferences.

Analysis of field study data and integration of results into the theoretical framework (task 1.3): In terms of a bottom-up approach the field study (conducted in WP2) does not serve to verify pre-conceived hypotheses, but to study openly which existing theories can explain findings to what degree. Within WP 1 the data collected in WP2 will be analysed by all partners in parallel utilising different methods. These methods will be contrasted with each other and intensely discussed. The advancements through the analysis and the subsequent integration of results are thus two-fold: At the end of the project, in the report (research paper) on the amended theoretical framework, the method discussion will lead to a proposal of how to raise experimental and evaluation standards of the field of sociability studies with agents and robots. On the other hand, the results will feed into design of the architecture (WP 3) and back into the theoretical developments.

<u>Task 1.1: Literature review</u>

A comprehensive review of theories, results and methods within the field of social human-machine interaction, with relevance to the project. All partners contribute.

Task 1.2: Theory development

Task 1.2 is carried out in close connection and interchange with task 1.3. Development tasks (task 2.2, and work in WPs 3 and 4) will require and use input from this task to ensure theoretical grounding of their work.

Task 1.3: Data analysis in 3 iterations

These three predominantly qualitative data analysis activities follow the iterations of data collection in WP2. It is planned to hold workshops in which analysis methods and results are compared and discussed, thus contributing to the validation of the qualitative analysis.

Deliverables

D1.1 Literature review (month 4)

D1.2a SERA theory framework (month 11)

D1.2b Revised journal papers (month 24): near-final research papers covering the main empirical, technical, and theoretical aspects of the project

D1.3a Minutes of data analysis workshop (month 15)

D1.3b Data analysis results (month 23)

Work package number	2	Start date or starting event:	month 1			
Work package title	Field studies					
Activity type	RTD					
Participant number	1	**2**	3	4			
Participant short name	OFAI	**USFD**	UT	UDE			
Person-months per participant	2	24	3	2			

Objectives

- To develop a scenario, based on the Nabaztag interface, that demonstrates using the set-up to modify behaviour.
- To provide a "set-up" in the natural setting of the subjects' home.
- To collect interaction data that can be used by consortium members to develop an affective social identity architecture.

Description of work

Implementing and installing a suitable setup for data collection will go through three iterations. The primary aim of the set-ups is to collect raw data on human-machine spoken interfaces for analysis. Data need to be "real" in the sense that they need to be taken from an interaction in the context of an application, and that they reflect state-of-the-art technology rather than some hypothetical ideal. Wizard of Oz experiments are not appropriate because the human wizard in such experiments on the one hand has a limited memory and speed compared to a computer, while on the other because the wizard's ability to use language is well beyond the current technology.

The three set-ups are based on a scenario that combines three proposals by Professor Hawley from USFD. The scenario is, he believes, one the subjects would want to participate in. From the perspective of the health service the aim is to encourage self-care, provide lifestyle monitoring, and provide physical assistance for tasks around the home.

Task 2.1: Scenario Development

The application domain is "lifestyle reassurance" in which primarily healthy people living alone can be reassured that, should they need it, they will be able to get help. This requires a subtle and appropriate level of monitoring and the means of calling for help should s/he fall and break a hip, for instance. Scenarios for the field study will therefore have direct relevance for this user group and domain. As a walk-through, consider a healthy 85 year old man living in his own home by himself. As he makes his breakfast in the morning, a robot sitting on the side board by the door wakes up and says good morning. After a brief pause, the robots reads out a weather report. A little later it reminds him that his sister is visiting that afternoon. After his sister leaves, the robot tells him that the clinic would like to see him the next day and have suggested a 10am appointment. He says 10 is too early and the robot suggests 11, which he says is OK. The appointment is confirmed with the clinic and entered in his calendar for tomorrow. That night he falls asleep in front of the TV and at 11pm the robot tries to wake him. if it succeeds, he goes to bed and the robot locks the doors.

The proposed implementation is based on using the Nabaztag "talking rabbit" as an interface to an intelligent room. The Nabaztag robot itself has very limited capabilities, however it does provide a standard interface (similar to the Philips iCat) that is "not like a computer," that can be always on, and that has a pleasing aesthetics with coloured lights and long rotatable ears. The Nabaztag product can also be connected to the Internet and can recognize RFID tags that can be attached to items such as car keys, a wallet or a glasses

case. The intelligence for the proposed system would come from sensors mounted on the walls, floor and furniture of the room, and from a personal computer either hidden in a cupboard or accessed remotely. The room is likely to be either the kitchen or living room of the subject's own home. Installing the system and the necessary monitoring equipment is a significant imposition on the subject and subjects would be recruited from appropriate volunteer groups with whom Professor Hawley has worked in the past. The standard University of Sheffield ethical guidelines for this type of experiment will be adhered to (see Section B4)—again as Professor Hawley has done in the past.

Task 2.2: Development and setup

In what follows the three set-ups planned are described along with the results we are expecting. These expectations are a professional assessment and, as such, might turn out to be wrong. What is more, it would be quite easy to find other professionals with differing opinions—particularly in retrospect. It may become necessary to modify the set-up in the second and third iterations from what is described below, based on the experiences with the set-up and the results we actually obtain. There has been some discussion of using the Kismet style head at Sheffield for some experiments, however at this stage we cannot see a need to move beyond the (modified) Nabaztag interface. That is, we intend to use the Nabaztag and no other robot in all the experimental set-ups.

Iteration 1: *Nabaztag "as is"*

As a commercial-off-the-shelf product, the Nabaztag has limited sensing capability. The first set-up will use the Nabaztag "as is", and so information can be "pushed" based on time of the day and external sources. There is a "push to speak" speech recognition system on the Nabaztag, but this functionality will be explored with a more sophisticated set-up below. In this first set-up the system can prompt the subject by saying 'it's time for your medication—take the big blue pill and three small orange ones,' providing reminders of doctor's appointments, reminders to monitor blood pressure and so on. As an Internet device, the system might also forward results to the community nurse. The system might also provide general encouragement to eat healthily and exercise, etc.

The predicted outcome is that the robot will be "annoying" because it says things at inappropriate times.

Nevertheless, iteration 1 will serve important purposes in the project:

a) it is a test for our approach to data collection
b) the quality of (inter)action and subjects' evaluation will provide the baseline for the subsequent iterations
c) it acts as a "trial run" for other components of iteration 2
d) it serves as testbed for the application of data analysis methods.

Iteration 2 *: Appropriate information push and Q&A*

As part of prior work at Sheffield, some older people have equipment in their homes that monitors their activity—basically, it allows carers to check whether people have got up and gone to the bathroom that day, with the assumption that if they are doing normal things then they are well. Current work at Sheffield is trying to be more sophisticated with this information by analyzing the activity data to automatically detect if someone's behaviour is normal for them and if not, it prompts someone to check up on them. In this iteration, the set-up will combine this existing sensor suite and analysis with the set-up in iteration 1 to enable the Nabaztag to provide advice and information in a timely manner. For instance, the system might remind the users to take their medicine as they start to make a meal. In addition, simple question and answer speech recognition will be used to extend the system's monitoring role. For example, the system might say 'It's 9 o'clock and you're usually up by now—are you OK?' or 'It's 3pm and you haven't made your lunch, would you like me to call your daughter?' Given the system's ability to ask questions with constrained single word answers (yes/no questions being the most basic case) the networking capability can be used to allow health services such as the local clinic to make appointments remotely. For instance, the system might say "Doctor Jones would like you to make an appointment to see him some time this week. He wants to know which day would suit you." With the ability to ask questions, the system can also control things around the home. For example 'It's 8pm, do you want me to put Coronation Street on?' or 'Shall I lock the back door for you?'

In the above description of the set-up, the example quotes suggest a robot that is helpful but they do not present a coherent picture of a social entity. The theory development task will at this stage provide some guidance as to what the robot should and should not do. For instance, robots have a low social status [deAngeli] and as such it is important that it is Doctor Jones who wants to know in the above example (i.e., implying institutional authority), not the robot itself. A coherent and clear set of guidelines about what and how the robot should say things would be a significant asset at this point.

This iteration will also trial the interface to the cognitive architecture and may use elements of that subsystem to make decisions about what to say and when.

The predicted outcome is that the user will over-estimate the system capabilities and become annoyed when the system does not respond as expected.

Iteration 3*: Theory implementation*

At this stage, we expect the theory development task (Task 1.2) to have provided a range of competing theories about the requirements for spoken language interfaces that are capable of keeping users socially engaged. As described in the section on progress beyond state of the art (see section B 1.2), the current best practice is based on information state update, and this has nothing to say regarding user's attitudes. Prior work by the team does however hint already at a range of explanations. One hypothesis is that users become annoyed because systems fail to account for their (mis)behaviour. Another one is that the robot fails to give and to react to signals of relative and situational social status (e.g. dominance through initiative).

The set-up for iteration three will look very much like that in iteration 2, except that the robot will have behaviours that "explain why" it behaves as it does. This explanation might take the form of explicit explanations such as 'I'm a robot; I don't eat anything` or 'Sorry I don't know where your book is. I can only find things that have a sticky tag on them.' or they might be implicit through appropriate verbal and nonverbal expression. For example, the ASR will, we expect, only work with one person and so, if the user has a visitor, the robot should appear shy to explain why it doesn't talk. At this stage, adaptations to the hardware may become necessary. Although the Nabaztag's rotating ears are surprisingly expressive, we may want to modify the standard robot to add a simple feature or two. Examples are modifying the robot so it can close its eyes—being asleep can be used to explain why it does not respond to commands out of context—or a rotating base so that the robot can pay attention to an individual or point to parts of the room: for example, 'your glasses case are over there!'

Another piece of prior work suggests that state-of-the-art dialog systems such as the set-up of iteration 2 do not allow for mixed initiative at the discourse level. That is, these systems "hold the floor" and do not allow the human to steer the conversation. This is, according to Brown and Levinson [1987, politeness universals] face-threatening. The "push" services the robot is supposed to provide (see scenario), however, imply a certain degree of initiative and dominance. The challenge we face therefore is to implement dialog management that provides appropriate (e.g. mitigating) behaviour, and we are expecting the advanced cognitive architecture to provide a means of doing this.

Optimistically, the expected outcome will be a radically more acceptable spoken language interface for machines in general and for the next generation of assistive technology for the elderly and disabled.

Task 2.3: Data collection

The intention is to provide a set-up in several subject's homes for each iteration for about a week. There are three kinds of data: the movement data picked up by pressure sensors in the floor and furniture, there are the audio recordings, and there are video recordings. Aspects of the subject's behaviour will be recorded over the entire period, which is of course quite intrusive. The following procedures and restrictions are proposed:

- The movement data can be recorded 24/7 for the study period.
- The audio data could be 24/7 for a particular room, theoretically, but restricted hours (e.g. combined with the lights in the room) may be less intrusive and more appealing to the subjects. Subjects will be consulted on an individual basis.
- The video recordings cannot be 24/7 and, following the approach taken in prior experiments, the intention is to ask the subject simply to turn on the recording equipment when he or she feels like it.

Given the duration of data recording, there is no need for continuous recording of either video or audio, because the quantity of data thus collected would be more than can be processed in analysis.

Task 2.4 and Task 2.5: ASR base-line implementation and adaptation.

The project is not engaged in ASR research, and the base-line system will use a commercial off-the-shelf system such as Dragon, or the speech system developed at Sheffield on other projects involving voice control in the home. However both speech recognition and speech generation will need to be adapted to the application in order to provide an integrated agent persona that can be trusted and believed. Task 2.4 implements the base-line system for iteration 1 of task 2.2, output of task 2.5 (adapted spoken language interface) feeds into iteration 2 (and is used, without further adaptation, also in iteration 3).

Deliverables

D2.1 Scenario for field study (month 3)

D2.2a Description of set-up for iteration 1 (month 6)

D2.2b Summary of development for iteration 1 and description of set-up for iteration 2 (month 12)

D2.2c Summary of development for iteration 2 and description of set-up for iteration 3 (month 20)

D2.3 Corpus description (month 21)

D2.4 ASR baseline implementation (month 3)

D2.5 Adapted spoken language interface (month 12)

Work package number	**3**	**Start date or starting event:**		month 7		
Work package title	Architecture for social engagement					
Activity type	RTD					
Participant number	1	2	**3**	4			
Participant short name	OFAI	USFD	**UT**	UDE			
Person-months per participant	7	3	14	1			

Objectives

- To develop, on theoretical grounds and empirical results, a social-emotional control architecture for interactive robots and agents.
- To implement core parts to a proof-of-concept state.

Description of work

Previous studies on social engagement and the interaction of users with agents and robots have focussed on a diversity of aspects related to interpersonal variables. This includes the study of rapport, social talk, friendship, politeness, and engagement, for instance. The studies vary, amongst others, in the theoretical framework assumed (focussing on standard social psychological theories such as attribution theory, or on linguistic pragmatics or sociolinguistics), the computational/cognitive models that are implemented (which can include a decision theoretic or other model of the Theory of Mind), the kind of interaction considered (long term/short term, focussing on task and dialogue progression or interpersonal relationship), and, related to the latter point, the place in the system where the variables are operative (cognitive processing, the emotional life or simply the choice of dialogue act on the behavioural level).

The goal of WP3 is to develop an integrated, holistic cognitive model for social engagement that can serve as a reference architecture. The architecture will integrate and generalize previous proposals and will be based on the output from WP 1. The general model thus derived will serve as the basis for building the proof-of-concept prototype.

Task 3.1: Design guidelines
This tasks regards the identification of the requirements for the design of a social-emotional control architecture, based on the initial results of WP1 and the analysis and evaluation of existing proposals and implementations of architectures that pertain to any aspect of social engagement in order to ensure the state-of-the art

Task 3.2: Reference architecture
This tasks regards the specification of the cognitive model that is to serve as a reference architecture based on the guidelines (task 3.1).

Task 3.3: Implementation
This tasks regards the implementation of the core architecture as a basis for the showcase system developed in WP4

Deliverables

D3.1 Requirements analysis for architecture design (month 10): Requirements analysis document including a state of the art report on implementations of social engagement architectures

D3.2 Initial design of the SERA architecture (month 12)

D3.3 Implementation of the SERA core architecture (month 16), including documentation

Work package number	**4**	**Start date or starting event:**		month 13		
Work package title	Developing a portable showcase					
Activity type	RTD					
Participant number	1	**2**	3	4			
Participant short name	OFAI	**USFD**	UT	UDE			
Person-months per participant	8	12	8	1			

Objectives

- To provide the means to present lessons learnt from the SERA project—both theory and practice.
- To build a robot system that can be run independently of the development/experiment set-ups of WP2.
- To provide a robot system that can be incorporated into new scenarios for further research.
- To demonstrate what is possible with existing speech recognition and COTS sensors when using an agent architecture designed for social engagement.

Description of Work

In the experimental set-up as envisaged for life-style reassurance (see task 2.1), the system is tightly interwoven with the subject's home environment. This work-package, run to a large extent in parallel with iteration 3 of work package 2, provides the same robot system but decoupled from the subjects' homes, and hence decoupled from any sensitive data on particular subjects. The aim of this work package is to deliver a robot system that can be used for dissemination of the project results at conferences and workshops. The system will also form the basis for further research.

Task 4.1: Scenario development

A different scenario from the one developed in WP2 is required if the system is to be operated away from the homes of individual subjects. The choice of public showcase scenario will need to be carefully considered in the light of experimental results obtained in WP2.

Task 4.2: (Dis)integration

Starting with a working system in subjects' homes, this task is to disentangle the aspects of the system that are generic from those that are location and application specific. Having decided what is re-usable, a generic interface is required for the components that are not. For example, in an individual's home it is possible to use pressure sensors and passive infra red devices (PIRs) to trace the occupant's movements. In a public space however, this input has to be substituted. In either case, the sensor system would ideally interface to generic system components through a suitable API. This task is primarily about "carving up" the system into tightly defined reusable packages, and packages that must be rewritten for a new scenario (application). An even more challenging component to this task is an application programmer "behaviour specification language", where behaviours that might be hard-wired into the experimental system are made available at the API. Existing projects at UT explicitly address this issue and will inform this task.

Task 4.3: Testing

The showcase system will be tested on a small scale during the finishing stages of this work package so that some test results can feed back into task 4.2. Test equipment (not home-bound) will be set up as determined by task 4.1 and a questionnaire will be used to collect subjects' opinions and feedback.

Deliverables

D4.1 Showcase scenario description (month 15)

D4.2 Showcase and video (month 24)

D4.3 Showcase test report (month 24)

Work package number	**5**	**Start date or starting event:**		month 1			
Work package title	Dissemination and networking						
Activity type	OTHER						
Participant number	**1**	2	3	4			
Participant short name	**OFAI**	USFD	UT	UDE			
Person-months per participant	5	1	1	1			

Objective:

- To actively promote scientific debate and networking with the goal of advancing European research in the domain of social interaction with robots and agents.

Description of work

The partners in the project are aware of the fact that SERA is embedded in a much larger research community pursuing related goals. The project therefore has the goal to render services to and to support advances in the robotics and ECA research communities, notably by facilitating access to its findings and results, but also by contributing to existing and fostering new networks and connections, with the longer-term perspective of helping to activate and coordinate the important European research potential in this area.

Task 5. 1. Dissemination & Networking Plan

Early on in the project's lifetime, the partners will coordinate their planned and especially joint activities. The plan will differentiate between the target groups that we want to reach (research community, industry/professional domain, general public), the kind of activities in each domain, and the expected outreach of the activities.

Task 5.2. Dissemination & Networking Activities and Outlook (see also section B3.2)

The activities laid down in the plan developed in task 5.1 are carried out, including the following:

- An early activity will be to open a website with regularly updated information about the project and access to its resources as far as they can be made public.
- We will propose a special session at ACII'09 (IEEE International Conference on Affective Computing and Intelligent Interaction) to be held in September 2009 in Amsterdam (month 9).
- We plan to have a further dissemination event in month 15, in the form of a symposium to be held at the 20th European Meeting on Cybernetics and Systems Research (EMCSR 2010) in Vienna. An open CfP will be issued, and all submissions, including those of SERA participants, will be peer-reviewed. Papers will be published in the EMCSR 2010 proceedings.
- Long papers on project work and results will be prepared in the later stages of the project (as deliverable D1.2b), for publication as a special issue of a scientific journal (probably Applied Artificial Intelligence). These papers will be peer-reviewed and will therefore also lead to important feedback on the project's success (see section B1.1). The plan is to have reviewed and revised near-final versions of the papers available at the end of the project, so that a date for publication (around spring 2011) can be committed to.
- Networking activities will involve establishing and keeping contact with related projects (e.g. COMPANION, LIREC, SEMAINE, SSPNet), with the HUMAINE Association (e.g. through a SIG), and with projects and actors related to the Joint Programme Ambient Assisted Living.
- The company producing the Nabaztag, Violet, was contacted early on in the preparation of the

SERA proposal, and invited to participate. The invitation was declined because of Violet's diverging strategic development goals. Violet will be informed of the project start, its objectives and methods, and be kept informed on progress if they should be interested. They will also be invited to suitable meetings and/or dissemination events, with a view to future collaboration in research and/or exploitation of the project results.

- It will be made sure that publications and presentations by individual participants, or by any combination of them, will acknowledge and present the project as a whole so that research activities pertaining to the project are clearly identifiable as such.

Deliverables

D5.1 Dissemination and networking plan (month 5)

D5.2a Proceedings of symposium at EMCSR 2010) (month 15)

D5.2b Final dissemination and networking report (month 24)

Work package number	6	Start date or starting event:		month 1			
Work package title	Project management						
Activity type	MGT						
Participant number	1	2	3	4			
Participant short name	OFAI	USFD	UT	UDE			
Person-months per participant	6	1	1	1			

Objectives

- To ensure the smooth and timely progress of the project, to coordinate partners and their activities, to control effective use of resources, to react quickly and efficiently to risks and problems, to liaise with the Commission, to document progress, to assure quality of work, and to control ethical issues of the project.

Description of work

Work is based on the management instruments and procedures outlined in Section B2. 1

Task 6.1. Adoption of ethical guidelines and data protection agreement.

Project coordinator OFAI will draft the documents, lead negotiations and keep documents in evidence. Other partners will participate in the negotiations and sign the documents (cf. D6.1, and section B4 on ethical issues).

Task 6.2. Management (for a detailed description see section B2.1)

This task includes the following activities:

- Coordination of and communication with partners
- Monitoring of resources, financial controlling and progress
- Reporting & EC liaising
- Documentation
- Control of ethical issues and data protection
- Organization of meetings

Task 6.3. Quality Assurance

Early on, the indicators of goal achievement and expected results (see section B1.1) will be further developed into a checklist of measurable progress for each work package and for the project as a whole, and procedures of quality assurance will be defined (e.g., internal reviewers). This checklist will then be used both in the production of the deliverables and their quality review (as laid out in section B2). Additionally, the partners will define where and how external review (peer review, expert opinion, etc.) shall and can be obtained. Control of achievements against this checklist is part of the Project Management Committee's functions and thus involves all partners.

The beneficiaries undertake to perform the tasks, produce the deliverables and organise respectively participate in the events specified in Appendix X to this Description of Work.

Deliverables

D6.1 Data protection agreement (month 2)
D6.2a Management report on first project year (month 12)
D6.2b Final management report, including self-assessment results (month 24)
D6.3a Self-assessment checklist (month 3)
D 6.3 Self-assessment results (month 24), to be included in D 6.2