MOBAS Project
Final Report
Dario Cavada – dario.cavada.lab@gmail.com
Omar Moling – omoling@gmail.com
Francesco Ricci – francesco.ricci@unibz.it
Floriano Zini – floriano.zini@unibz.it
## Changes

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Author</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>04.10.2012</td>
<td>Francesco Ricci</td>
<td>Initial version</td>
</tr>
<tr>
<td>0.2</td>
<td>10.10.2012</td>
<td>Floriano Zini</td>
<td>Section 2 (people) added. Revision of Section 3 (activities)</td>
</tr>
<tr>
<td>0.3</td>
<td>10.10.2012</td>
<td>Dario Cavada</td>
<td>Section 4.1 (general architecture) added.</td>
</tr>
<tr>
<td>0.4</td>
<td>11.10.2012</td>
<td>Floriano Zini</td>
<td>Added material to Sections 4, 5, 6, and 8</td>
</tr>
<tr>
<td>0.5</td>
<td>14.10.2012</td>
<td>Omar Moling</td>
<td>Section 4.5</td>
</tr>
<tr>
<td>0.6</td>
<td>15.10.2012</td>
<td>Francesco Ricci</td>
<td>General revision</td>
</tr>
<tr>
<td>0.7</td>
<td>15.10.2012</td>
<td>Floriano Zini</td>
<td>Section 9. Some typos and cross reference fixed</td>
</tr>
<tr>
<td>1.0</td>
<td>15.10.2012</td>
<td>Francesco Ricci</td>
<td>Final revision</td>
</tr>
</tbody>
</table>
Table of Contents

1. Project Goals .................................................................................................................. 4
2. People Involved in the Project ....................................................................................... 4
3. Research Activities ......................................................................................................... 5
4. Final System ..................................................................................................................... 7
   4.1. General Architecture ................................................................................................. 7
       4.1.1. Liferay Portal .................................................................................................... 8
       4.1.2. MOBAS Portlets ................................................................................................. 8
       4.1.3. External components ......................................................................................... 11
       4.1.4. Mobas JQM ....................................................................................................... 11
   4.2. Messaging Component .............................................................................................. 14
   4.3. Map Component ........................................................................................................ 17
   4.4. Chart Component .................................................................................................... 18
   4.5. Adaptive Disease Information System (PHIS) ........................................................ 19
5. Presentations .................................................................................................................... 24
6. Students’ Thesis and Research Projects ......................................................................... 26
7. External Collaboration ..................................................................................................... 30
8. Scientific Publications ..................................................................................................... 31
9. Project Result and Impact ............................................................................................. 33
1. Project Goals

The MOBAS project was aimed at designing and developing a mobile, personalized information service in the hospital. The ultimate goal was to improve the quality of the communication between the medical staff and the patients in a day hospital scenario. The implemented information system, called MobiDay, is using pervasive technologies and contextual information in an oncology unit, to provide up-to-date, context dependent information to the patients, and to let them enter various information required by the doctors to assess their state and take decisions related to the patient’s therapy. The ultimate goal of this system is to provide not only a valuable set of information to the patients (e.g., what to do next, or information about their disease) and the doctors, but also to learn from the patients’ actions (opening and reading messages, replies to questionnaires) better strategies for delivering personalized support during the day hospital workflow. The practical effect of the learning procedures is to increase the effectiveness of the information and the user interface.

2. People Involved in the Project

The MOBAS project was a collective effort of several people. It started on January 2008 and finished on September 2012. This section lists them in alphabetical order and explains their role in the project. The detailed description of the work done is included in the following sections of this document.

- **Bernd Ludwig – Post doc** (September 2010 – November 2010). Analyst of the data collected from the experimentation of MobiDay 1. Contributor to the design and development of the component of MobiDay 2 that provides adaptive information on the patient’s disease.
- **Manfred Mitterer – Head of the oncological unit of the Meran hospital** (January 2008 – September 2012). Domain expert.
- **Laura Napolitano – Bachelor student** (November 2010 – March 2012). Developer of the questionnaire component of MobiDay 2 and experimenter of such component in the hospital.
• **Valdemaras Repsys – Master student** (August 2009 – May 2010). Compiler of a literature survey on the applications of context aware techniques in healthcare.

• **Francesco Ricci – Associate professor** (January 2008 – September 2012). Project and research leader, supervisor of all the activities of the project.


• **Hannes Tribus – Research assistant** (July 2010 – December 2010). Developer of a preliminary version of the questionnaire component of MobiDay 2.


• **Floriano Zini – Researcher** (March 2010 – September 2012). Partial supervisor of the activities of the project, analyst of the data collected from the experimentation of MobiDay 1, developer of the messaging and chart components of MobiDay 2.

### 3. Research Activities

At the beginning of the projects, the work group focused on the design and development of an innovative mobile information system (MobiDay 1), able to provide to the patients visiting the day hospital context-dependent information related to their activities. In the supported usage scenario, the nurse gives to the patient who registers at the reception of the day hospital a mobile phone where MobiDay 1 is installed. The system is able to:

- Provide to the patient information of various types, such as the status of her workflow (with particular emphasis on the activities she has still to execute) or possible side effects of her therapies.

- Send to the patient various types of messages, such as, calls for her medical examination or blood sample taking, notification of delays in the medical process, or medical prescriptions. These messages could be automatically generated by the system or compiled by the clinical personnel.

- Send to the patient questionnaires on the quality of life, that can be filled on the mobile phone and sent back to the system for further processing.

MobiDay 1 has also a server component integrated with the hospital information system (ONCONET), and with an additional system (CHES, developed by the University of Innsbruck, Prof. B. Holzner), which is devoted to the generation of clinical questionnaires, and to the processing of gathered data. An important feature of MobiDay 1 is that while the medical staff interacts with the hospital information system the generated actions produce workflow events (process status changes) that activate various functions of MobiDay 1.
During the execution of the day hospital workflow the patient can use the mobile phone to be always informed about the status of her visit and to provide the medical staff with useful information, that improves the interaction between patient and doctor.

An additional feature of the system regards the possibility of localizing the patient in the hospital. During the visit, the patient wears an active RFID badge. In such a way, MobiDay 1 can detect the patient position, and can exploit this information to predict what the patient is doing. The final goal is to provide the patient with informative messages at the right time, that is, when it is most likely that the patient will read them without being disturbed, for example, to avoid sending any message during the medical examination.

In order to develop this prototype, the team has first executed, in agreement with the project plan, a phase in which the requirements of the system were gathered. In this phase we organized several meetings with the medical personnel of the Meran hospital (Dr. Mitterer and Dr. Spizzo), and other experts form Innsbruck hospital (Prof. Holzner). We defined together the system functionality, and the research objectives. We also evaluated some initial prototype solutions for mobile phones, so that we could converge to an effective system design.

In parallel, we immediately started the implementation of the prototype: we designed the system architecture, and tackled the system integration with the hospital information system ONCONET, for the workflow management functionality, and with CHES, for the generation and the analysis of the clinical questionnaires for patients.

Moreover we designed and implemented the subsystem that receives the data generated by the active RFID tags and determines the position of the patient in the hospital. This task has been conducted in cooperation with ISI Torino (Dott. Ciro Cattuto).

In parallel with the development of the system, we conducted a literature survey and produced a report on the state of the art of technologies for the detection of the patient status and the detection of suitable situations for the system to push information to the user, i.e., without a specific user request.

Real patients of the hospital of Meran were involved in a first field experimentation of MobiDay 1. We performed two experiments:

- We evaluated the usability of the messaging service of MobiDay and we studied the impact of the patient context (location and workflow step) on the acceptance of the messages.

- We investigated the impact of the patient’s clinical profile on the usability of the questionnaire-filling component of MobiDay 1, on a smartphone and other smart devices (a tablet PC running CHES and a laptop), compared to a traditional paper form based approach.

For each experiment we defined specific evaluation strategies in order to assess if the mobile phone-based system was easy to use in comparison with the other systems and to find correlations between various indicators included in the
patient's clinical profile and the perceived usability of the used questionnaire filling system. About 50 patients in total were involved in the two experiments.

After the development of the first system prototype and studying the results of the live user study in the hospital we have designed an improved system, MobyDay2 that is actually described in this final report. The new system has been developed in 2011-2012, and is now being evaluated in the hospital.

A first pilot test with a group of test users was been planned and executed in order to find and fix bugs of the system, issues regarding the reading user interface and errors in the information provided to the patients. The test group did not involve patients of the hospital, which will be asked in a second moment to participate into an on-field beta test.

4. Final System

MobiDay 2 is the final system produced by the research activities conducted in the MOBAS project. It provides a single web-based access point to services dedicated to both patients and clinicians. The services for the patients are:

- Hospital guide;
- Clinical questionnaire filling;
- Personalized information on patient's diseases.

The services for the clinicians are:

- Management of the patient workflow in the hospital;
- Management of questionnaires and personalized information;
- Statistical elaboration and graphical visualization of patient’s answers to questionnaires.

In this section we first describe the general architecture of MobiDay 2, and then we focus on the services for patients and clinicians.

4.1. General Architecture

MobiDay 2 is built on Apache Tomcat, an open source web server and servlet container developed by the Apache Software Foundation (ASF). Tomcat implements the Java Servlet and the Java Server Pages (JSP) specifications from Oracle Corporation, and provides a "pure Java" HTTP web server environment for Java server-side code. The general architecture of MobiDay 2, the main components of the web server, and the technological stacks used for the implementation of the MobiDay 2 client and server are depicted in Figure 1.
4.1.1. Liferay Portal

Liferay Portal is a free and open source enterprise portal written in Java. It allows users to set up features common to websites. It is fundamentally composed by functional units called portlets. Liferay is sometimes described as a content management framework or a web application framework. Liferay works with a servlet container such as Apache Tomcat.

4.1.2. MOBAS Portlets

We developed customized portlets embedded in Liferay, which implement main system functions.
**Nurse portlet**

This portlet provides the graphical interface for the management of the patient workflow in the hospital. As shown in Figure 2 and Figure 3, the nurse can assign a hospital workflow to the patients, advance the patients in the activities of the workflow, and set up possible delays and reasons.

![Figure 2: Patient workflow management.](image1)

**Doctor portlet**

This portlet provides the graphical interface for the management of questionnaires and documents assigned to the patient and for the visualization of charts related to the patient's health status. Figure 4 shows the doctor's main view, including the list of all patients (including the activity of those currently in the hospital). By clicking on *details* the doctor can assign clinical questionnaires to the patients, visualize their completion status (Figure 5) and study the graphical presentation of the answers to the questionnaire aggregated into clinical indicators of the patient's health status (Figure 6). The doctor can also visualize and edit the detailed answers of the patient. Moreover, the doctor can assign the patients documents included personalized information on their diseases (Figure 7).
Elenco pazienti

<table>
<thead>
<tr>
<th>ID</th>
<th>Nome</th>
<th>Lang</th>
<th>Activity</th>
<th>Status</th>
<th>Room</th>
<th>Waiting Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>10711</td>
<td>Clark Martin</td>
<td>it</td>
<td>Nessuna</td>
<td>Nessuna</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10001</td>
<td>Rossini Paolo</td>
<td>it</td>
<td>Esame del sangue</td>
<td>Athens</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10020</td>
<td>Griffin Sara</td>
<td>it</td>
<td>Esame del sangue</td>
<td>in corsa</td>
<td>2:62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11726</td>
<td>test1002 test1001</td>
<td>it</td>
<td>Nessuna</td>
<td>Nessuna</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11746</td>
<td>test1002 test1001</td>
<td>it</td>
<td>Nessuna</td>
<td>Nessuna</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11082</td>
<td>test1002 test1001</td>
<td>it</td>
<td>Nessuna</td>
<td>Nessuna</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4: Doctor main view.

Scheda medica di: Griffin Sara

<table>
<thead>
<tr>
<th>Questionnaires</th>
<th>Informazioni</th>
<th>Scale funzionali (littimo)</th>
<th>Scale dei sintomi (littimo)</th>
<th>Scale funzionali (Intervallo)</th>
<th>Scale dei sintomi (Intervallo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id</td>
<td>Type</td>
<td>Name</td>
<td>Due to</td>
<td>Status</td>
<td>Action</td>
</tr>
<tr>
<td>9812</td>
<td>qol</td>
<td>gen</td>
<td>2012-09-06 23:59:59.0</td>
<td>ongoing</td>
<td></td>
</tr>
<tr>
<td>9756</td>
<td>sw</td>
<td>fec</td>
<td>2012-09-10 00:00:00.0</td>
<td>completed</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Management of questionnaires.

Scheda medica di: Clark Martin

Clark Martin: Tue Oct 09 16:41:52 CEST 2012

Figure 6: Chart with clinical indicators.
Patient portlet
This portlet provides the hospital guide service via AJAX component to Mobas JQM (the patient interface on smartphone or tablet).

Services portlet
This portlet provides various AJAX services called by the component Mobas JQM (client side) and called by the portlet Nurse and Doctor.

4.1.3. External components
In addition to the MOBAS portlets developed for the Liferay framework, there are some other components developed with Java technology and running directly on top of Tomcat. These components are services accessible via AJAX calls (REST). Here we list them. They are described in details in the following sections.

Messaging component
This service sends messages to the patient or to the nurse using contextual patient data. The business logic used to send messages is described in Section 4.2.

MAP component
This service provides a graphical map for guiding the patient to the location of her activities (e.g., from the waiting room to the doctor’s room). This component is described in Section 4.3

Charts component
This service provides the display of medical charts and is described in Section 4.4.

PHIS component
This service offers to patient an adaptive selection of content about her illness. This component is described in Section 4.5.

4.1.4. Mobas JQM
This component is based on JQueryMobile, a unified, HTML5-based user interface system for all popular mobile device platforms. Mobas JQM implements the multi-lingual (English, German, and Italian) user interface, the javascript
logics behind it, and the REST calls to services. The patient’s login interface is shown in Figure 8. The main view of the hospital guide function is shown in Figure 9; this view shows the status of the patient in the hospital workflow and highlights the activities already executed, and those still pending but already scheduled. Figure 10 shows the interface for reading personalized information on the patient's disease. The interface for the fill out of a clinical questionnaire is shown in Figure 11.

![Figure 8: Patient's login interface.](image-url)
Figure 9: Guide in the hospital.

Figure 10: Personalized info on disease.
4.2. Messaging Component

Patients visiting the hospital are involved in rather complex sequences of tasks, including: analysis, examinations, and treatments, executed in various wards and rooms. Patients are requested to move independently to reach the location where the medical cares are provided. In this scenario, patients can benefit from the messaging component of MobiDay 2, which supports them in the execution of their hospital tasks. The messaging component provides the patients with push messages of three different types.

- **Call messages** are sent when the patient is requested to start a new activity, and the nurse advances the patient in the workflow. The messaging component reads the new status of the workflow from the system database, sends the patients a call message (Figure 12), and possibly it sends a reminder message if the patient does not show up after a given timeout. The nurse is possibly called if the patient did not notice the two previous messages. A wall screen located in the waiting room is also used to call patients (Figure 13).

- **Apology messages.** These messages are sent when there are problems that slow down the hospital process. If the nurse sets a delay (and a reason for it) in her interface, this is captured by the messaging component, which promptly notifies the patient and apologizes for the inconvenience (Figure 14). Apology messages are also used to notify updates of the time delays, the reason for such delays, and to announce when the problems, which originate the delays, have been solved. The
selection of the apology messages was conducted in cooperation with the hospital personnel, in order to be as much effective as possible.

- **Entertainment messages.** When the patients are waiting for their next activity, the system may propose them some news to read (Figure 15), coming from RSS feeds. The information sources depend on the patient language and there are three types of news: local information concerning South Tyrol, world news from authoritative sources as “Corriere della Sera”, “Der Spiegel”, or “BBC”, and good news from specialized sources, which are supposed to improve the mood of the patients. Other entertainment messages invite the patients to fill out the clinical questionnaire the doctor has assigned to them (Figure 16), or to read the documents about their disease. This second type of entertainment messages aims at encouraging the patients to provide (via questionnaires) information that can be exploited by the doctor to better select their therapy, and promoting the reading of documents that improve their awareness about their diseases.

![Figure 12: Call message.](image-url)
Figure 13: Wall screen.

Figure 14: Apology message.

**Pablo,** we are very sorry to inform you that your next activity (**Esame del sangue**) is delayed by 15 minutes due to technical complications in the laboratory of analysts. We are doing our best to resolve the problem.
4.3. Map Component

The map component is dedicated to the visualization of digital maps. This service is designed for helping the patients to reach examination rooms or laboratories.
inside the hospital. The map component can be used when the patient does not know how to reach the destination where the next activity is taking place. The system shows the map of the hospital highlighting the destination (Figure 17).

![The map for the patient's destination in the hospital.](image)

The map component was implemented using Java technologies. A servlet was created for generating the map in requested language (the existing system supports English, Italian, and German). The servlet also accepts a destination id as a parameter and accordingly marks the destination on the map image.

### 4.4. Chart Component

The chart component provides the doctor with seven different charts, illustrating useful statistics. In particular:

- A bar chart illustrating the values of Global Health status and Functional scales of a given patient, obtained from the most recently filled Quality of Life questionnaire (Figure 6).
- A bar chart illustrating the values of Symptoms scales of a given patient, obtained from the most recently filled Quality of Life questionnaire.
- A line chart showing the variation in a time interval of the Global Health status and Functional scales of a given patient.
- A line chart showing the variation in a time interval of Symptoms scales of a given patient.
- A bar chart illustrating the number of patients treated with the four mostly common oncological therapeutic protocol in a given time interval.
• A bar chart illustrating the number of patients who suffer, in a given time interval, from any side effect of a given therapeutic protocol.

• A line chart showing the variation in a time interval of the side effect intensity experienced by a patient treated by a given therapeutic protocol.

The chart component is a web application written in Java. The component reads the data from the system DB and calculates the charts input data. The charts are then build interfacing with Google Chart Tools1.

4.5. Adaptive Disease Information System (PHIS)

The aim of the PHIS (Personal Health Information System) component is to enable the patient to access and read documents about her illness. These are documents that the doctors deem important that she should read. They contain detailed information about the patient's disease, diagnosis, evolution, effects on the affected organs, possible treatments, and various issues related to the illnesses.

PHIS aims at making the information acquisition process of the patients more effective by presenting a document split in smaller blocks. These text blocks are presented, and added to the currently visualized document, block by block. In a more traditional way, the entire document would have been presented at once. For this purpose, all available documents in German and Italian language (54 documents in total, 31 in German and 23 in Italian) have been logically divided in blocks of 100 words, on average. It is important to obtain a low average block length since reading and rating smaller blocks of text will most probably result in a better understanding of the presented information. Moreover, mobile devices visualize a limited amount of words on the screen and shorter blocks of text can reduce scrolling actions.

All blocks in a document have been labeled with the information type they represent. Among the 10 labels which have been identified and which represent the various information types, there are, for instance, some related to the "diagnosis of the illness", and some related to the "possible treatments". Moreover, logical dependencies among the blocks of each document have been identified. These dependencies are constraints among the possible visualization orderings of the blocks: a particular block cannot be visualized to the patient if all the blocks from which it depends have not yet been visualized and read by the patient. For instance, detailed descriptions about the diagnosis or the available treatments cannot be visualized if the introductory section was not already shown. Thus the former will have a logical dependency on the latter.

The ultimate goal is to learn, for each document, and depending on certain user's features, the optimal ordering and amount of text blocks to be show to a user. Optimal is to be intended as maximizing the knowledge acquired by the patient about his disease. The acquired knowledge is measured with a questionnaire given to the patient at the end of the reading process.

1 https://developers.google.com/chart/
Reading process
The reading process unfolds in the following way: A patient accesses the PHIS system with a standard browser-based interface (customized for smartphones, tablets or PCs), and chooses a document among a list of documents that have been assigned to her (Figure 18). PHIS immediately proposes a first block to be read. If this is not the first time the patient accesses the selected document, all blocks read up to that point in time are shown. When a new block of text is introduced, a rating control is also displayed, which allows the patient to enter whether the new content was understood clearly on a predefined 3-value scale (negative, neutral, positive) (Figure 10). After having entered this mandatory rating, the patient can click on the “Continue” button, and possibly a new block of text is added. In fact, the system may chose to pause or stop the reading process with a small probability (learned by the system). In all the other cases, the system will iterate again adding to the visualized document a new block of text.

When the whole document has been visualized to the patient, or when the system opts to stop presenting new blocks, a final questionnaire about the document is presented to the patient (Figure 19). The questions included in the questionnaire are dependent on the document content, which in our case is mainly dependent on the language of the document (i.e., German documents are richer). The patient must reply to all the questions in order to continue. After having answered to the presented questions, and clicked on the “Continue” button, PHIS presents the whole document to the patient.

The user can stop the reading process at any time, and only the blocks read up to that point will be shown to the user after she answers the final questionnaire. The remaining blocks of text contained in the original document will not be available any more to the patient. Moreover, we observe that when PHIS shows a new block, this can provide some additional information related to a block...
shown, for instance, at the beginning of the interaction. In this case, the new block is inserted between that block shown at the beginning and the others shown later. In other words, the original ordering of blocks in the document is preserved in the visualized document. PHIS only adapts the presentation ordering, and as we mentioned above, the total number of visualized blocks. We discuss this point better later on.

**Block visualization strategy**

PHIS is able to present and add to the currently partially visualized document the remaining blocks in an order that could be different from that generated by the sequential scan from the beginning to the end of the document. For example, as shown in Figure 20, in step 1, when Block 1 and Block 2 have already been presented to the patient, a new block of text, Block 4, is introduced. In step 2, another block, Block 3, which appears before Block 4 in the document, is introduced and inserted between Block 2 and Block 4, in order to preserve the original ordering of the document. This may easily happen in a scenario where, i.e., Block 2 contains introductory information on the diagnosis and Block 3 contains some detailed information about the diagnosis of the illness, while Block 4 contains introductory information on the possible treatments. PHIS may decide to introduce Block 4 after Block 2, both containing introductory information, and later Block 3, which extends Block 2.

![Figure 20: Example of the reading process.](image)

PHIS supports various policies to present the document blocks to the patients in sequence. The policy, which has been identified as baseline policy, follows the original sequence of a document with a probability of 90%, while for the remaining 10%, the system chooses among all blocks that may be visualized due to the logical dependencies among the blocks. This baseline policy is intended to be used for “exploring” the reactions of the users to the variations of the presentation ordering with respect to the standard way (presenting the blocks in the order in which they appear in the document).
By using reinforcement learning (RL) techniques, PHIS computes a reward for the chosen block visualization actions. Block visualization actions are categorized (tagged) with the labels representing the information types contained in the presented block. The underlying hypothesis is that the optimal block selection strategy must depend on the quantity of information presented on the various topics (information types).

PHIS uses a general state model and action model that can be applied to all documents since rewards are assigned to labels, i.e. information types, rather than to specific blocks of text of a single document. This allows the system to learn and optimize a policy from the user feedback generated on any of the available documents (transfer learning).

The action model comprises all possible actions that PHIS can take at a given reading step. As shown in Table 1, there are 12 actions, 10 of which correspond to the labels assigned to text blocks. The remaining two are system actions that represent the actions to pause (PAUSE) and to stop (EXIT) the reading process. These two actions are available at each step, while for all other actions, PHIS will determine at each step in the reading process which actions are actually available in order to select one among the available blocks of text. The base information types that have been identified are the following: general introduction, diagnosis, evolution, affected organ, treatment, types, and specific advices. Most of the analyzed documents explain the diagnosis and the treatments in a more detailed way; thus, there are two and three different labels respectively in order to allow PHIS to adapt to different levels of detail. Moreover, label DTR_details_spec has been introduced to differentiate between overall details on the possible treatments and specific details to additional content dependencies like the size or stage of a tumor or a very specific information block on only one type of treatment. There can be multiple content dependencies for a block. At this stage, the prototype does not take into consideration the content dependencies, which are planned to be used as a further detail in the learning process and possibly as a filter in order to avoid patients to get blocks of text proposed that do not apply to their illness.

Each document begins with an overall introductory block of text (INT). As this first block is in all documents analyzed so far a reading dependency for all subsequent blocks, at the very first step in the reading process PHIS will have only this action available among all, except for the PAUSE and EXIT actions mentioned before.

Table 1: PHIS Action Model

<table>
<thead>
<tr>
<th>Action (Label)</th>
<th>Detail level</th>
<th>Content dependencies</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INT</td>
<td>-</td>
<td>-</td>
<td>Overall initial introduction block</td>
</tr>
<tr>
<td>DDI_intro</td>
<td>introductory</td>
<td>-</td>
<td>Introduction on the diagnosis</td>
</tr>
<tr>
<td>DDI_details</td>
<td>detailed</td>
<td>-</td>
<td>Details on the</td>
</tr>
</tbody>
</table>
The state model includes 13 variables in order to represent the current status in the reading process (see Table 2). The first three variables hold information about the patient (tendency to depression, level of education, cognitive functioning). All other state variables represent the reading status of the patient with respect to the current document as a logarithmic scale, being so able to represent different amounts of read content in fewer values than by simply counting the number of blocks per each label that were read so far. This is a necessary, and in our opinion fair tradeoff between the level of detail of the reading status and the size of the state space, which counts a few millions of states rather than more than 100 millions of states. For each of the 10 labels, the maximum value that their state variable can assume has been limited according to the maximum length, in terms of number of words, of each label in a document among all documents. For example, label DTR_details_spec has a maximum length in a document over all documents of about 2300 words while label DTR_intro has a maximum length of about 160 words, thus, the representing state variables will have 6 and 2 possible values respectively.

<table>
<thead>
<tr>
<th>Label</th>
<th>Status Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET</td>
<td>-</td>
<td>Description of the evolution of the illness</td>
</tr>
<tr>
<td>DOR</td>
<td>-</td>
<td>Description of the organ affected by the illness</td>
</tr>
<tr>
<td>DTR_intro</td>
<td>introductory</td>
<td>Introduction to the possible treatments</td>
</tr>
<tr>
<td>DTR_details</td>
<td>detailed</td>
<td>Details on the possible treatments (no specific content dependency)</td>
</tr>
<tr>
<td>DTR_details_spec</td>
<td>detailed with further content dependencies - size: small, medium, big - stage: stage 0, stage 1, stage 2, stage 3, stage 4, stage 5, recurring - treatment: surgery, radiotherapy, chemotherapy, hormonal, biological, bone marrow</td>
<td>Details on the possible treatments with possible dependencies on the content, i.e., size, stage or treatment</td>
</tr>
<tr>
<td>DTY</td>
<td>-</td>
<td>Description of the types of tumor that can occur</td>
</tr>
<tr>
<td>TCP</td>
<td>-</td>
<td>Advice on specific problems related to the illness or the therapy</td>
</tr>
<tr>
<td>PAUSE</td>
<td>-</td>
<td>System action to pause the reading process</td>
</tr>
<tr>
<td>EXIT</td>
<td>-</td>
<td>System or user action to stop the reading process</td>
</tr>
</tbody>
</table>

The state model includes 13 variables in order to represent the current status in the reading process (see Table 2). The first three variables hold information about the patient (tendency to depression, level of education, cognitive functioning). All other state variables represent the reading status of the patient with respect to the current document as a logarithmic scale, being so able to represent different amounts of read content in fewer values than by simply counting the number of blocks per each label that were read so far. This is a necessary, and in our opinion fair tradeoff between the level of detail of the reading status and the size of the state space, which counts a few millions of states rather than more than 100 millions of states. For each of the 10 labels, the maximum value that their state variable can assume has been limited according to the maximum length, in terms of number of words, of each label in a document among all documents. For example, label DTR_details_spec has a maximum length in a document over all documents of about 2300 words while label DTR_intro has a maximum length of about 160 words, thus, the representing state variables will have 6 and 2 possible values respectively.
<table>
<thead>
<tr>
<th>#</th>
<th>State variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>tendency to</td>
<td>Boolean value expressing a low / high tendency to depression</td>
</tr>
<tr>
<td></td>
<td>depression</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>level of education</td>
<td>Boolean value expressing a low / high educational level</td>
</tr>
<tr>
<td>3</td>
<td>cognitive functioning</td>
<td>Boolean value expressing a low / high cognitive functioning value</td>
</tr>
<tr>
<td>4</td>
<td>INT</td>
<td>Read status of label INT</td>
</tr>
<tr>
<td>5</td>
<td>DDI_intro</td>
<td>Read status of label DDI_intro</td>
</tr>
<tr>
<td>6</td>
<td>DDI_details</td>
<td>Read status of label DDI_details</td>
</tr>
<tr>
<td>7</td>
<td>DET</td>
<td>Read status of label DET</td>
</tr>
<tr>
<td>8</td>
<td>DOR</td>
<td>Read status of label DOR</td>
</tr>
<tr>
<td>9</td>
<td>DTR_intro</td>
<td>Read status of label DTR_intro</td>
</tr>
<tr>
<td>10</td>
<td>DTR_details</td>
<td>Read status of label DTR_details</td>
</tr>
<tr>
<td>11</td>
<td>DTR_details_spec</td>
<td>Read status of label DTR_details_spec</td>
</tr>
<tr>
<td>12</td>
<td>DTY</td>
<td>Read status of label DTY</td>
</tr>
<tr>
<td>13</td>
<td>TCP</td>
<td>Read status of label TCP</td>
</tr>
</tbody>
</table>

### 5. Presentations

The research conducted in the MOBAS project was presented at several events.

1) In June 2009 we organized a workshop, in collaboration with MEDAN project. There, we met and discussed with FUB researchers and personnel of the Merano Hospital, the problems found and the obtained results. The following presentations were made:

- Bruno Cadonna (PhD student FUB): Temporal Pattern Matching for Medical Data;
- Mourad Khayati (PhD student FUB): Similarity Search in Chemotherapy Histories;
- Jay Anderson (Prof. Charleston University USA): Visualization of Chemotherapy Histories;
- Andrej Taliun (PhD student FUB): Visual Analysis of Patient Histories;
- Andrea Moskwita (student FUB): Data Cleaning: Laboratory Data;
- Stefan Platzgummer: Bestimmung von Referenzwerten mit parametrischen und nicht parametrischen Methoden;
• Patrick Lamber, Andrea Girardello, Francesco Ricci (FUB): MobiDay: A Personalized Content-Aware Mobile Service for day Hospital Workflow Support.

Prof. Mitterer, Prof. Spizzo, Dott. Huber, Dott. Moskwita (Merano Hospital); ASL general director Dott. Fabi, ASL administrative director Dr. Corazzola, participated to the event.

2) A first report on the project results was presented at 12th Conference on Artificial Intelligence in Medicine (AIME’09), Verona 18-22 July.


3) The first system prototype MobiDay 1 was presented by F. Zini at the 2nd MEDAN/MOBAS Workshop on Medical Data Warehousing, Bolzano, 26 November 2010.

4) The results of the evaluation of the first system prototype MobyDay 1 were presented by F. Zini at 12th IEEE International Conference on Mobile Data Management. 6-9 June, 2011, Luleå, Sweden.


6) The results of the MOBAS project were illustrated on November 9, 2011 in a conference organized by the autonomous province of Bozen-Bolzano (“Punto d’incontro ricerca”) by F.Ricci:


7) The general topic of presenting documents to patients as in the PHIS system was presented by Omar Moling at the 1st Italian Workshop on Machine Learning and Data Mining (MLDM), Rome, June 13-14, 2012.
8) The evaluation of the questionnaire function of MobyDay 1 was presented by F. Zini at the 25th International Symposium on Computer-Based Medical Systems (CBMS), Rome, June 20-22, 2012.


9) The final system MobiDay 2 was presented to the general public at the Long Night of Research, Bozen, 28 September 2012.

6. Students’ Thesis and Research Projects

Patrick Lamber (Master Student 2008-2010)

The quality and the effectiveness of information exchange between patients and clinicians is a key aspect of e-health systems. Mobile communication technologies can help addressing this problem by providing ubiquitous and personalized information access. Lamber’s thesis illustrates a novel mobile service, called MobiDay, integrated in the Hospital Information System and aimed at supporting patients and clinicians in a day hospital scenario. MobiDay provides patients with contextual messages giving therapeutic information related to their disease, or instructions on when to execute their tasks in the day hospital. Moreover, MobiDay submits questionnaires on quality of life to patients, so that clinicians can have a more accurate picture of their health status. The thesis assesses the usability of MobiDay messaging feature and performs a comparison between MobiDay and two other services for questionnaire submission: a traditional paper form and a Tablet-PCs. The evaluation is based on the feedback from real patients about the services, collected during an experiment performed in the day hospital of Meran. The results show that MobiDay is well accepted for patients with mobile phone experience and that the application has the potential of being used as an alternative to the more traditional services such as a paper form or a Tablet-PC. Furthermore, the results show that there are still some aspects to be improved in this novel mobile service. Some of the improvements are related to the messaging feature to better support the patients during their stay in the day hospital with more accurate and informative messages. The basis for these improvements was created during the experimental evaluation by collecting the contextual data such as the patient’s location in the hospital, current activity, and the trace of patient’s message readings.

Andrea Girardello (Master Student 2009)

The patient location is of primary importance in order to provide appropriate contextual-dependent messages to the patients. Considering the hospital environment, localization techniques based on GPS, network cell towers or Wi-Fi access points do not provide sufficient precision for determine patient’s location
in the hospital. To deal with this situation, Girardello developed the localization system's component of the first MobyDay system - based on RFID tags. Radio-frequency identification (RFID) allows, through the use of a tag, the identification of objects by means of radio waves. Active RFID tags were used. Each room taking part to the workflow of patients was equipped with an RFID tag. Moreover, each user (patients and doctors) needed also to wear a tag. This simple design enabled to detect “contact” events between patients and rooms tags, thus locating the user among one of the tagged spaces. To receive the full power signals from these beacons, the area of the hospital interested by the experiment has been covered by two RFID USB-readers installed in fixed locations; each reader was connected to a laptop that received the packets broadcasted by the RFID tags and, through a local network, these computers forwarded the received information to a server for further processing. The server processed the tags' packets and exposed the computed position of a user through a REST service.

Valdemaras Repsys (Master Student 2009-2010)

The goal of the research project was to develop a literature survey on the following topics: the applications of context aware techniques in healthcare; sensors for capturing contextual data; user activity modeling and detection using sensor data; assessing the interruptibility of an activity; context supported human computer interaction. The result of the work has been a review report which discusses state of the art research on the definition of context, context awareness, context-aware computing. The report then describes some Illustrative examples. It further provides a categorization of context-aware features. Then it focuses on existing research on applying context and activity aware systems in hospitals and healthcare. Then the description of sensors and context-aware systems that use those sensors to capture the context is provided. Then it focuses on state of the art research on activity inference algorithms. The topic of interruptibility is then discussed, and the paper illustrates different ways to handle interruptibility, and interruptibility inference algorithms. Finally the report discusses current research on implicit human computer interaction and context aware user interfaces.

Linas Baltrunas (PhD Student 2011)

The research project was targeted to the design, implementation and test of machine learning techniques for assessing the contextual state of a Human-Computer interaction and producing relevant recommendations based on the context state. The contextual variables relevant for that interaction have been defined. The variables were defined in order to the recommendation algorithm could be able to: a) assess the availability of contextual data, b) identify discrepancies from current know contextual variables and predictions of their status; c) identify actively the context variables that should be collected - either by starting a dialogue with the user or by accessing other information services. The goal was initially to produce a set of recommendations, or information messages to the user (doctor or patient) that are more relevant, given the current context of the user. But ultimately the research project focused on the adaptive delivery of information about the patient’s disease. This research
project put the base component for the development of the adaptive information component in the MobyDay2 system that was developed by Omar Moling.

**Bernd Ludwing** (Post Doc 2010)

This research project was targeted to the design of context dependent information and content delivery for medical applications. The researcher first analyzed the current state of MobiDay prototype that FUB developed and tested in the hospital in Meran. He performed a detailed analysis of the system prototype and especially of the log data produced by the evaluation conducted in the hospital. Then the researcher elaborated, together with the MOBAS team, based on his own experience in similar projects on intelligent assistance for patient-centered health care, a proposal for a new version of the system. This actually became the definition of MobyDay 2. He focused on context dependent recommendations for activities and information that could improve the patient quality of life. He integrated into the new system proposal the latest results and techniques related to Context-Aware and Activity-Based Ubiquitous Computing that were reviewed in a previous deliverable of the project. He also participated to writing a scientific paper that was accepted for publication on in the MDM (Mobile Data Management) conference. He also gave a strong contribution to the design and development of the component of MobiDay 2 that provides adaptive information about the patient disease. He introduced the methodology for tagging the document portions with the relevant topic.

**Hannes Tribus** (Research Assistant 2010)

The work was targeted to the development of a first version of the questionnaire function of MobiDay 2. An independent software system was designed to simplify the every day's work of a doctor in the oncological department of a hospital, and to speed up the gathering of information from patients prior to a medical visit. During a visit the doctor usually asks the patient several questions about her actual health status, as well as the physical changes observed since the last visit. Despite that the list of questions highly depends on the therapeutic protocol, within such a protocol the questions and the corresponding possible answers are clearly defined and therefore the acquisition of information can be automated. The developed system offered to the clinicians the possibility to define two types of questionnaires, which can be filled out by registered patients. The first type is dedicated to a questionnaire in which patients can enter the side effects they noticed together with the degree of toxicity of those side effects. The second is a generic questionnaire, which can be fully defined by the doctor. This type is intended for Quality of Life questionnaires.

**Laura Napolitano** (Bachelor Student 2010-2012)

The work focused on the acquisition of comprehensive and accurate information from patients in the medical environment, which is fundamental for enhancing the quality of care. Napolitano’s thesis describes the design, the implementation, and the evaluation of a web-based questionnaire service that oncological patients can use to fill out questionnaires on their quality of life, and
questionnaires on the side effects of their treatments. Starting from the Tribus' version of the questionnaire service, the first goal was to enlarge the number of potential users and improve the usability of the system. Specifically, the objective was to make the interfaces of the service adaptable to a variety of devices, such as mobile phones, tablets, and standard PCs. The implemented questionnaire service was able to recognize the kind of device the patient is using and to customize the layout of the web pages for the specific device. A second important contribution of the work was the assessment of the effect of the clinical and psychological status of the patients on the usability of the questionnaire service. To test the proposed solution, a user study was conducted in the oncological day hospital of Meran, involving patients of the unit. The subjects used a laptop to fill out a quality of life questionnaire, and then replied to a survey on the usability of the service. Analyzing the collected data, we found that some psychophysical indicators, derived from the answers on the quality of life, have an impact on the evaluation of usability. This suggests that the patient clinical profile should be carefully taken into consideration when designing and developing web applications for patients.

**Omar Moling** (Master Student 2012)

This research project focused on the analysis and implementation of a learning-capable system to ease information acquisition by patients. The system that has been developed, PHIS, proposes a set of documents in German and Italian, which can be assigned by a doctor to a patient. All documents have been logically divided into blocks of text containing specific types of information. In addition, an average block length of 100 words has been achieved by further splitting blocks and adding reading dependencies among them. The patient can access the content of a given document on a block-by-block basis. PHIS can work with different recommendation policies, i.e. a baseline policy which follows at a rate of 90% the original sequence of a document and performs 10% of exploration steps or a Learning policy which chooses the recommendations according to a Reinforcement Learning algorithm that assigns a reward to each recommendation action and computes this way the best actions to be chosen. PHIS is explained in more details in Section 4.5.

**Guoda Taraskeviciute** (Research Assistant 2011-2012)

This project concerned the design of a map system dedicated to the visualization of digital maps for the patients, who have to reach examination rooms or laboratories inside the hospital. The patient activates the map system in case she does not know how to reach the destination where the next activity is taking place. The system shows the map of the hospital highlighting the destination. The project was approached with an initial overview of existing solutions in order to ensure the project novelty in the field. It was concluded, that the field is indeed very innovative and no functioning mobile map and direction system has been used in the hospitals for patient navigation. The related work study showed that new visitors in the new location prefer a map over instructions, therefore it was considered essential in the project to provide a map as opposed to text instructions only. Based on related work analysis, it was evident that the
classical building maps are not suitable. Therefore, a simplified landmark-enriched map was designed, ensuring a clearer representation. Also, a small study with users was implemented at the university to find out the user performance with different types of maps. The findings showed that the map type did not influence the performance, while users preferred traditionally looking maps slightly more than metro-like maps. Moreover, the performance was equal to that of experienced users, if the map orientation was indicated at the start of the experiment. The map component was also implemented using Java technologies. A servlet was created for generating the map in the requested language (the existing system supports English, Italian, and German). The servlet also accepts a destination as a parameter and marks it on the map image. Such solution ensures fast service, as images are preloaded in the servlet. The solution is also resistant to client related resizing issue, as the destination point image is fixed on the server side. The map image was drawn using the fire escape maps present at the hospital, as they precisely represent the architecture of the floor. Elevators, stairs and toilets were replaced with standard symbols to decrease the complexity of the map. The areas which are irrelevant for the patient were represented as gray areas to discourage the user to focus on less important information. The choice was based on research showing that users presented with less information on the map spend less time interpreting the map and reach the destination faster.

7. External Collaboration

Several collaborations were established during the course of the MOBAS project.

- **Merano Hospital.** The project was conducted in collaboration and strict contact with Merano hospital, and particularly with Dott. Prof. Manfred Mitterer (Director of the Day hospital department), with Dott. Peter Huber (ICT director) and with Dott. Andrea Moskwita (IT department).

- **ISI Foundation.** We have established a collaboration with ISI Foundation in Torino, in particular with Dott. Ciro Cattuto; a world expert in embedded systems. ISI is a private research center, founded 30 years ago by Piemonte region and Torino province. His mission is to promote pre competitive and basic research in IT, Mathematics and Physics. The goal of the cooperation has been the design and development of the location detection techniques (patient location) based on active RFID.

- **EDP Progetti.** We have established a collaboration with this IT company based in Bolzano in order to develop the first MobyDay system. We met several times the technical director of the company ing. Corrado Ganis in order to define the integration of MobyDay with the hospital legacy system. This enabled us to run the first test of the system on a scenario very close to the real operational one.

- **University of Liverpool and Istituto S. Raffaele.** We have established a contact with Prof. Floriana Grasso (University of Liverpool, UK) and Ing. Marco Nalin (e-Services for Life & Health, Research and Development, Scientific Institute Hospital San Raffaele). They have been invited to visit
the MOBAS team in Bolzano. They made presentations of their research to the MOBAS team and the students and we discussed further research objectives and proposals.

- **Innsbruck University.** We have started a collaboration with Innsbruck University, in particular with Prof. Bernard Holzner and Prof. Johannes Giesinger (Division of Psychooncology and Psychoimmunology Department of Psychiatry Medical University of Innsbruck) and with Prof. Barbara Weber (Department of Computer Science Quality Engineering Research Group). The collaboration was motivated by the need to integrate into MobyDay their system: CHES. This system is dedicated to the managemet of the quality of life questionnaires. In the first test experiments we also compared the original CHES system for tablet with our mobile system MobyDay for smartphones.

- **City e-health Research Centre (CeRC).** We have established a collaboration with prof. Patty Kostkova, the Head of City e-health Research Centre (CeRC) in London². They investigate various aspects of semantic web, serious education games, social media for epidemic intelligence and user profiling, engagement & recommender systems for e-health applications. They collaborate with WHO, ECDC, NHS, HPA and other healthcare organizations on provision of real world services used for conducting our research. The collaboration is aimed at preparing new research proposals in the area of e-health.

- **Regensburg University.** We have collaborated with Prof. Bernd Ludwig for the analysis of the texts describing the patient disease. Prof. Ludwig developed the methodology for tagging the texts and identifying the topics of the document. The tagging of the texts has been used to develop the adaptive system for presenting to the patients the description of their disease.

8. Scientific Publications

A number of research papers were presented in international conferences on mobile technology, e-health, and user modeling, adaptation and personalization.


**Abstract:** The quality and the effectiveness of the communication between patients and clinicians is a key aspect of an e-health system. Mobile communication technologies can help addressing this problem providing ubiquitous and personalized information access. In this paper we illustrate the architecture of a mobile service, integrated in the hospital information system,

² [http://www.city.ac.uk/health/research/research-areas/city-ehealth-research-centre](http://www.city.ac.uk/health/research/research-areas/city-ehealth-research-centre)
aimed at supporting the user task in a day hospital scenario. The mobile device provides to the patient information messages related to her disease or her current task. Message delivery time is personalized using recommendation technologies that exploit contextual data such as the patient’s position and current activity, and the history of user’s previous message reading behavior.


Abstract: When visiting a day hospital for periodical examinations, analysis, and treatments, patients execute a set of activities ideally organized in well-defined workflows. However, the hospital is a highly dynamic environment and for this reason the waiting times between the activities in the workflow and even their actual sequence are often scarcely predictable. Therefore, it is important to timely inform the patients about their next activity, where it takes place, and when it starts. In this paper we present MobiDay a novel mobile service, which is integrated in the hospital information system, that supports patients and clinicians in the day hospital scenario. We describe the MobiDay message-posting algorithm; it uses expert-defined context-aware rules elicited from the clinicians to decide the time and content of the guidance messages that are pushed to the patient’s device. MobiDay and its guidance service were tested with real patients during a 4-months-long experiment held in the hospital of Meran in South Tyrol, Italy. We report on the results of the system evaluation and its guidance service, obtained from a survey submitted to patients involved in the experiment. Moreover, we discuss the goodness of the design choices behind the guidance service by analyzing the MobiDay logs collected during the user study. Taking into account some weaknesses found in the design, we finally propose some general guidelines for the development of message-based mobile guidance services for patients.


Abstract: Automated patient guidance in a hospital can be a helpful service for outpatients. In fact, they often need to move independently to reach locations where medical cares are provided. The provision of such a guidance service motivated the development of MobiDay, a mobile advisory system for patients. A live user experiment of the first version of MobiDay revealed some shortcomings that stimulated the design of a new improved version that is illustrated in this paper. The new system focus on the exploitation of a workflow management system and on the usage of multiple and distributed user interfaces.


Abstract: In this paper we investigate the impact of patient’s profile on the
usability of filling clinical questionnaires on smart devices. Our study was conducted in an oncological day hospital, where the EORTC QLQ-C30 quality of life questionnaire is administered to outpatients using computerized devices (smartphone, tablet, and laptop) and a paper form. We show that all the devices are evaluated as usable by the patients, under the dimension of easiness of use, and provided information. Moreover, we show that the patient’s cognitive functioning (CF) impacts negatively on the evaluated usability of laptop-based surveys, suggesting that CF must be taken into account in the GUI design. Finally, we illustrate that the patient age and her technological skills also have a negative impact on the evaluated usability.

9. Project Result and Impact

The MOBAS project was aimed at designing and developing a mobile, personalized information service in the hospital. The ultimate goal was to improve the quality of the communication between the medical staff and the patients in a day hospital scenario. With the strict cooperation of the personnel of the hospital of Meran we have designed and implemented a system that, even in a prototypical form has demonstrated to be usable by patients and clinicians.

The on-site experimentation with real patients of the first version of the systems, MobiDay 1, has demonstrated that the system was well accepted by the patients, who evaluated positively its features, and by clinicians, who were able, in some cases, to take better clinical decisions on the basis on the information gathered by MobiDay 2 from patients. The results of the first experimentation gave us also very useful feedback that were exploited to design and develop the extended system ModyDay 2, embedding enhanced functionality that was implemented using the most recent web technologies. In particular, MobiDay 2 can be accessed from any smartphone, without the need of installing any specific application on the phone. We are confident that MobiDay 2 has enhanced the state of the art of the research in pervasive e-health and can be a valuable starting point for the development of a fully engineered mobile information system that supports patients and clinician in a hospital scenario. We had a very positive reaction to the system when it was presented at the Long Night of Research held in Bozen at the end of September 2012: many people (including health care operators, patients and patients relatives) visited our stand and appreciating the features of the systems, stressing their novelty, usefulness, and easiness of use.

We believe that MobyDay 2 can be the starting point both for further researches and industrial exploitation. Regarding the first point we are preparing the proposal for a European project on e-Health where the adaptive presentation technologies developed in the MOBAS project will be further extended and applied to other scenarios, e.g., web based portal for physicians. Regarding the second point, we plan to present MobDay 2 to our industrial partners to raise their interest and plan a joint exploitation strategy to bring MobyDay 2 finally to the market.