COMMIT

PROJECTPLAN

WORKPACKAGES

DELIVERABLES

BUDGET

USER CENTRIC REASONING FOR WELLWORKING (P07)

Projectleader prof. dr. ir. Wessel Kraaij, TNO

1. Background

Managing work and family responsibilities is often difficult and impacts the health and well-being of employees, their families, and the workplace performance. A healthy workforce is a happier and more productive workforce. Keeping people healthy and at work has obvious benefits: protection against financial hardship, promoting a better quality of life and allowing people to make the most of their potential. Conversely, being out of work can exacerbate physical and mental health problems and increase the chance of social exclusion. The objective of this project is to develop user-centric sensing and reasoning techniques that help to improve physical well-being (mostly in a private context) and to improve well-working (in a work context). Of course physical well-being influences well-working and vice versa. Well-working could be defined as “being and feeling in control”, with a positive impact on work efficiency and effectiveness, work pleasure, mental and physical health status.

Especially the rising age of the Dutch citizen as well as an increasing number of people with chronic diseases puts an extra pressure as both elderly and people with chronic diseases are more viable to become victim of all kind of complaints and with the consequence of problems with their balance between work and private life. Supporting these people in deploying a healthier life style as well as facilitating their ability to work more flexible is considered important, especially in times of economic uncertainty. Employers, communities and the taxpayer all bear the costs of working-age ill-health which is estimated to run to around several billion Euros every year. Since health, work and well-being are closely and powerfully linked, they need to be addressed together. Well-being applications at work and at home are expected to help people to continue contributing to society, the marketplace and the economy. Furthermore, these applications may help suppressing the rising costs of chronic disease and ill-health.

On of the key aspects in deploying a healthier life style is supporting people in becoming more active because a sedentary lifestyle is one of the main risk factors for all kind of health problems such as cardiovascular diseases, diabetes and musculoskeletal problems and because of the existing evidence that being active contributes positively to feeling healthy and quality of life. Although people do recognize the need for a more active lifestyle, they often find it difficult to get started and/or to stay motivated. Effective motivational well-being applications that provide people with frequent information about their physical health status, changes in time, specific well-being objectives as well as daily routines and programs by timely personalized feedback are expected to be effective in making people aware of their sedentary life style, to motivate people to change as well as to support people in really changing and continue their healthier life style once being reached. In addition an important feature of well-being applications is to facilitate communities with peers (enabling social connectedness), as well as data sharing with these peers as sort of social comparison needed for motivation but also to share health data with professionals if desired or when professional support is needed.

To get accepted and being used, these applications need to be unobtrusive, easy to use and need to adapt to the context the person is in. As such these applications will typically use small wearable embedded sensors, e.g., activity sensors, have local application logic, actuators for feedback to the user and multi-modal interaction facilities.

The productivity of modern knowledge workers is reaching its limits. Real-time communication means, such as e-mail and web publishing for the masses, have generated an overflow of information, lacking a structure that is adapted to the user's tasks. Working harder is not a real solution to the problem as networked professionals will thereby increase the workload for others and the most likely result is more and more people struggling with stress due to information overload. Well-working (mobile office) applications empower office workers to become nomadic workers, who can work from anywhere at anytime using a range of devices, making the office more a place to meet than a place to work. Although this facilitates a better work-life balance and a reduction of commuter traffic, it does provide a challenge for the nomadic worker to stay in sync and to keep control. To stay in sync means having the right information under the right circumstances, and being able to keep in touch with colleagues that are elsewhere. To keep control means having the freedom to decide for what and when you can be disturbed and on what you spend your time, i.e. it creates flexibility. Selective user transparency concerning his or her activities also bears the potential to automatically harvest new opportunities such as new contacts or relevant content.

Scientific and technological advances in sensing, machine learning, pervasive computing and user-centered design enable a series of applications that can support the user in staying or becoming healthy and work efficiently and with pleasure. The goal of this project is to exploit these advances to support adaptive and intuitive behavior in user-centric well-being and well-working applications. The project will develop distributed reasoning capabilities and mechanisms for easy personalization of the application behavior including the privacy aspects. The project will also perform field trials in real-life settings to evaluate user experience.

Research shows that work interferes with family life and that introducing work-life initiatives is good for well-being at work and at home 1. Although some systems supporting applications for well-being and well-working exist2, a number of clear limitations and drawbacks of these systems can be identified:

- Cost and complexity. Current systems are specialized, utilize expensive, dedicated components and sensors, and require professionals for configuration, calibration and often even for operation.

[1] See e.g. www.familiesandwork.org.
[2] DirectLife **(**www.directlife.philips.com **),** Fitbit (www.fitbit.com), MiLife (www.milife.com), BodyMedia (www.bodymedia.com).

- Feedback. Current systems do not provide real-time feedback, as data analysis and reasoning is usually performed offline on high-end platforms.
- Size and usability. Current systems are not very adaptive and easy to use and therefore deliver insufficient user experience. This reduces the potential market of people that are willing and able to use them.
- Privacy. Existing systems assume a one-size-fits-all privacy architecture, or require such elaborate configuration of the privacy preferences that most users are not able and willing to do this.

Starting from these points, this project presents the following innovations beyond the state of the art with the ambition to stimulate the uptake of well-being and well-working applications:

- The ability of capturing fine-grained, distributed activity [3], situation and health parameters from a combined wireless and wired network of relatively cheap and simple sensors instead of a single, highly complex and expensive measuring system, without requiring professionals or even significant user configuration calibration or operation support.
- Smart social network profile management, minimizing maintenance time while maximizing support for the creation of peer groups.
- The ability to process and reason about the captured parameters when and where they are observed as well as to provide feedback in real-time by exploiting the distributed processing power available on sensor nodes and the wireless connections that can be established ad-hoc among sensors and possible actuators. Actuators may vary from complex ones, such as a mobile phone or TV, to simple devices, such as a headset or a vibrating bracelet.
- Providing mobility and self-configurability supports.
- Enabling ease of use and requiring little or no attention from the user.
- Providing personalized privacy that is understandable for the user.

This project continues and extends work by TNO on monitoring emotional states that was carried out in MultimediaN N2 (multimodal interaction). This project also builds upon the BSIK projects Freeband AWARENESS, Freeband TUMCAT and Smart Surroundings, and is well aligned with the IIPs Intelligent Communication, Sensor Networks, Health Support, and Brain & Cognition. Research partners in UCR4W are TNO, University of Twente (UT) and Radboud University Nijmegen, industry partners are Philips Research (PhR), Ericsson (Eric), Noldus IT, Novay (Nov) and Roessingh Research and Development (RRD). The fact that each of the industrial partners also has its own research activities contributes to the emergence of a core of competence in The Netherlands with respect to smart reasoning and privacy preserving systems for well-being and well-working. Each of the partners brings in expertise that is essential for the fulfillment of such systems. Finally, two non-profit partners provide important context information that will help to guide the design and deployment of the envisaged technology. The

[3] This includes: interaction with other people, creating documents, the contents and metadata of those documents, information (e.g. URL's) accessed, etc.

Netherlands Center for Social Innovation (NCS) ensures an important link with activities in the area of 'new ways of working'. The Dutch ministry of interior (BZK, Bestuursondersteuning Kennis) will link UCR4W activities to BZK's project on the development of a new workplace for government workers.

The project relates to both the Content & Interaction theme (semantic characterization of user's information need and activities, multimodal interaction) and the Cooperative & Embedded Systems theme (aggregation of heterogeneous distributed sensor information and reasoning).

2. Problem description

The distributed reasoning capabilities envisaged by UCR4W should provide people-centric reasoning, i.e., sensing and reasoning to support humans in their daily life. A possible embodiment of a reasoning component is a digital personal coach that processes the sensor information, compares measured indicators with a certain (personalized) reference profile and e.g. provides feedback to the person in order to help him to keep behavior between healthy boundaries. Likewise, a virtual personal secretary can easily be imagined in an office setting. People-centric reasoning integrates observed data from wearable sensing devices (such as mobile phones or body area networks) with data obtained from fixed sensors in the home or office environment. However, data collected by these sensors is by no means perfect and error-free. Reasoning algorithms should provide real-time meaningful information about the data. By taking the past context and user interactions of a specific user into account, they provide an implicit personalization through learning. Since these reasoning algorithms and the context they use are very privacy sensitive, the user needs to be empowered to personalize his or her privacy preferences, making not only the application behavior adaptive and intuitive, but the privacy aspects as well. Altogether, these functionalities are required to provide for tailor made, customized and personalized well-being and well-working applications that optimally meet the user's needs at any time and any place and therefore facilitate acceptance.

Several challenges can be identified. A main challenge is to handle the complexity of dealing with incomplete sensor information for run-time adaptation of application behavior. This requires dynamic reasoning capabilities that are distributed for resource consumption and scalability reasons (e.g., close to the sensor if possible). A second challenge is how to address the privacy issues, and in particular how to provide simple yet sufficiently personalized control to the end-user in order to achieve the required level of perceived privacy. The main challenge, however, for the well-being application domain is to get a good understanding of someone's activities and actual context in order to be able to provide personal feedback (coaching) without relying on professional healthcare givers. Better insight in different motivational strategies and the use of communities of e.g. peers in a similar situation may help in optimizing feedback. The main challenge for the well-working domain is to support nomadic workers while minimizing the attention they need to give to these well-working applications.

UCR4W will address the following key research questions:

- How to infer the user's state from heterogeneous and incomplete sensor information?
- How to present feedback information in an intuitive unobtrusive manner?
- How to design user friendly and adaptive privacy policies regarding the use of context information?
- How to design coaching tools that have a real impact/uptake?

In short: UCR4W tries to address these challenges by researching smart reasoning components that take the user's current situation (physical health status, activity, tasks, interests, workload) into account, in order to enable personalized intuitive end-user applications that preserve the user's privacy. Real-life pilots will be used to evaluate the successfulness of this ambition and to further improve the reasoning components and application adaptability.

3. Objectives

Project's goal

The objective of this project is to develop user-centric sensing and reasoning techniques that help to improve physical well-being (mostly in a private context) and to improve well-working (in a work context). Techniques will be deployed in personal digital assistants for a rehabilitation and nomadic work scenario giving feedback and context sensitive recommendations in order to help to achieve personalized targets related to health, well-being or efficiency. The impact on society will be a decreased risk on welfare diseases, a better work-life balance, and increased productivity due to efficient working, facilitation of an older workforce, fewer sick leaves, and a reduction of commuting travel. The activity, health status and information access patterns of an individual will be monitored by a series of sensors. The resulting model, which will be continuously learning from and adapting to and individual , can subsequently be used to provide input for an unobtrusive coach or assistant based on robust reasoning techniques, thereby increasing the individual's sense of feeling in control.

Planning of all dimensions

The project consists of three layers:

- Specification of overall architecture, user requirements and evaluation methods (WP1)
- Design and Implementation of novel methods for person centric privacy respecting inferencing techniques (WP 2, 3, 4). These WP's are bounded by the context defined in layer A.
- Finally layer C (WP5, WP6) consists of two work packages focusing on the development of two integrated demonstrators, one for well-being at home, one for well-being at work.

The project will yield some 70 deliverables. Some 50 scientific papers are planned and 5 PhD projects. In addition there is a large selection of software deliverables planned, in the form of downloads and licensed software along with related documentation such as architecture descriptions and user requirements studies. Social sciences play an important role in the project as the final goal is to develop e-coaching software that is supportive for behavioral change. Contributions are expected in the form of refined evaluation methodologies, social impact studies and user studies. The project is expected to contribute to the international research field of personal information management and life logging by releasing a partially annotated dataset reflecting the activities of a set of knowledge workers over a series of months. In addition dissemination for both areas will be organized in close cooperation with stakeholder worktables such as NCSI (partner in P7) and IIP sensornetwerken care&lifestyle. Yearly dissemination events will be organized to support the influx and outflux of ideas and improve the visibility of the project. In addition these organizations (and the industrial partners within the P7 consortium) will help to realize its ambitions w.r.t. valorization. Stakeholder organizations such as the ministry of interior (partner) and COPD patient organizations will be involved to keep the project focused on real user needs. Dedicated valorization subprojects are planned for the 2nd half of the project in cooperation with e.g. Microsoft.

Ten important project results are:

1. Overall architecture for privacy respecting pervasive human monitoring technologies
2. User needs analysis for well-being e-coaching technology
3. Evaluation framework for behavioral change (method, paper)
4. Goal and activity recognition algorithms based on inference
5. Public dataset of knowledge worker activity registration
6. Empowerment by interaction based inferencing (software/papers)
7. Cognitive load assessment measurement method (software/papers)
8. Adaptive privacy control policies (software/papers)
9. Well-being at home demonstrator
10. Well-being at work demonstrator

Results

Main results of P7 are new techniques, methods and integrated prototypes that support individuals to improve their personal well-being in a rehabilitation or work context. Personal digital assistants (e-coaches) will use user centric inferencing techniques in order to support people to maintain a healthy work (golden demo 1) and lifestyle (golden demo 2). Well-being at home and at work is of increasing importance given our ageing population and increased demands for e.g. knowledge workers. Flexible location independent work can help to reduce the carbon footprint and reduce mobility problems. Advancements in the state of the art will be achieved in the areas of multimodal sensor integration, contextual reasoning, activity and task recognition, mental and physical state estimation, user adaptation through learning. Task based user centered evaluation and computational psycho-social models for behavioral change are crucial to guarantee effectiveness for lifestyle adaptation. Important conditions for uptake are usability and trust, these are addressed by context aware privacy policies The consortium includes social scientists and user centered developers in order to maximize impact and uptake of technology.

Deliverable Impact and Valorization

The project is quite well organized for valorization since project results may very well be exploited by its partners. For instance, one of the growth platforms of Philips Consumer Lifestyle is the 'Healthy Life' platform. This platform is based on the premise that health increasingly needs to be approached in a holistic way. The knowledge and demonstrators developed in this project enable RRD to further expand and optimize their remote monitoring and treatment concepts and in particular their body area networks for measuring physical functioning and their personalized feedback strategies. Ericsson's participation in UCR4W oiginates from the R&D unit responsible for the Ericsson Service Platform product, making it easier to forward UCR4W results towards product management and development. Whereas industrial partners will mostly focus on monetary valorization in terms of licences and patents, knowledge partners will make some deliverables available in the form of open source downloads. An example of a download is the "activity and interaction dataset"(D3.5), which will be made available to the research community.

In addition UCR4W milestones and evaluation results will be good starting points for other mixed funding (public private) projects initiated in the context of e.g. the IIP sensor networks worktable "care and lifestyle" or NCSI. Strong interest has already been expressed by workplace suppliers such as ATOS and Getronics. The active participation of BZK (in particular the department which investigates new ways of working and workplaces for employees in the public sector) will certainly be a good starting point to stimulate government procurement.

In terms of social impact, we hope that P7 technologies will eventually be adopted as recommended practice by employer organizations (that will be contacted through e.g. NCSI's network) and patient / medical organizations.

Deliverable Dissemination

P7 is well positioned for dissemination since all partners are major stakeholders in the R&D ecosystem for 'e-health". P7 will use the facilities and networks of the partners to approach press and media at regular intervals to disseminate major milestones. Two integrated demonstrators (WP5 and WP6) and several smaller demos (such as those based on the Noldus platform) will be shown at COMMIT related events and submitted as demo to academic and professional conferences in order to visualize and demonstrate the potential of user centric reasoning, explain why privacy control is essential and how the goal of behavior changes can be realized.. Since the problems addressed by the project are high on the national and EU agenda, P7 is well positioned to get attention of the broad audience and professionals. Our main focus will be professionals. A project website, blog and social media links will help to disseminate information in a modern light weight but effective fashion. In addition platform organization NCSI will organize P7 focused activities for stakeholders. The following formats are envisaged: 1) knowledge table consisting of 30 people: HR & IT staff, change agents, consultants of big companies and researchers. They stem from organizations that are implementing 'the new world of work- concepts (Het Nieuwe Werken, HNW), such as: Rabo bank, SNS Reaal. KPN, TNT, IBM, min. BZK, FNV Formaat. 2) NCSI Seminar 'Embeded intelligence for the improvement of well being and performance'. Normally 50 – 80 people attend these seminars; they come from the NCSI network of HR and ICT staff, workers representatives (works councils, trade unions) from a variety of companies and institutions as well as self employed people and policy makers from ministries, unions and employers associations

International Imbedding

The use of "embedded intelligence" to improve the well-being at work is a new concept. Traditionally, well-being at work is approached from the angle of ergonomics and occupational health, dealing with physical characteristics of the workplace. Digital coaches do exist for RSI prevention, but the objectives of P7 are far more ambitious. The idea is to create the reasoning components that understand activities, goals and context of a worker on a task level. To our knowledge no large scale studies exist that try to model the relations between activity, content, task load and well-being based on real measured data (instead of questionnaires). In addition, current PDA's in a medical context only measure status parameters such as heart rate, activity etc. without interpreting these results on a higher level. High level activity and goal information is necessary for contextually aware feedback, essential for uptake and effective interventions. A few R&D initiatives exist which develop similar ideas (such as DARPA's PAL programmme:
http://www.darpa.mil/Our_Work/I2O/Programs/Personalized_Assistant_that_Learns_%28PAL%29.aspx) but there are no "near to market" equivalents. In the starting phase of P7, a state of the art survey will review relevant NSF/DARPA/FP7 projects in order to cooperate where possible and improve focus and uniqueness on a global scale.

Deliverable Synergy

P1: The P1 project shares an interest in indexing and reasoning about content

- Receive FROM P1: Information extraction modules developed in P1 WP5
- Deliver TO P1: D3.6, D3.7

TO P11: P7 deliverable 1.2a will be input for a course on system design. Synergy will be sought with P15 regarding the alignment of privacy requirements (D4.1). Both projects will choose the same scenario and P7 will reuse privacy related deliverables from P15.

Synergy will be sought with P19. Database expertise to capture large sensor data streams and making these available for inference is not the focus of P7 and here P7 could benefit from P19.

4. Economic and social relevance

The research in this project proposal will enable new, technology-mediated applications that empower users to deploy a healthier lifestyle and to facilitate "well-working". Since health, work and well-being are closely and powerfully linked, they need to be addressed together.

Social impact of the project is along three dimensions: 1) well-being of knowledge workers (decreased risk on welfare diseases, a better work-life balance, increased productivity due to efficient working and reduction of information overload, fewer sick leaves[4]) 2) specific support for elderly people at work (potential gains for technology mediated well-working are higher for this age group 3) reduction in CO2 emission levels by a reduction of commuting travel 4) Improved well-being for people with e.g. chronic diseases, due to real-time monitoring.

The economic impact will be a reduction of healthcare costs[5], better employable of elderly, and that new economic activity will arise: new devices and services will be created for the well-being domain (e.g., by Philips) and well-working domain (e.g., by Ericsson). In addition, new generations of sensors will be developed that integrate intelligent pre-processing mechanisms thereby stimulating high-tech SME activity in the Netherlands. The deployment of these new devices and services in the well-working domain will enable new ways of working, thereby improving effectiveness at lower costs.

Ageing and the increasing number of people with chronic diseases is beginning to change the shape of labour markets and is already strongly influencing the needs for care and 'lifelong participation' in society. Driven by productivity increase, job creation, new services and new markets for inclusive ICT, the shorter-term impacts of well-being services on the gross domestic product in Europe is estimated to be of the order of EUR 100 billion (for the next 5 years alone)[6].

A good example of exploiting the UCR4W results as candidates for future development activities is their usage in the development of new services. As general exploitation perspective, the project shapes our vision of what should be the architecture of future well-being and working applications. It is expected that the reasoning, personalization and privacy functionalities are generic enough for wider application. The project will produce demonstrators and do pilots with these demonstrators to validate the research and facilitate valorization. The above-mentioned socio-economic benefits will be taken into account while evaluating the well-being and well-working demonstrators in real-life settings. The ambition of UCR4W is to demonstrate and measure socio-economic impacts of the demonstrators.

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[4] For instance, the Confederation of British Industry estimates that employee absence cost the UK economy £13.2 billion (2007) and research by the Sainsbury Centre for Mental Health highlights that the costs of staff working below par because of mental health issues costs businesses a further £15 billion each year. The Dutch Centraal Planbureau estimates that employee absence costs about €6 billion.

[5] Employers, communities and the taxpayer all bear the costs of working-age ill-health which is estimated to run to around several billion Euros every year.

[6] From Updated Work Programme 2009 and Work Programme 2010 Cooperation Theme 3 ICT – Information and Communications Technologies, see ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/ict-wp-2009-10_en.pdf

Several reasons exist that motivate subsidizing the project. The most important reason is that multiple stakeholders must be involved to be able to address the complexity of problems and to provide the complementary expertise. A multidisciplinary approach, that involves wireless sensor technology, reasoning, privacy and domain knowledge to support technology mediated well-being and well-working is needed. This cannot be carried by industry alone and requires support from the government. Furthermore, by addressing two application domains the project increases impact, and at the same time it is facilitating wider applicability of the knowledge developed in the project. Cross-domain knowledge exchange has proven to be one of the key drivers for innovation[7]. Such cross-domain knowledge exchange is best facilitated in a triple helix of academic, industry, and government interaction[8]. In addition, the applications need to share privacy sensitive sensor information of users. As privacy protection is a primary role of the government and goes beyond the control of industry, this also motivates the need for subsidy.

Uptake and continued development of the project results is safeguarded at multiple levels: The industrial partners (Novay, Ericsson, Philips, Roessingh R&D, Noldus IT) have an interest in exploiting the results of the project, both in the well-being and well-working domain. The participation of NCSI (representing stakeholders from government, industry, health insurance) and BZK (being responsible for the new workplace of government workers) and strong interest from other industries like Getronics (the biggest workplace facilitator) and ATOS demonstrates the high expectations from the field for technology that supports well-working. These partners have expressed interest to host field trials. In order to consolidate and further develop project results in the well-working domain, we intend to involve stakeholders associated to NCSI early on. The research partners will use this project to (a) gain impact with their knowledge on standardization and subsequent product development activities in industry, (b) synchronize their long-term knowledge-development plans with long-term trends in industry, and (c) translate the know-how obtained in UCR4W into new consultancy or training activities in their product portfolio.

5. Consortium

The project consortium has been carefully composed of both knowledge institutes and industry to support the cooperation and flow of knowledge from theory to practice. The project consortium consists of the following partners/groups (including key persons):

Knowledge institutes:

- TNO
  - Multimedia Technologies (Wessel Kraaij, John Schavemaker)
  - Strategy, Policy and Innovation (Bas Kotterink, Valerie Frissen).
  - Labour productivity (Fietje Vaas, Peter Vink).
  - Human Interfaces (Marc Neerincx).

[7] See e.g. Nico Baken & Robert van Oirschot, Transsectorale Innovatie, in Reflecties op Elektronische Communicatie, nr. 5, 2007 or AntenneWijzer 2005: signalen van Syntens-adviseurs, Den Haag.
[8] Loet Leydesdorff & Martin Meyer, The Triple Helix of university-industry-government relations, Scientometrics, Vol. 58, No. 2 (2003) 191-203.

- NOV - Novay - INCA group (Bob Hulsebosch, Maarten Wegdam, Henk Eertink).
- UT - University of Twente – CTIT
  - IS - Information Systems group (Marten van Sinderen).
  - PS - Pervasive Systems group (Paul Havinga).
- RUN – Intelligent Systems group (Tom Heskes).

Industry:

- PhR - Philips Research
  - CCS - Connected Consumer Solutions group (Jos van Haaren, Aart van Halteren).
  - ISS - Information & System Security group (Bart van Rijnsoever).
- Eric - Ericsson (Jan van der Meer, Stefan Burgers).
- RRD - Roessingh R&D (Miriam Vollenbroek-Hutten, Hermie Hermens).
- Noldus Information Technology (Lucas Noldus).

Non Profit/Government:

- NCSI Netherlands Center for Social Innovation (Fietje Vaas).
- BZK Dutch Ministry of Interior Affairs (Mildo van Staden).

This consortium combines leading knowledge institutes in the areas of people-centric reasoning and context (NOV & UT), machine learning and information modeling (RUN), social impact of ICT, human in the loop and occupational health (TNO). Wireless sensor networks (UT), two major R&D labs (Philips & Ericsson) with expertise on mobile applications, consumer solutions and privacy (Nov), an SME (Noldus IT) with expertise in intelligent observation and experts on the application domains (RRD, Ericsson, TI, Philips,). NCSI provides a dissemination forum to stakeholders such as trade unions and employer organizations. Finally, the involved department of BZK guides the development of a new workplace for government workers. Disciplines needed are:

- Reasoning – this is the main generic functionality that the project is working on.
- Sensing & context – the project will not develop new sensor technology, but expertise on sensing and interpretation of context, and how to deal with the inherent quality and heterogeneity issues is needed.
- Adaptive privacy – how to empower the user to provide personalized privacy policies and enforce these.
- User interactions – how to interact with the user, including using dedicated wearable hardware.
- Well-being and well-working – since these are the targeted domains.

The below figure depicts the mapping of the main disciplines with the partners.

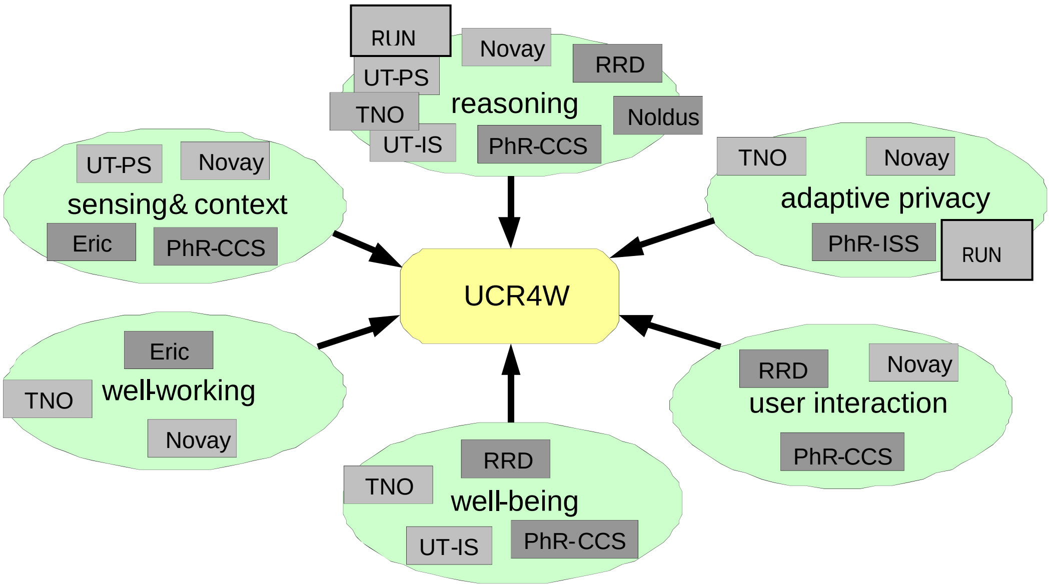

Figure 1: Mapping of main disciplines with partners.

The project management structure is depicted below.

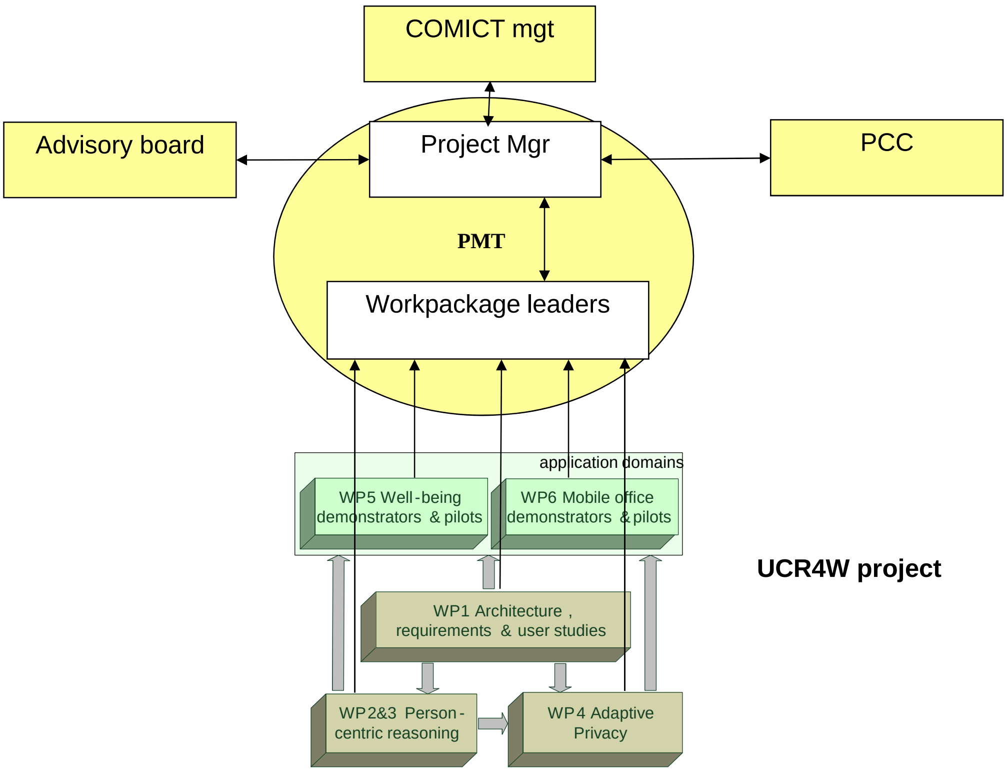

Figure 2: UCR4W management structure.

The project leader is responsible for the day-to-day management of the project. He chairs the project management team (PMT), in which all work package leaders are present. The PMT meets regularly and is responsible for the delivery planning. It gives account of the project progress to a steering committee, called Project Co-ordination Committee (PCC), which is responsible for project supervision. Each partner is represented in the PCC. The PCC meets three-monthly. They have access to all results and relevant project information, give advice to the project, handle all issues that are beyond project management, and advice in project go/no-go points. The project manager represents the project towards the outside world, and reports about its progress to the COMMIT program management.

Project deliverables are reviewed by the producing work package, whereupon the work package leader may submit them to the PMT. The PMT reviews the deliverables, makes them formal, and makes them available to the PCC, which is responsible for the final quality control and approval.
Furthermore, an Advisory Board (AB) will be established consisting of thought leaders in the area of intelligent reasoning, public and occupational health, and privacy for well-being and -working. The AB is instrumental in providing the project with input on its direction and to increase visibility of the project results. The AB meets at least once per year.

There are several links to other projects in COMMIT. UCR4W will investigate the use of sensor network technologies developed in P8 Sensor Networks for Public Safety and P9 Very Large Wireless Sensor Networks for Well-being. We also observe a strong relationship with the privacy research conducted in UCR4W and Trusted Healthcare Services (P15). A key differentiating aspect is that UCR4W focuses on making the privacy functionality of context and identity management more user-friendly and adaptive by means of person centric reasoning whereas P15 provides techniques and tools for secure and privacy-friendly communication and medical data management in healthcare in a broad sense.
UCR4W also has strong links with P5 (Sensor content for Well-being). Compared to P5 the following differentiating elements have been identified:

- P5 focuses on entertainment and relaxation, mood and emotion detection and influencing the mood with smart actuators. P7 focuses more on activity patterns and work-related sensor inputs like presence and calendar information.
- P5 focuses on body signal/content processing and feature-level fusion whereas P7 focuses on the combination of fixed/static environmental and mobile/dynamic sensor information.

Clearly, all these projects are complementary to each other. It is therefore important to organize our work in the projects well by cooperating closely, by building on each other's capabilities, and by reusing knowledge and maybe even components for building our demonstrators, to avoid duplicate work, create synergy and innovation acceleration. The overlap of partners (e.g. Philips, Ericsson, Novay, TNO) participating in most of these different projects helps to facilitate this.

6. Workplan

The project activities are structured into the following work packages:

- WP1 – Architecture, requirements, user studies – establishes the foundation and focus of the project; ensures a common vision and inter-working in the project.

- WP2 – Person-centric reasoning at home – studies approaches and issues for reasoning over distributed, heterogeneous and incomplete sensor data; derives and implements algorithms, includes sensing and context management. Output will be used to optimize privacy control (WP4) and smarten the well-being and working applications (WP5 and WP6).
- WP2 – Person-centric reasoning at work – develops models for cognitive load, task analysis and interest profiling; derives and implements algorithms, includes sensing and context management. Output will be used to optimize privacy control (WP4) and smarten the well-being and working applications (WP5 and WP6) by operationalizing the well-being determinants empowerment (+) and workload (-).
- WP4 – Context Aware Adaptive privacy – researches and implements personalized, adaptive, and non-intrusive privacy control through reasoning. Elaborates and specifies reasoning algorithms from WP2, WP3 and uses user interaction results from WP5 and WP6 to optimize intuitiveness of non-intrusiveness of privacy controls.
- WP5 – Well-being demonstrators and pilots – investigates and implements user interaction strategies; researches designs, develops and evaluates a proof-of-concept well-being application through pilots performed with real users in every day life.
- WP6 – Mobile office demonstrators and pilots – investigates and implements user interaction strategies; researches, designs, develops and evaluates a proof-of-concept well-working mobile application through pilots performed with real users in every day life.

The figure below depicts the WPs, indicating the main input relationships between them.

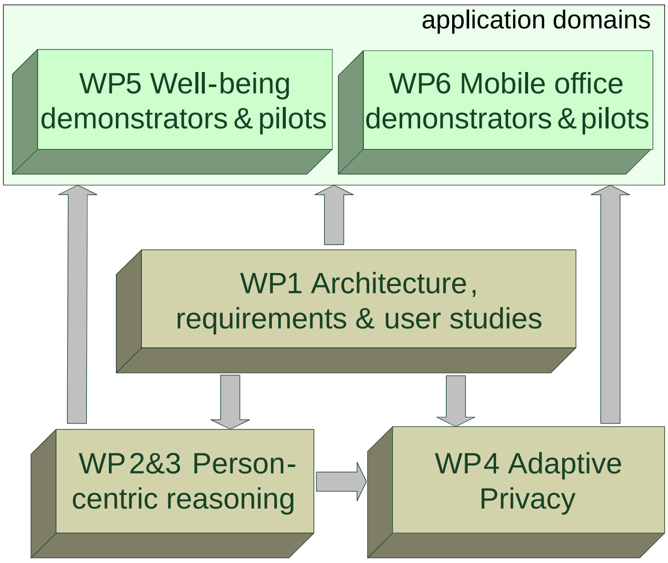

Figure 3: Work packages and their mutual relationships.

The project will follow an iterative approach, with yearly cycles. Each cycle will address requirements, architecture, algorithm development, reasoning and privacy control. The requirements will mostly be determined in the first cycle, while in the following cycles the activities are increasingly focusing on validation through the development of demonstrators and pilots.

Major milestones are:

- Year 1: Requirements, user study, first architecture, initial reasoning and adaptive privacy results, hardware selection (devices and sensors).
- Year 2: Reasoning algorithms and adaptive privacy control mechanisms, refined architecture using feedback provided by the WP2 and WP3, first demonstrators of generic reasoning components and well-working (supporting the mobile office worker) and well–being (monitoring health for individual patient coaching) demonstrators.
- Year 3: User interaction analysis, second version of demonstrators, pilot definition, and start with validation through piloting.
- Year 4: Scientific results (PhDs), system improvements and valorization, continuation and evaluation of pilots, knowledge, software and dataset consolidation

Major overall project milestones are:

- Functional and technical requirements, based on scenario analysis and use-case studies.
- Architecture for local/remote real-time reasoning over distributed heterogeneous sensor data.
- Methods and algorithms for smart reasoning with incomplete and heterogeneous sensed information to support adaptive and intuitive person-centric mobile applications.
- Unobtrusive and adaptive personalized privacy control mechanisms over sensed information.
- Easy-to-use devices, operation and feedback.
- A well-being and a mobile office (well-working) demonstrator ("Golden Demo" at mid-term review).
- Pilots in real-life settings and evaluation of the well-being and mobile office applications' adaptability and intuitiveness capabilities for personalization and privacy control
- Papers for international scientific recognition and exposure and PhD theses.

Five PhD students will be active in UCR4W. Recruiting proper candidates may, giving the current situation on the labor market, delay the work to be done in UCR4W. There is however sufficient resources available at the partners to ensure proper continuation of the project's activities. Privacy regulation may be a potential show-stopper for the pilots in real-life setting. Users that are active in the pilots will be informed about this and their consent will be explicitly asked. Furthermore, it is one of UCR4W's objectives to offer the user sufficient control over his privacy during the pilot. If needed, consult from College Bescherming Persoonsgegevens (Dutch Data Protection Authority) will be asked. In addition, existing living labs will be used or a new one will be implemented, where some daily work will be captured/simulated. TNO/UT have built considerable expertise with this approach in the EU FP7 AMI and AMIDA projects. In addition the data collection effort has already been piloted in 2008: moderately sensitive data such as call logs, email traffic logs and RFID location data has already been captured at TNO by a group of 40 subjects (in a living lab situation).

WORK PACKAGES

Project number: P7	
WP title & acronym	WP1: Requirements, architecture and impact
WP leader	Marten van Sinderen

Objectives: WP1 will elaborate a common vision and context for the project, sharpen its focus, furnish the architectural foundation, and study its impact on organizations.

WP1 builds on previous results in the area of requirements on and architectures for context-aware systems. These results were obtained by the participants in other projects, such as MultimediaN, Awareness and Smart Surroundings.

WP1 will achieve its objectives by undertaking four main activities. First, WP1 will capture and analyze domain and user requirements to understand the motivation, interests, priorities and abilities of various actors and players, establishing a context and reference for the design and development of technical solutions. Requirements elicitation will be based on stakeholder identification, scenario development, and use-case studies, all with special attention for well-being and well-working. Second, WP1 will develop an overall architecture. This architecture provides a high level specification of person-centric reasoning and adaptive privacy components and functions, in accordance with the user and domain requirements. Results obtained in this activity are important to align and coordinate technical work in different work packages. Third, WP1 will conduct user studies in order to uncover potential hurdles and provide insights regarding the motivation and expectations of users with respect to 'intelligent' technology support for work and well-being. And fourth, WP1 will consider the intelligent workplace architectures and solutions against the background of a disruptively evolving societal and business context. This activity will develop ways to model, monitor and evaluate effects of information technology on the way people and businesses organize and experience work.

Project number: P7	
WP title & acronym	WP2: Person centric reasoning at home
WP leader	Mihai Marin-Perianu (UT/PS)

Objectives:

This work package focuses on person reasoning in a home environment. The general objective of this work package is to devise a person-centric solution for persons at home with chronic conditions - like elderly people - based on miniaturized wireless inertial sensors, which provide distributed motion caption and intelligent recognition of activities and situations.

The results of this work package enables the recognition of patient condition in real-time, by exploiting the processing power of the sensor network in a collaborative manner. This means that the home becomes the main care environment, and, in addition, patients can receive real-time feedback in order to monitor, self-manage and improve their physical condition according to their specific situation. Main challenges include the use of distributed, heterogeneous and incomplete sensor data to perform reliable and real-time reasoning in order to be able to give instantaneous and adequate feedback to the user.

Task 2.1. Distributes activity monitoring and reasoning

Design and develop distributed data processing, with the final goal of detecting reliably and in real-time the user condition, situation and activity. In addition, it explores how the system can adapt to the user specific conditions and learn about those situations that were not pre-programmed at development time.

Task 2.2. Interaction

This task focuses on enhanced user interaction and real-time feedback, mainly using simple and ubiquitous interface devices will be preferred, such as the TV, lights, or frame displays.

Project number P7	
WP title & acronym	WP3
WP leader	John Schavemaker

Objectives

WP3 aims at developing person centric inferencing techniques with a focus on the well-being at work scenario. The core of this WP are two PhD projects that address two different determinants of well-being: 'empowerment' and 'workload management'.

Well-being and productivity of knowledge workers is a largely unexplored research area. Sensor based techniques for the recognition of human behaviour and state are developing rapidly. WP3 will create a link between the social sciences and sensor bases human activity recognition in order to support knowledge workers to improve their well-being.

Task 3.1: Empowering the user

This task will focus on the development of user centric inference techniques based on topical preferences and interaction preferences. Preferences can be gleaned from online (and local) behavior and information access and production, Inference techniques and secure privacy aware (WP4) preference sharing can be used to guide resource discovery helping knowledge workers to avoid the duplication of work and optimize their planning.

Task 3.2: Controlling the workload

This task will focus on the development of user centric inference techniques that reason about the actual and optimal workload of a knowledge worker. Using various types of sensors, a low level data stream will be interpreted in terms of task level actions, user goals and cognitive load. Proof-of-concept strategies will be developed and evaluated where the inferred information will be used to help the user to mitigate high workload situations.

Both tasks will start with capturing the datastreams of sensors and communication protocols and ground truth information that reflect the activity of a reasonable size of subjects (knowledge workers at one or more associated P7 partners). Data will be cleaned and anonomized with the aim to share (part of the) data with the research community. The data will be used to train and evaluated the activity recognition models. Empowerment and workload controlling assistants (well-working e-coaches) will be based on inference techniques exploiting this data, potentially in the context of peer groups. E-coaches will be evaluated in cooperation with WP6

Project number: P7	
WP title&acronym	WP 4: Context Aware Adaptive Privacy (CAAP)
WP leader	Bob Hulsebosch (Novay)

Objectives

The use of multi heterogeneous sensory devices gives rise to an increased information level about persons but also poses an increased privacy risk, especially when ubiquitous sensors and devices are networked and connected to on-line services. User awareness and control are essential for privacy preservation and ultimately for the acceptance of well-being and well-working services. It is therefore crucial that the user is in control of data collection, processing and distribution. Somehow the user should be empowered to control his/her privacy, e.g. by delegation, consent, policy management, or via existing user centric identity management solutions. User privacy control however is not easy to achieve in ubiquitous environments. Privacy control must be user intuitive and non-intrusive, i.e. it must be adaptive to changing contexts. Context aware adaptive privacy exploits the ability to sense and use contextual information to augment or replace traditional user privacy control mechanisms by making them more flexible, intuitive and less intrusive. The objective of WP3 therefore is to research and implement personalized, adaptive, and non-intrusive privacy control through reasoning. In particular, WP4 researches and demonstrates how the end-user controls the gathering, processing and distribution of information. The underlying mechanism is based on policies that allow the user to express what information sharing is allowed. The policies are personal and adaptive to the user's preferences. It is essential that the user is able to set information sharing policies in an intuitive and simple way, i.e. that he/she is in control. This work package elaborates and specifies reasoning algorithms from WP2 and WP3 and uses user interaction results from WP5 and WP6 to optimize intuitiveness of non-intrusiveness of privacy controls. WP5 and/or6 will integrate and demonstrate the technologies developed in WP4.

Project number: 7	
WP title & acronym	WP5: Smart well-being applications for lifestyle changes
WP leader	Aart van Halteren (Philips Research)

Objectives

This workpackage studies the effective deployment of a smart reasoning infrastructure, and applications that use such an infrastructure, on motivating consumers to make healthy lifestyle choices. A key objective is to identify effective feedback strategies and incorporate these strategies into technology-mediated behaviour change applications.

To empower individuals to live a healthier, more active lifestyleseveral basic human needs must be fulfilled to increase intrinsically motivated behaviour, e.g. competence, autonomy and relatedness. Smart reasoning technology potentially can contribute to intrinsically motivated lifestyle choices, when these needs are addressed effectively. Further understanding in technology-mediated behaviour change applications is needed.The target group concerns individuals with a chronic condition that will benefit from a more active lifestyle.

WP5 will construct, demonstrate and evaluate, according to user-centered design principles, well-being applications that incorporate results from user-studies and technological results from WP1, WP2, WP3 and WP4. A key requirement for these demonstrators is that they are person-centric (i.e. easy to experience, and designed around the end-user) while the underlying technology delivers an advanced experience. Demonstrators will be validated in a pilot setting situated in everyday life. Frequent feedback from stakeholders will be taken into account. A well-being application will be demonstrated as a part of the P7 "golden demo".

Project number P7	
WP title & acronym	WP6: Smart well-being applications for flexible working
WP leader	Stefan Burgers (Ericsson)

Objectives

The main objective of this WP is to improve the effectiveness and flexibility of (nomadic) workers by developing methods, an integrated infrastructure, and applications to facilitate personalized access to relevant context information of themselves, co-workers and work activities. We focus on providing and effectively presenting all sorts of context information to a (nomadic) worker to enable to become and stay 'in sync' and 'in touch' with co-workers and their work activities.
This deals with developing a context management architecture that is suitable to support various user centric and intelligent well-working scenarios. Additionally, pre- and post-processing of context and work related information to facilitate such scenarios is a focal point.

The increased variance in work setting with respect to place, time and collaboration activity makes nomadic work becoming more and more important. Therefore better information management and context-rich information handling strategies are required to support workers in this kind of work setting.

To realize our objective, we design, integrate, demonstrate, and validate the added value of the functionalities provided by the UCR4W reasoning (WP2) and privacy components (WP3) for applications supporting well-working (mobile office) scenarios (WP1). This work package builds an integrated intelligent workplace system that maintains a personal semantic profile of the worker's context and activities (both current and historic), investigates and implements user interaction strategies; researches designs, and demonstrates and evaluates a well-working mobile application through pilots performed with real users in every day life. The system will be demonstrated as a "golden demo", which is developed in several iterations.

DELIVERABLES

Number of important journal paper
7

Number of important conference contributions
30

Products

1. D3.9 Cognitive load assessment tool

   Software assistant which estimates the cognitive and affective load of a (knowlegde) worker on the basis of sensor data. Unlike existing assistants that focus on perceptual and motor actions (e.g., for RSI prevention), this assistant will focus on cognitive an affective processes, using sensor information in order to learn and assess the personal coping behaviours. Current cognitive load (incl. work pace) and affective responses will be measured and feedback regarding work planning will be given with unobtrusive persuasive techniques such as avatars. Possible applications are self management or monitoring in case of reintegrating patients. Final result is a plug-in for Noldus tool suite.

   - WP 3 YP 2014

2. D5.2 Well being at home demonstrator (golden demo) [new PhR description pending, temporary text inserted from WP5 sheet]

   WP5 will construct, demonstrate and evaluate, according to user-centered design principles, well-being applications that incorporate results from user-studies and technological results from WP1, WP2, WP3 and WP4. A key requirement for these demonstrators is that they are person-centric (i.e. easy to experience, and designed around the end-user) while the underlying technology delivers an advanced experience. Demonstrators will be validated in a pilot setting situated in everyday life. Frequent feedback from stakeholders will be taken into account.

   - WP 5 YP 2014

3. D6.2 Description Well being at work demonstrator (golden demo)

   Based on the research performed in the project an integrated demonstrator is provided which can be used in pilot studies with flexible workers. The demonstrator will use WP6 and WP3 components to provide support for flexible nomadic working. This means that sensor and interaction is used as an input for activity/task recognition and adaptive information presentation, scheduling. An integrated personalized feedback module will support workers to maintain a healthy work style and prevent a burn-out.

   - WP 6 YP 2014

Software

1. D2.3 Goal and activity recognition algorithms.

   The ultimate goal of WP2 is to achieve distributed and collaborative recognition and monitoring of user activities. As much as possible reasoning needs to be take place inside the wireless sensor network, reducing thus the communication requirements. For this purpose, the sensor information flow will be divided in two steps. First, relevant features will be extracted on-line on the sensor nodes, by segmenting and processing the continuous stream of data (deliverable D2.2). The features need to be simple enough to be quickly computed by limited hardware, yet expressive enough to capture the specifics of the data. Second, features extracted by multiple nodes will be cooperatively combined to infer, monitor and classify the actual higher-level activities (deliverable D2.3). The reasoning and classification algorithms will have to yield a good accuracy, measured in terms of both precision and recall. They also have to cope well with partial information embedded into the features, with imprecise and even erroneous data, as well as with changing conditions and user specifics.

   - WP 2 YP 2014

2. D1.2 Overall architecture for privacy respecting pervasive human monitoring technologies

   This deliverable provides the specification of the overall architecture for user-centric reasoning for well-being and well-working, identifying major components, their responsibilities and their relationships, in according to user and domain requirements. Special attention is given to the privacy of end-users, which is challenged by the use of pervasive human monitoring technologies. The architecture is a "durable" result (as opposed to results that quickly erode as a consequence of technology developments) in the sense that it represents key decisions with respect to structuring (separation of concerns) and information hiding, thus faciliting design, maintenance and evolution of compliant systems. Since the architecture is a direct translation of stated (user) requirements to supported (system) requirements, it is also instrumental in achieving (and keeping) alignment between business and IT. We will share this result with as many as possible projects and communities in the area (such as EIT ICT Labs - Health & Well-being / Smart Spaces) to have maximum consolidation and impact.

   - WP 1 YP 2011

3. D3.7 Context and task sensitive information filtering and sharing agent

   Guiding hypothesis for this research project is the idea that well-being at work can be improved by providing knowledge workers with an information assistant, which gradually develops a model of the information needs of a knowledge worker. This model includes preferences concerning the size, content, form and timing of information, and its relation to the context (e.g., worker's task, goals and peers). A capable assistant should ideally help a knowledge worker to collect and filter relevant information and either push the information or make it available for access at a proper moment. The assistant will learn the interests and information access preferences through a combination of implicit and explicit learning methods (i.e., by observing interaction with work related devices such as PC, Smartphone, asking for feedback, and analysing the content and context). The assistant will mediate information interests with peers in a social network of experts, optimizing the flow of information in an organization.

- WP 3 YP 2013

4. D4 Design, specification and implementation of adaptive privacy control mechanisms.
   Privacy control must be user intuitive and non-intrusive, i.e. it must be adaptive to changing contexts. Context aware adaptive privacy exploits the ability to sense and use contextual information to augment or replace traditional user privacy control mechanisms by making them more flexible, intuitive and less intrusive. The objective of D4.7 is to specify and design an approach for personalized, adaptive, and nonintrusive privacy control through reasoning. The design will be used for the actual implementation of the approach and further incorporation in the overall demonstrator(s) that are developed in WP5 and WP6 of P7. The underlying mechanism is based on policies that allow the user to express what information sharing is allowed. The policies are personal and adaptive to the user's preferences. It is essential that the user is able to set information sharing policies in an intuitive and simple way, i.e. that he/she is in control. Reasoning solutions from WP2 and WP3 will be taken into account in the design. Design will be implemented and evaluated in the context of golden demos.
   - WP 4 YP 2013

5. D6.4 PDA plug-in implementing strategies for behavioral change.
   The PhD at RRD will focus on research and development of effective intelligent feedback strategies to promote a healthy lifestyle for patients with COPD. An automated intelligent feedback strategy that adapts the feedback messages to the individual patient taking the stage of change of the patient, disease status information as well as other context parameters into account. This to ensure that the feedback strategy is individual tailored and as such more effective. The work of this PhD concerns both experimental researches resulting in papers as well as a software module which will subsequently be tested in a group of patients.
   - WP 5 YP 2014

User studies

1. D1.1 User needs analysis for well-being e-coaching technology

This deliverable presents the capturing and analysis of user and domain requirements for well-being and well-working applications, with a focus on applications that employ well-being e-coaching technology. The capturing of the requirements will be based on stakeholder identification, stakeholder interviews, scenario development and use-case studies. Requirements constitute an important artefact of the development process, which drives the development of the architecture. It will also play a key role in evaluating derived technology products. Since users often revise or explicate their initially stated requirements after they experience the developed system (or mock-up), evolveability is an important quality of the requirements document. Analysis should focus on resolving conflicting requirements of stakeholders, prioritizing requirements, and taking account of (in this case, well-being e-coaching) technology (non-)capabilities.

- WP 1 YP 2011

2. D5.4 and D6.5 Best practices resulting from user centred pilots with golden demos.

   D5.4 and D6.5 are user centred evaluation studies in a well-being at home scenario and a well-being at work scenario. The former is centred around a COPD patient scenario, building on existing expertise and networks of RRD. The latter will be carried out in field labs at TNO, and ministry of BZK. The large scale evaluations will be carried out in several iterations, to provide for the agile development steps of the demonstrators (personal digital agents, providing feedback and support). The evaluations will be contrasted with the theoretical models for behavioural change (developed in WP1) and lead to best practices of applying personal digital coaches in a range of scenarios.

   - WP 5 YP 2014

Other results

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Werkpakketnr. →	Kennisinstelling	[non]Profit	% matching (alleen 0 of 45)	1	2	3	4	5	6	7	8	9	10	11	Overige kosten budget	Totaal Budget	Totaal Subsidie	Totaal Matching
Naam partner				Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten	Kosten
TNO	1		45%	427	85	906	239	85	359	111						2212	995,4	1216,6
Novay		1	100%	16	0	0	282	0	0	16						314	314	0
UT	1		45%	312	379	167	0	178	89	59						1184	532,8	651,2
Ericsson		1	45%	108	0	0	0	0	585	36						729	328,05	400,95
Philips		1	45%	105	140	0	403	482	0	60						1190	535,5	654,5
RRD		1	45%	97	19	39	0	312	0	25						492	221,4	270,6
Noldus		1	45%	25	0	190	0	0	0	11						226	101,7	124,3
NCSI		1	45%	61	0	0	0	0	0	3						64	28,8	35,2
RUN	1		27%	72	36	288	378	0	135	48						957	258,39	698,61
Totaal				1223	659	1590	1302	1057	1168	369	0	0	0	0	0	**7368**	3316,04	4051,96
Totaal Kennisinstellingen				811	500	1361	617	263	583	218	0	0	0	0	0	4353	1786,59	2566,41
Totaal [non]profit				412	159	229	685	794	585	151	0	0	0	0	0	3015	1529,45	1485,55
[non]Profit/totaal				33,7%	24,1%	14,4%	52,6%	75,1%	50,1%	40,9%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	40,9%	46,1%	36,7%