POSEiDON

Pers**O**nalized **S**mart **E**nvironments to increase **I**nclusion of people with **DO**wn's sy**N**drome

New Report 1

Overarching vision of POSEIDON

Final version

Contents

Executive summary

POSEIDON is a project which was running 2013-2016. The POSEIDON-project addressed people with Down syndrome. The purpose of this document is to provide a concrete and easy to comprehend vision for the POSEIDON-project. It is intended to help future developers to get into POSEIDON and take benefit from it.

The main objective of the project was to exploit ICT as an instrument to inclusion in society, increase the quality of life and support a more independent life for people with Down syndrome. In addition, an objective was to create a developer framework, which can foster a wide range of services for people with Down syndrome.

The requirement acquisition showed that a common characteristic is that persons with Down syndrome have tight schedules. This demands managing time, destinations and distances. Mobility is a central issue to become more self-dependent. This led POSEIDON to develop a navigation service with specific additional help for the primary users, a calendar service with additional reminders and instructions, an app for assist in shopping, and an app for training the value of money handling. In addition, POSEIDON developed a wide range of personalisation services where the POSEIDON-system could be adapted and configured to the individual user.

An important objective of the POSEIDON-project was to provide a developer framework. This framework was developed in an iterative way during the project, in parallel with the development of the POSEIDON services. The POSEIDON family of apps were being built on active use of contextual information to improve the user experience, safety and privacy of the end user. It may be connected to such parameters as location, identity, activity/task, time and the device itself.

The developer framework is a collection of methodologies, infrastructure, middleware, tools, specifications, etc. These are things which were used in the development of the POSEIDON prototype system. It is provided to other developers interested in developing applications for people with cognitive disabilities and/or connect to the POSEIDON system. This is partly methodologies, open-source code and free tools of general use, and partly the POSEIDON infrastructure which other applications can make use of.

Third party developers can use this framework to foster a wide range of services for people with Down syndrome.

A guide for developers, based on the framework, is available on the POSEIDON web site.

1   Introduction

The purpose of this document is to provide a concrete and easy to comprehend vision for the POSEIDON-project. Another purpose is to inspire third party developers to embark on the task of providing useful services for people with Down syndrome and other people with cognitive disabilities.

The POSEIDON-project addresses people with Down syndrome. The main objective of the project is to exploit ICT as an instrument to increase the quality of life and support a more independent life for people with Down syndrome.

The project had two main objectives:

1. to exploit ICT as an instrument to inclusion in society, increase the quality of life and support a more independent life for people with Down syndrome,
2. to create a developer framework, which can foster a wide range of services for people with Down syndrome.

POSEIDON has been co-designed by final users. It has been user-centred from its inception and gave all main stakeholders ample opportunities to shape the output of the project. This has resulted in a final out-come which is of practical usefulness and interest to the intended users.

Families can provide supportive material instructions through personalised lists, images, and videos on how to perform some activities at home, work or travelling. Teachers and employers can create supportive material on how to perform certain tasks. Local authorities and business interested on being inclusive can produce instructions to guide how to find places and how to make the use of their infrastructure easier.

A general impression was that both the persons with Down syndrome and their carers (mostly family) enjoyed using the system and found it as a useful support for their daily living. People with Down syndrome felt more independent and self-confident. Their carers felt that their stress level could be reduced when POSEIDON became an integrated part of their everyday life.

The developer framework can be used by organizations as a stepping stone to develop more new services for inclusion in the future. POSEIDON is a working system with basic services to support inclusion, which illustrates the effectiveness and potential of our project. We are conscious that people with Down syndrome have their own strengths, preferences and needs, so POSEIDON will focus on using their strengths to provide support for their needs whilst allowing each individual to personalize the solution based on their preferences.

Although POSEIDON had a focus on people with Down syndrome, the results of the project contribute to the body of knowledge, which can guide future developments in other areas of inclusion.

On overview of the developer framework is described in section 3.3 of this report and to a greater detail at the POSEIDON web site www.poseidon-project.org.

2   Down syndrome

2.1   Some characteristics of Down syndrome

There is a general perception in society that people with Down syndrome can achieve little for the society they live in, however, the reality is that, with the right support, they can give much more. POSEIDON was about empowering people with Down syndrome to reach their potential.

Most people with Down syndrome experience low integration with society. There is a perception that they can achieve less than what they really can. Recent research and new opportunities for their integration in mainstream education and work provided numerous cases where levels of achievement exceeded the (limiting) expectations. Contrary to common belief, there is considerable variety and richness between individuals with Down syndrome. However, society tends to simplify their view of people with Down syndrome, usually in a way, which is detrimental to them, and in a way, that reduces their chances to achieve their potential as citizens, despite having exactly the same rights than everybody else.

Common characteristics for people with Down syndrome include[1, 2, 3, 4]:

Relative strengths in some aspects of visual processing, receptive language, nonverbal social functioning.

Relative weaknesses in gross motor skills and expressive language skills. People with Down syndrome sometimes find transitions difficult, need prompts/reminders as they go about their daily lives, benefit from structure and routine as a way to cope with the complexity of the world, they need a little more time to process information and have difficulties with time because it is quite an abstract concept.
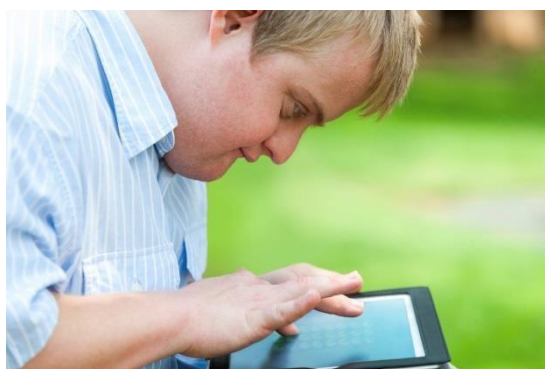
The POSEIDON solution gave priority to preferences like these to create technology that is appealing and useful to them.

Lot of other transitions are difficult for persons with Down syndrome, e.g. exploit practical knowledge on something similar or new situation, e.g. peel a carrot transferred to peel a potato or an apple, go from instructions to actions in real life, e.g. navigating, buying ticket, make food, perform a professional working task. Persons with Down syndrome may need many repetitions. The ICT solutions in POSEIDON may help these tasks with a reduced effort from carers and managers at work.

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[1] S. Brigstocke, C. Hulme and J. Nye. Number and arithmetic skills in children with Down syndrome (online) Down Syndrome Research and Practice doi:10.3104/reviews.2070 Available at http://www.down-syndrome.org/reviews/2070/reviews-2070.pdf (2008).

[2] D. J. Fidler. The Emerging Down Syndrome Behavioural phenotype in Early Childhood: Implications for practice. Infants and young children, 18(2)86-103. 2005. http://depts.washington.edu/isei/iyc/fidler_18_2.pdf

[3] C. Jarrold, H. Purser, and J. Brock. Short-term memory in Down syndrome. In T. P. Alloway & S. E. Gathercole (Eds.), Working memory and neurodevelopmental conditions (pp. 239–266). Hove, East Sussex: Psychology Press. 2006.

[4] T. Courtney, J. Pahl, S. Karrim. Employment in Down Syndrome. In Proceedings of 11th World Down Syndrome Congress. 15-17 of August, Capetown, South Africa. 2012.

However, the most difficult transition of all, is to become more independent, do tasks on their own, and be included in the society. This is what POSEIDON strived to support.

2.2   Needs of users with Down syndrome

The basic concept of POSEIDON is to support both primary and secondary end users. The foundation of POSEIDON is a user-centred approach and co-creation with the primary and secondary users.

A common characteristic is that persons with Down syndrome have tight schedules. This demands managing time, destinations and distances. Mobility is a central issue and most interviewees say clearly that they wish to be more self-dependent in their mobility. They would like to go out on evenings alone or even travel abroad alone. It is also worth mentioning from one of the secondary users: "He is so proud when he does something by himself. Being independent would be a huge boost to his self- esteem and give him the confidence to try harder challenges." Both primary and secondary users say that handling money is a challenging issue. Independence creates the need for getting some overarching understanding of the concept and value of money.

Central general aspects of the POSEIDON-suite of services are:

1. **Personalisation**. Here, secondary user(s) together with the primary user can adapt the app family as such, and the individual app, to individual preferences. The apps can be adjusted "just-for-you". This flexibility is built into the (visual) user interface as such, and the flexibility connected to the feature portfolio that can be chosen for each individual end user. For some, a rich functionality can be appropriate and necessary, whilst for others, the POSEIDON app must be as simplified as possible.

   In a nutshell, personalisation in POSEIDON is about considering the following knowledge about the end users, people with Down syndrome:

   Challenges

   - They are often visually oriented end users.
   - They may have visual and hearing impairment.
   - They may have difficulty with fine motor skills.
   - They may have difficulty with the short-term working memory.
   - They may have difficulty with learning, conceptualisation, abstract thinking and problem solving.
   - They may have a reading difficulty, and some do not read at all.
   - They may have difficulty in the application of existing knowledge in new situations/contexts.

   Strengths

   - They can master many activities of daily life with appropriate support or through repeating training over an extended period.
   - They are often clever users of information technology such smart phones and tablet PCs.

The personalisation aspects of POSEIDON are divided into three main categories: personalised content, preferences for apps, and other configuration. For personalised content, we have routes, calendar events and instructions, shopping lists, and video lists.

Personalisation is performed by a POSEIDON web service where carers can configure the POSEIDON system according to the skills of each individual person with Down syndrome, and enter content for routes, calendar, shopping and videos.

More detailed information about personalisation in POSEIDON is found in the R2-document, available at the POSEIDON web site www.poseidon-project.org.

2. **Accessibility**. The POSEIDON family of apps follows widely accepted accessibility principles. Concrete examples of accessibility are: clean interfaces without disturbing, decorative elements, large text with screen fronts, opportunity to choose high-contrast alternative, combinations of text and icon in action buttons, look- and-feel approach for easy recognition of the apps and their principles for functionality. In addition, one app has been chosen as the "portal" into other apps: the calendar. This supports the look-and-feel approach to accessibility.

3. **Context awareness**. The POSEIDON family of apps have been built on active use of contextual information to improve the user experience, safety and privacy of the end user. Context is any information that can be used to characterise the situation of a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and the application themselves.

While context can be many different aspects, in the POSEIDON project, we considered the following types of context: user (preferences, needs, assumed knowledge, activity, privacy, mood), device (connectivity, battery level), and environmental (location, time, weather). These different categories are driven either by the system, or by the user.

By being context-aware, an app can dynamically change either the content, or the behaviour of the application to suit a given situation. We gather the different situational data from different sources including phone sensors, internet resources, and behaviours of the users. This includes information about light levels, location, facing direction, weather forecasts, perhaps traffic one day (providing sources exist). The data is put into a knowledge conceptualisation repository. Two main lessons can be gained this way: (a) Reactiveness: Dealing with for example the user deviating for a route, or possibly waiting for a bus that does not arrive. (b) Proactiveness: Dealing with weather conditions at different locations, possibly looking at traffic conditions ahead of time before a journey commences. Other apps in the market are more static.

In the future, we anticipate that systems inspired by POSEIDON may consider a larger array of context types. Context awareness will provide the capability for POSEIDON-like systems to understand the situation the user is in at any time to be able to deliver appropriate inclusive services according to that situation.

Learning facility. POSEIDON offers a set of training applications. This is particularly important to POSEIDON's primary end users to gain confidence in the use – both the spectre of opportunities and restrictions such as safety and privacy.

2.3   Target groups for POSEIDON

POSEIDON aims to assist people with Down syndrome. We call them *primary users*. A second group we aim to help are those who live with the primary users: usually their family, we can also include carers who are daily in direct contact with primary users and have a duty of care to them. We call this group *secondary users.* We also considered the group of people who may be in contact with primary users more or less frequently but are not part of the very close care circle, this group is better understood as service providers, for example, teachers, employers, restaurant waiters, bus drivers, etc. We call this group *tertiary users.* Their actions may provide input to the system by approving services the primary users is accessing or by providing feedback or setting up some form of training (e.g., homework at school).

Every user of POSEIDON is different - this made our endeavour a very complex one. The system should support all user groups and particularly for primary users there is a strong need for personalised solutions, as each person with Down syndrome has an individual set of strengths and weaknesses that have to be addressed. The approach we chose was to find methods for personalisation that were particularly suited using a user-centred methodology leading to a set of requirements that was adapted after each piloting phase.

A basic assumption of the POSEIDON project was that a market for assistive technologies, such as the apps provided by POSEIDON, *exists*.

2.4   Findings from pilots and user testing

2.4.1   Prototype 1, tested at Workshop in Mainz, August 2014

In Mainz, we had guests from Luxembourg, Portugal, Switzerland and Ukraine. Two persons with Down syndrome from Germany also participated. The persons with Down syndrome tested a first navigation prototype together with their carers.

It is questionable if participants would have found the way if they had to manage it one their own. Participants seemed to like the app, even though they indicated that practice is needed to travel safely with the help of such an app.

Important feedback for the next iteration was:

- Safer navigation, mark crossings, give guidance on which side of the road to walk, avoid that persons look at the screen and not paying attention to the traffic.
- Give guidance for direction. Images and instructions functions well. Spoken instructions should be considered.

2.4.2   Pilot 1, POSEIDON-system tested in Germany, Norway, UK, Summer and autumn 2015

Pilot 1 tested the refined navigation app, calendar, the web personalisation service and two training apps, one for navigation, the other for money handling.

PUs like the idea of using a screen-based tool, being reminded by a smartphone, having their own pictures integrated into routes and learning how to handle money via a gamification approach. They like mastering things and succeeding in doing something. In contrast, they don't like getting negative

feedback, the feeling of being unsafe or the usage of unreliable products or products they are not able to use.

SUs can imagine, that the POSEIDON systems can help people with Down syndrome to become more independent. However, for reaching this aim, all POSEIDON applications and devices needed further developmental activities. When summarizing the results, three main points should be considered:

- Usability and user experience
- Safety
- Personalisation

All systems could be improved regarding their usability and user experience. That means the PU should be supported by doing a specific task in a more efficient and effective way, e.g. navigating to a certain place. The navigation system leads to too much confusion and does not help to navigate safely. In addition, also the MHG needed to be revised to achieve significant learning successes. Everything should be easy to understand and information had to be clear without ambiguity and further interpretation. Moreover, the systems should provide a high tolerance for mistakes, this is especially true for entering text information in the calendar. Auto correction or auto completion could be a good solution. In addition, using the POSEIDON applications should lead to a good user experience. That means, none of the systems should be annoying or disturbing. This is especially true for the alarm sound (calendar). PUs should have the chance to easily turn off the alarm. Feeling safe when using the POSEIDON applications can also contribute to a good user experience. None of the POSEIDON applications must be dangerous to our PUs at any time. Therefore, solutions had to be found especially for navigating with the navigation system. When using the navigation, it has to be avoided that PUs are distracted by the smartphone display, they have to be warned when crossing a street. Routes and decision points have to be chosen by the SUs.

Since we were working with a highly varying target group, personalisation must not be disregarded. We had to focus on different levels of personalisation in relation to competencies (calculating, reading, spelling) and preferences (e.g. sound of alarm, preferred routes) of people with Down syndrome. Only if they are able to deal with the POSEIDON devices they will use and trust them, and most importantly, only then they will benefit from them. Using a MHG which do not challenge them enough might be fun for the first time, but will not increase their knowledge on money handling. In contrast, a navigation system which exceeds their competencies and leads to uncertainty and frustration, might never be touched again. PUs must enjoy the usage of POSEIDON, they have to feel safe and they should benefit from using it.

2.4.3 Pilot 2, POSEIDON-system tested in Germany, Norway, UK, Summer and autumn 2016

Pilot 2 tested updated versions of the apps from pilot 1. In addition, we introduced a new route creator app, a shopping app, a video service which could be used for entertainment and instructions and a controlled social network. We recruited new families for the second pilot.

In the second pilot the system worked more reliable than during the first pilot, and many problems could be solved by the users themselves. Nonetheless, it remains a challenging system, both on the cognitive and the motivational level.

People with Down syndrome have highly different abilities and therefore need different forms of support. It was a central aim of POSEIDON to take this into consideration and to develop for every

application a possibility to customize it to the abilities and needs of the person with Down syndrome. The Secondary Users customized different levels of personalization depending on the competencies (reading, spelling) and the preferences (e.g. sound of alarm, preferred routes) of the person with Down syndrome. They reported what they personalized and if they thought other functions should be personalized.

The central result of pilot 2 is that using POSEIDON can probably lead to an increasing independency and autonomy of people with Down syndrome, a better organization of daily tasks and a higher mobility. All SUs of the pilots can see the potential POSEIDON has on independency and autonomy.

Using the calendar made the PUs feel more independent although they needed some prompt adding their appointments. However, with help of the calendar app they achieved their goal remembering appointments and bringing all necessary things to school or work. Helpful in many respects was the use of the navigation system: it made travelling more secure for the PUs and was reassuring for their carers who could easily be informed about the position of their protégées.

By combining different apps of POSEIDON users could organize and conduct different tasks. They could for instance do a shopping tour completely on their own: creating a shopping list, organizing the money for the planned purchase, planning the route to the shop, using the navigation system to go there, doing the shopping, paying on their own and going back home again with help of the navigation app.

POSEIDON is a complex system, which combines and integrates different apps and the POSEIDON website. This makes testing more complicated, requiring more time than the testing of just single features. Technical problems, which had to be solved during the pilot, arose most times in complex tasks. So, for instance, it became a problem to secure that the PUs outside their homes paid sufficient attention to the ongoing traffic while concentrating their attention to the navigating device.

Personalization of tasks is the key concept in using POSEIDON. Because Down syndrome includes highly diverging problems, tasks have to be developed and modified according to different abilities. This means that a system as POSEIDION cannot be reliable in general but there can only be sufficient reliabilities for different groups.

Taking such limitations into consideration POSEIDION definitely has the potential to increase the Primary Users independence and autonomy. The Primary Users need to practice and use the functions more and over a longer period in order to adapt the system in their daily life.

Also after pilot 2, 45 recommendations were suggested for improvements of the POSEIDON system. Most of these recommendations were implemented in the final POSEIDON prototype, prototype 4.

Personalisation in pilot 2

For every POSEIDON application, there are possibilities to customize it to the abilities and needs of the person with Down syndrome. The SUs were asked in the interviews what they personalized and if other functions should have the possibility for personalization.

All in all, the SUs were quite confident and personalized a lot. However, they suggested many ideas of improvement for further development.

Regarding the **POSEIDON personalisation web** nearly all SUs indicated that they were able to customize it sufficiently to the abilities and needs of their children. They customized for example the screen settings of contrast, the alerts on calendar and routes linked to calendar. The SUs used text that

the PU would understand, added links to videos the PU liked, and made shopping lists with products they are familiar with.

As an improvement for the **calendar** it was suggested that there should be a possibility to change from a 24-hour to 12-hour clock with an icon of a sun or moon to indicate if it is evening/night or morning/daytime, because the 24-hour digital clock was often too difficult for PUs. Also, if the PU inserts an appointment via app it should be possible to choose pictures or sign/symbols from a list, if the PU is not able to write. If SUs add pictures, links to videos or instruction messages, they should be able to decide how large the window for the picture, video or text should be (for example full screen) accordingly to the needs of the PU.

Moreover, most of the SUs would like to know what weather information messages the PU will receive and to be able to personalize these messages. The weather notification should also not disappear that fast and should be retrievable. The font should be adjustable as well.

For the **video instructions**, there should be a more visual view of the videos linked to in the app, and not a list of Video 1, Video 2, etc. For example, there could be thumbnails with the title of the video. In addition, it should be possible to decide which videos should be streamed when using mobile network or not. Now you can only select to stream all or none of the videos.

The SUs personalized the **navigation** through the route creator app by adding own pictures of decision points and instructions. The images in decision points should be larger or "zoomable" because the PUs did not see all the important details in some of the images. Moreover, there should be a message saying that the route has ended. SU could insert an own advice such as: "You have arrived the destination!" or "You are finished". Ideally, the SUs wish to track the PUs inside for example of shopping malls, etc. For some PUs the map was a bit abstract, especially when the map is viewed from above and there is no arrow showing which direction to walk. A map with a more realistic view should be available.

There is only the possibility to change the products and prices in the **Money Handling app** for personalization. To provide other/more learning levels would give the possibility to customise it more to the individual needs. Moreover, it would be good to have the possibility to decide if bills are necessary or not, or other coins are needed. For money learning beginners, this could be helpful. In addition, it would be nice to get feedback when paying too much for the product, not only the symbol for getting change. And there should be an acoustical feedback to try again.

3   Methods and tools for designing software for persons with Down syndrome

We share our experiences and tools gathered during the POSEIDON project with anyone who would like to develop an App for persons with Down syndrome. We offer requirement gathering methodologies, information about the user group, ethical and privacy checklist, a basic app to start with, special libraries and APIs and best practices.

3.1   Methods

A system development methodology specifies structured ways of creating ICT systems. The framework describes the following methodologies:

- UC-SDP: User Centered Software Development Process. This software development process focuses on facilitating stakeholders to co-create intelligent environments.

- eFriend: A set of engineering principles to guide and encourage developers to secure that ethically sensitive aspects of technology are explicitly addressed in the development of a product, especially within the Ambient Assisted Living field.

- R4C-AS: A methodology for requirements elicitation in Context-Aware systems. It provides a structured approach to gather and define the requirements of such systems, including diagrammatic support, which can be then linked to design and correctness analysis.

The framework also includes tools to support the methodologies. See the Tutorial for context-aware systems for a practical introduction. Documentation references:

- D5.1 Development framework chapter 3.
  http://www.poseidon-project.org/wp-content/uploads/D5.1-Development-framework-v4.pdf

POSEIDON has created a framework to guide development of technology with ethical considerations embedded in the development process. The framework is based on the eFRIEND ethical framework, which was created for Intelligent Environments in general.

- Ethics in POSEIDON
  http://www.poseidon-project.org/wp-content/uploads/Ethics-in-POSEIDON.pdf

3.1.1 User-centred methodology

POSEIDON had a strong end-user involvement in all phases of the project, from end-user requirements acquisition, through systems design and implementation via pilot studies to the final POSEIDON-products and –services.

Pilot studies was the most thorough examination exercises for our technology. We gave the families of people with Down syndrome the product we had developed, at two different stages of evolution. It was used in a variety of settings (e.g., at home or at school, at work or leisure, in daily living like shopping and travelling). We worked closely with the person with Down syndrome and their carers, with wider family or support workers, to find the most appropriate way of recording data. Being flexible allowed us to obtain rich data that was analysed and used for improvement of POSEIDON-services.

3.1.2 Requirements acquisition

POSEIDON uses several methodologies for requirements acquisition. End-user involvement was key in all methodologies:

- An online questionnaire to assess the requirements of people with Down syndrome seen from the carer's viewpoint.
  - Around 400 people, 267 in UK, 106 in Germany and 18 in Norway answered the initial questionnaires. More answers, also from other countries, were received during the project.
  - 85 % of the respondents were parents having a child with Down syndrome.
- Face-to-face interviews with people with Down syndrome, to get the user's opinions.
  - 29 people were interviewed, 16 were female and 13 were male. The age range was from 14 to 38 years. 17 participants were living with their parents and 12 in sheltered

homes. There is no significant difference between countries regarding their living circumstances.

- Personas and scenarios to illustrate which impact POSEIDON might have on the life of people with Down syndrome, to be used for collectivization and better understanding of the primary user's needs and problems in the project team.

- International workshops with invited participants from 10 European countries, to disseminate information and get feedback from other parts of Europe.
  - o The project invited three guests from each country to the workshops, one person with Down syndrome, her carer and a national expert on Down syndrome.
  - o Workshop 1: Oslo, January 2014. Croatia, Italy, Romania, Slovenia.
  - o Workshop 2: Mainz, August 2014. Luxembourg, Portugal, Switzerland, Ukraine. At this workshop the first navigation prototype was used for the first time.
  - o Workshop 3: London, September 2016. France, Ireland.

- Pilots with 9 families, 3 in each country to get feedback on the present version of POSEIDON-system.
  - o Pilot 1: Summer and autumn 2015.
  - o Pilot 2: Summer and autumn 2016.

- Extended pilot in all 3 countries, with several families assembled a weekend during autumn 2015, to get additional feedback of the POSEIDON-system, 28 persons with Down syndrome and 22 secondary users participated.

- More than 50 co-creation activities with the target group in all participating countries during the project.

Deliverables D2.1, D6.2 and D6.3 provide more details.

3.2   POSEIDON integrated technology overview

A goal of the POSEIDON project was to foster development of inclusive services for people with Down syndrome, and a commercial POSEIDON solution needs to be extensible with new services. The development framework is the project's way of addressing these goals. Here we give an overview of the framework for new developers, along with references to more detailed information.

The developer framework[5] and developer guide[6] are available on the POSEIDON web site.

The objective of this section is to give a brief description of the complete POSEIDON prototype system, including the infrastructure as well as all prototype applications, to give the reader the overview needed to go into some of the more detailed pieces of documentation on specific parts or aspects of the system. The material in this section is taken from D5.6 Integrated POSEIDON technology technical documentation, section 2[7].

Starting with Figure 1, this presents the system and services as tested in the second and last pilot. We have three types of users. The primary user, on the right side of the figure, is the person with Down syndrome. This role entails using the system both for training and preparation, and to receive guidance in daily activities at any time. The secondary user enters and configures instructional content and

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[5] http://www.poseidon-project.org/wp-content/uploads/D5.1-Development-framework-v4.pdf
[6] http://www.poseidon-project.org/introduction/
[7] http://www.poseidon-project.org/wp-content/uploads/D5.6-Integrated-technology-doc-v3-FINAL.pdf

system behaviour, as well as being able to monitor the primary user. The tertiary user role is similar to the secondary user in that it can entail entering content and/or monitoring, but will typically have a more limited access to a whole set of primary users (this could be a school teacher or other form of professional).
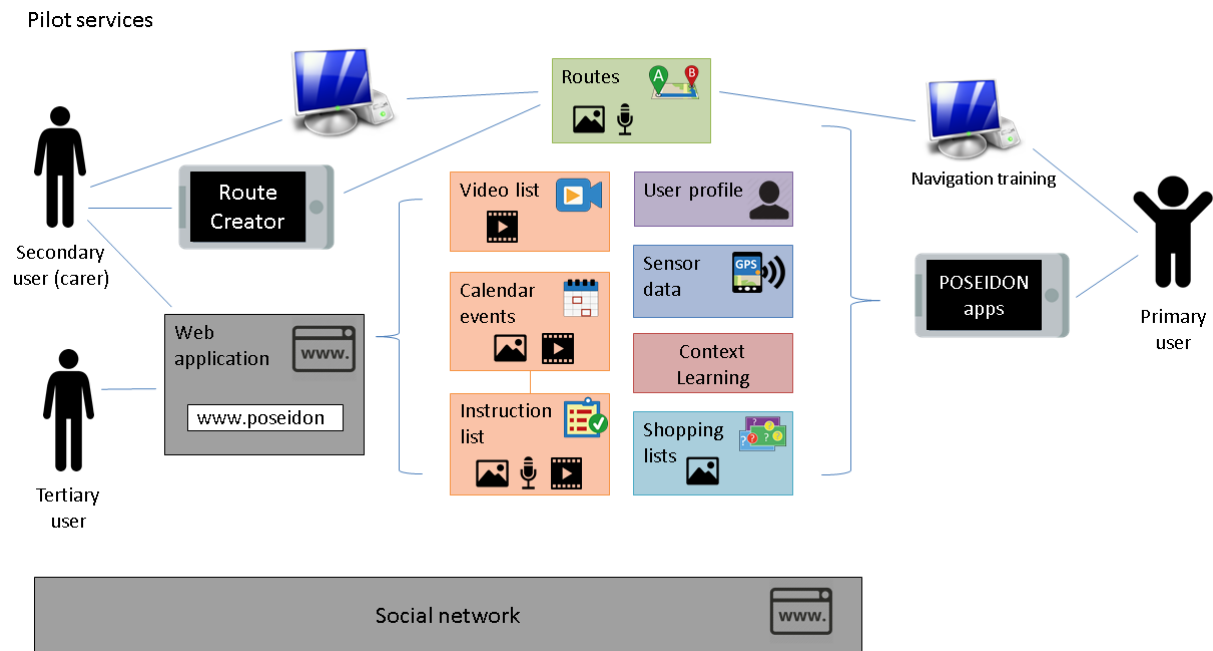

Figure 1: Pilot system overview – users, platforms and functionality

POSEIDON applications are available on three types of platforms: traditional computers (for stationary use), mobile devices and web (running on both computers and mobile devices). For primary users, training has mainly been done on computers while the guidance is otherwise available through apps on the mobile device. For secondary and tertiary users, the POSEIDON web application is the main user interface. Only the navigation-related activities of creating routes and setting up training must be done elsewhere, with computer and mobile app alternatives. A web-site with social network is also an important part of the system, making information available to the users and allowing exchange of experiences.

3.2.1   Shared data

The applications give access to the various forms of data in the system, indicated in the centre of Figure 1. All data is available to all user types, with the POSEIDON infrastructure providing shared storage. Much of the data is instructional content, with media content of images, audio and video indicated with additional icons in the figure.

- Routes: For navigation training and real-time guidance, with text, audio and images.
- Video list: List of private or YouTube videos, for giving instructions to the primary user.
- Calendar events: Time-based content, to notify and instruct on events.
- Instruction lists: A calendar event can have an additional sequential list of instructions.
- User profile: Contains user preferences for personalisation.
- Sensor data: Position and other tracked data is stored for monitoring.
- Context and Learning: Context awareness middleware monitors context information and stores it for learning.

- Shopping lists: Products and shopping lists for money handling training and guidance.

3.2.2   Framework and infrastructure

One of the main results of the POSEIDON project is the developer framework. This is a collection of methodologies, infrastructure, middleware, tools, specifications, etc. which are used in the development of the POSEIDON prototype system and parts of it. This is partly methodologies, open-source code and free tools of general use. But here we are mainly concerned with the POSEIDON infrastructure. It is what binds our applications together in a system, and it also allows new applications to integrate with this system. A goal of the POSEIDON project is to foster development of inclusive services for people with Down syndrome, and a commercial POSEIDON solution needs to be extensible with new services. The development framework is the project's way of addressing these goals.
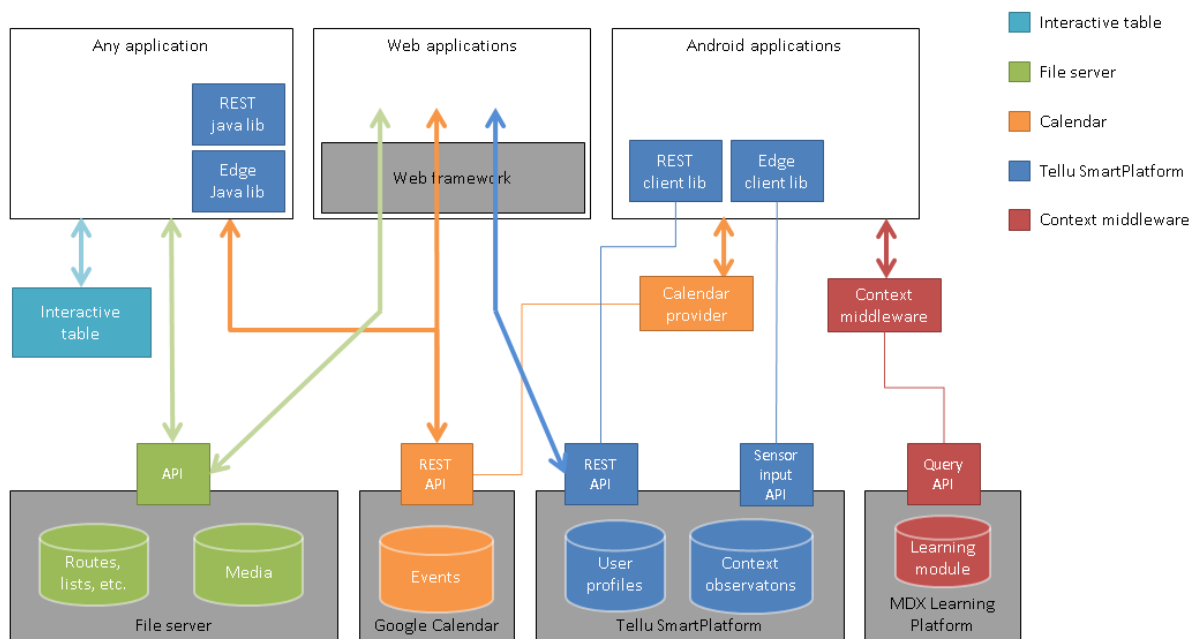

Figure 2: POSEIDON framework architecture and infrastructure

Figure 2 shows the framework architecture with infrastructure. The server-side parts of the system are shown along the bottom, with the data stores. There is a calendar server, while a file server stores the rest of the instructional content and media. The SmartPlatform server holds the POSEIDON accounts with user profiles along with tracked data for monitoring. Any POSEIDON application can connect to the infrastructure and access the data, as long as it has authentication as a registered user. The Learning Platform holds context data for learning. It is connected to context middleware running on the mobile device.

Middleware running on devices is another part of the infrastructure, and also includes calendar data synchronisation. The context middleware provides context awareness to mobile applications, using the sensors of the device as well as external services to monitor context. Context considered includes location, time, weather, battery capacity, user preferences etc. Applications can subscribe to context updates from the middleware, and also post their own context observations to the middleware.

The boxes in the top part of the figure indicate applications connected to the infrastructure, showing some of the components we provide for building such applications and connecting them to the infrastructure. Android is the primary mobile platform, with specific components provided, while we have also produced Unity and Java components of a more generic nature. A set of technologies and code forms the basis of the POSEIDON web application, and this can also be reused by others.

3.2.3   Prototype system

Figure 3 provides a third view of the integrated system, this time showing all the main components of the final prototype system and how they are distributed. The servers of the infrastructure take up the middle part of this figure. Connected to this are the three types of applications – stationary (computer), mobile (phone/tablet) and web – with their functional components. This shows how the different functional aspects (colour-coded in the figure) are distributed throughout it. Note that the colour-coding is different from that of Figure 2.
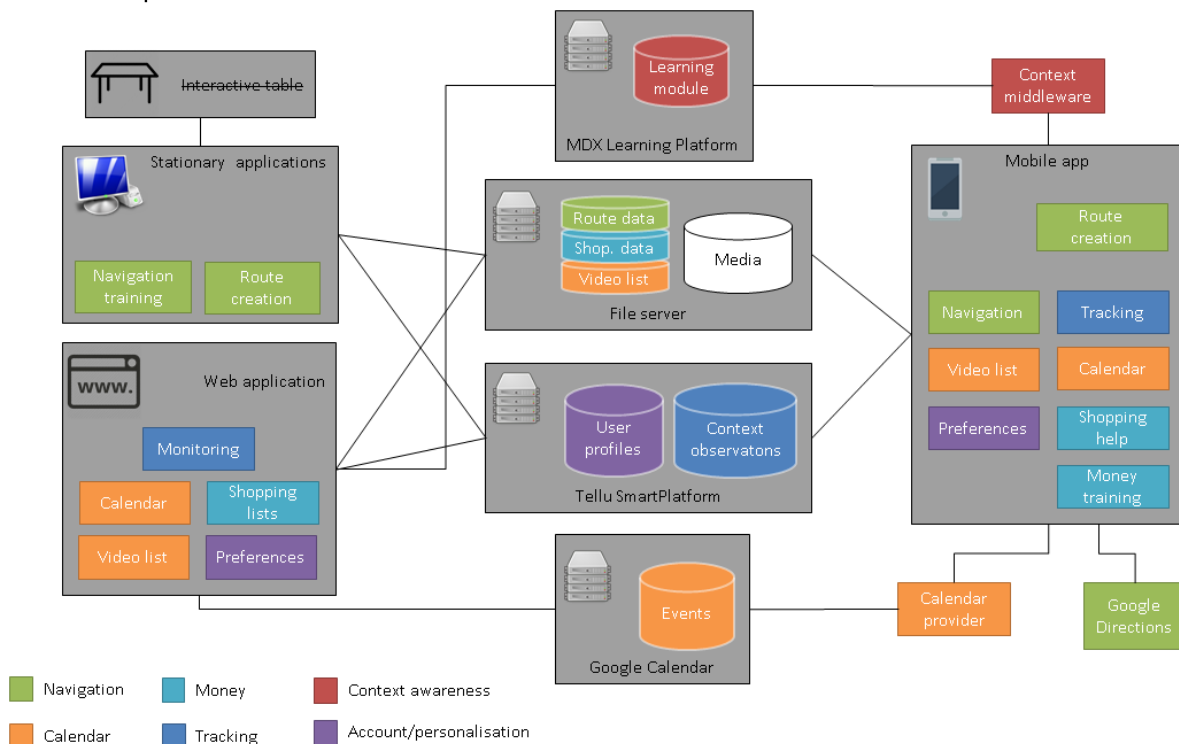

Figure 3 – Overview of POSEIDON final prototype system

Not all prototypes have been included in the final pilot system, most importantly the interactive table. The interactive table has been a central focus in the project, tested in the first pilot and considered a part of the infrastructure for stationary applications. It is a prototype of a new interaction device, which combines the size of a multi-touch table with 3D hand position recognition. It is intended to be unobtrusively built into tables, allowing the user to control applications via hand gesture on or over the table. It can be part of the stationary system, used to control training applications for navigation and money handling.

Looking at some of the colour-coded functional aspects, green is for navigation – the guidance related to space. The home system part is used by carers to create personalised routes, and by primary users to train with virtual reality. Routes and instructional media are stored on the file server. Route creation

can also be done by walking the route with a mobile application. Navigation guidance is provided on the mobile device, tracking the user on a trip. While the main routes are created by carers to be personalised for the primary user, the mobile application can also use the Google Directions service to find the way back to the main route if the user gets lost.

Support for the use of money is likewise distributed throughout the system, shown in cyan in the figure. Products to buy, and shopping lists based on these, are defined using the web application and stored on the file server. Training money handling based on the shopping lists was initially provided on the stationary system, using the interactive table, but was moved to the mobile system for the second pilot. The mobile application provides the aid the when out in the shop.

Orange highlights the assistance related to time – the calendar-based functionality. The web application has a calendar interface, for managing events and connecting them to functionality such as navigation. The mobile application also has a calendar interface – a simpler interface better adapted to the smaller screen and primary users, but also allowing entering basic events. And the mobile application provides reminders. All calendar-based functionality connects to the same cloud storage of events. The events themselves are stored in Google Calendar, but the POSEIDON-specific extension of the calendar supports lists of instructions, and media stored on the file server. Included in orange is also the possibility of defining a list of instructional videos in the web application, which is stored on the file server and provided to the primary user on the mobile device.

3.3   Developer Guide

The POSEIDON developer Guide is available at the POSEIDON web site and contains the following:

Understanding the POSEIDON framework. This is important in order to get to know the existing architecture of technology and methodologies how to execute a fine-grained requirement analysis.

Mobile application tutorial. We take you step by step through the basic usage of the POSEIDON infrastructure. You will use the Starter App as working example. As the main theme of this tutorial is the communication with the infrastructure, you will go through code examples from the Starter App which explain the basic connection to the POSEIDON infrastructure. Links to the different resources assure that you can start developing.

Extending your app with context awareness. This tutorial explains the process on how you can integrate generated code from the context awareness methodology into a basic app. This is important in case you want to develop an app where different automatically detected situations (contexts) trigger functionality in your app.

Info on user group. Here you can find a concise description on persons with Down's syndrome as computer users.

Ethical, privacy and security principles. Once you have developed your first app idea, please read these, and check if all of the principles are taken into account.

Design user interfaces for persons with Down syndrome. In the first part you will find the general principles and how POSEIDON recommends to implement them. In the second part you will find developer guidelines with concrete examples what to use and what to avoid.

Lessons learned during our cooperation with the persons with Down syndrome. We address the requirement gathering, the app design and the app testing phase.

# 4   Best practice - some POSEIDON services

There is an emphasis on clean and simple human-computer interfaces, responsive design, personalisation features and context awareness. POSEIDON now has the following prototypes, which will be made ready for commercialisation (see: http://www.poseidon-project.org/product/).

4.1   POSEIDON app for users with Down syndrome

This app supports daily planning, traveling, shopping and personal video clips.
The main menu gives the user with Down syndrome the following options:

- o   Routes – Start navigation by using planned routes
- o   Preferences – Turn on/off position tracking and choose colour themes
- o   Calendar – View planned events and add new events
- o   Videos – View videos that are uploaded by the carer
- o   Training – Access the Money Handling Training app
- o   Shopping – Access the Money Handling Assistance app
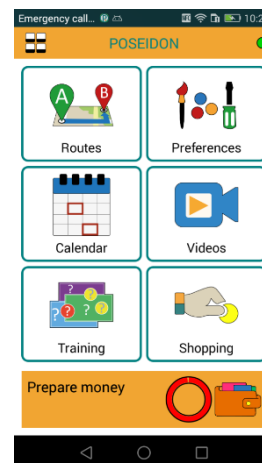
Personalised events and routes

- o   Carers can make personalised events in the Web for carers, and personalised route descriptions in the Route Creator app. The events and routes will automatically show up in the app for users with Down Syndrome.

Video clips

- o   Carers can add personal video clips to calendar events and to a video list.

Money handling apps Shopping assistance

- o   The Money Handling Training and Assistance apps are accessible from "Training" and "Shopping" on the main menu.

4.2   Web for carers

On the web the carer can make personal calendar events, shopping lists and add videos that will appear on the app for users with Down syndrome. The carer can also track the user´s position and mark important places on the map.

Calendar

- o   Carers can make personal calendar events with instructions by adding text, images, sound recordings and videos. They can also add pre-defined routes (made in the Home Navigation app).

Shopping

- o   Carers can make shopping lists that will show up in the Money Handling Assistance app on the user´s smartphone. The shopping lists contain which products to buy and the price including what type of coins and notes to pay with.

Monitor

- o   The monitor lets the carer track the user´s current or last position. The carer can also mark important places on the map, such as school or work.

Video
- o Carers can add YouTube videos that will appear on the user´s mobile device. Read more about personal videos clips.
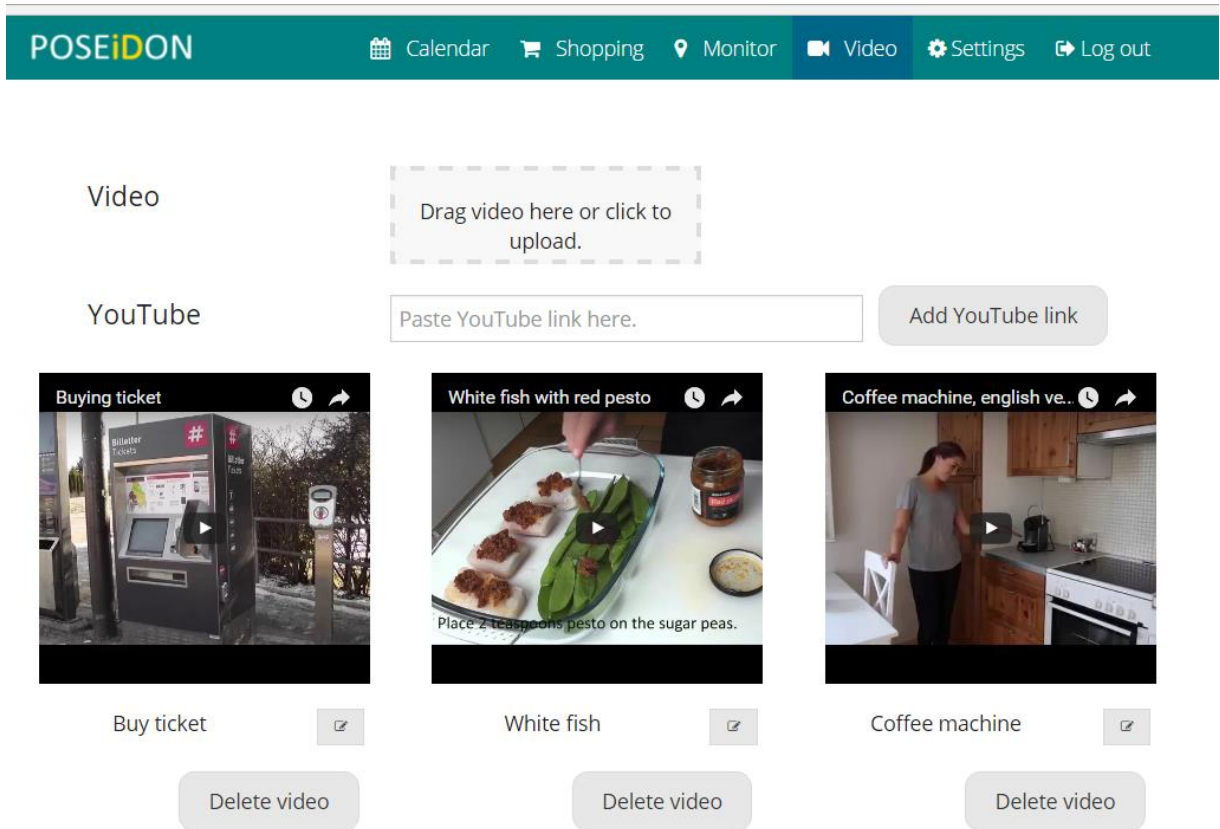

Personalisation symbols
- o We have developed a set of symbols that carers can add to the app for users with Down syndrome. The symbols support the users by offering complementary easy-to-understand-information.

4.3 Route Creator app

By using this app, the carer can make route descriptions that will show up in the App for Users with Down Syndrome. The carer can customise the steps of a journey by adding:
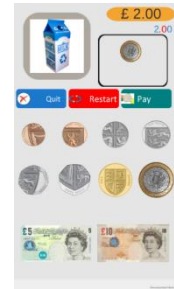
- Text
- Photos
- Speech
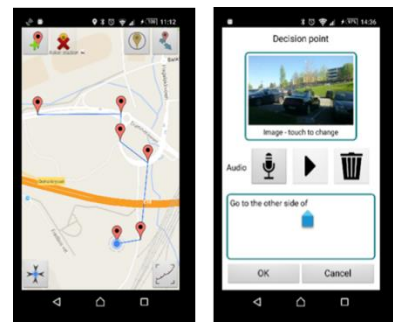
4.4   Money Handling apps

Money Handling Training

- o   Money Handling Training app (on Smartphone) aims to train the users in handling money so that they are better prepared when they go shopping. They can train using the phone, directly on the prepared shopping list.

Shopping app

- o   Money Handling Assistance is a shopping app (on smartphone) that supports the users on the spot – when they are out shopping. Click on the item below to learn more about the app.