HEARTFAID

D33 – 8th Quarterly Managerial Report

(MB and STAB meeting minutes)
Submission date: 15/03/07
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HEARTFAID

A KNOWLEDGE BASED PLATFORM OF SERVICES FOR SUPPORTING MEDICAL-CLINICAL MANAGEMENT OF THE HEART FAILURE WITHIN THE ELDERLY POPULATION

Project summary	
Project acronym:	HEARTFAID
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Project Co-ordinator Name:	Domenico Conforti
Project Co-ordinator Organisation:	UNICAL University of Calabria (Italy)
Thematic Priority:	Information Society Technology-ICT for Health
Instrument:	Specific Targeted Research Project

Consortium

- UNICAL- Università della Calabria (Italy)
- UNICZ- Università degli studi Magna Graecia di Catanzaro (Italy)
- UNIMIB- Università degli studi di Milano Bicocca (Italy)
- JUMC- Jagiellonian University Medical College (Poland)
- VMWS- Virtual Medical World Solutions Ltd (United Kingdom)
- FORTHNET S. A.- Hellenic Telecommunications and Telematic Applications Company S. A. (Greece)
- SYNAP- Synapsis s.r.l. (Italy)
- CNR- Consiglio Nazionale delle Ricerche (Italy)
- FORTH-Foundation for Research and Technology Hellas (Greece)
- RBI- Rudjer Boskovic Institute (Croatia)
- AUXOL- Istituto Auxologico Italiano (Italy)

D33 – 8th Quarterly Managerial Report
MB and STAB meeting minutes

Document summary	
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Short Description
This document describes the activities of the Consortium during the eight quarterly of HEARTFAID project and its future activities.

Change Record		
Version Number	Changes	Release date
1.0	First draft of the Document	14-01-2008

1.1	Contributions from WP leaders and partners	03-03-2008
1.2	Further Contributions and final version	14-03-2008

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Executive Summary

The eight Quarterly Managerial Report describes the activities and the objectives reached by Heartfaid Consortium during the period November 1, 2007- January 31, 2008.
In short the following WPs have been involved in the work:

- WP0: Management
- WP2: Biomedical Data Identification and Collection
- WP3: Middleware, Interoperability and Integration
- WP4: Knowledge, Representation, Discovery and Management
- WP5: Data processing and Decision support devices
- WP6: End-User application and Services
- WP8: Dissemination and Exploitation

In particular, the following activities have been satisfactorily carried out:

- WP0: monitoring of the overall technical and management activities, coordination and support for the organization of the steering meeting in Cracow (hosted by JUMC) and the next steering meeting in Milan (hosted by UNIMIB and AUXOL), coordination and support for the second review meeting and developing of all the related activities. Development and finalization of the deliverables D26, D27 and D33.
- WP2: further development and testing of the data acquisition and transmission infrastructure and further development of the clinical data collection.
- WP3: final development of the prototype of the middleware infrastructure (Deliverable D28).
- WP4: further development of the knowledge discovery activity (Deliverable D29) and refinement of the medical Knowledge Base.
- WP5: development and implementation of data processing functionalities (Deliverable D30) and decision support services.
- WP6: development of end-user applications and services (Deliverable D31).
- WP8: further dissemination activities according to the early plan. In particular organization of the clustering event among FP6 e-Health projects held in Madeira (Portugal) within the Healthinf 2008 event. Development of the Deliverable D32.

The subsequent interim period will be particularly devoted towards the organization of the second review meeting.

WORK PACKAGE: 0
TITLE: MANAGEMENT
START DATE: MONTH 1
WORK PACKAGE LEADER:UNICAL
PARTNERS INVOLVED:UNICZ, UNIMIB, VMWS , FORTHNET, SYNAPSIS , CNR, RBI

STATUS OF DELIVERABLES DUE IN THIS PERIOD

		DATE DUE	COMMENTS
DELIVERABLE	N°		
1st Periodic Report on the Distribution of the Community contribution among contractors	D27	31/01/08	The deliverable has been completed by UNICAL according to the relevant financial records from all the partners.
1st Periodic Report (activity and management)	D26	31/01/08	The deliverable has been completed following the structure suggested by the relevant guidelines, with the remarkable contribution of the WP leaders and the whole consortium.
8th Quarterly Managerial Report	D33	31/01/08	The deliverable has been completed following the template already established with WP leaders contribution

STATUS OF MILESTONES DUE IN THIS PERIOD

Milestone	TITLE	COMMENTS
M.S.0.2	2nd Periodic Report	The milestone, including reporting aspects and review issues, has been achieved and evaluated with the active interaction of all partners. Deliverable D26 of this periodic report defines and reports all details and aspects.

FORECAST STATUS OF DELIVERABLES DUE IN THE NEXT 3 MONTHS

		DATE DUE	COMMENTS
DELIVERABLE	N°		
9th Quarterly Managerial Report	D34	30/04/08	The deliverable will be developed and completed by UNICAL, reviewed with the contribution of all WP leaders and partners with regards to Consortium activities from February 1st to April 30th 2008.

MEETINGS OF THE PERIOD AND FORECASTED WP0- MB & STAB MEETINGS

ACTIVITY	Attendants	DATE/PLACE
MB & STAB Meeting	Coordinator: JUMC Attendants: Representatives from MB and STAB	Krakow 9-11 November 2007
MB & STAB meeting	Coordinators: UNIMIB/AUXOL Attendants: Representatives from MB & STAB	Milan 18-19 February 2008
2nd Revuew Meeting	Steering meeting for the organization of the review meeting	Milan, 9 -10 April 2008
2nd Review Meeting	Coordinators UNIMIB/AUXOL/UNICAL Attendants:Representatives of MB, PO and Reviewers	Milan 11 April 2008

Description of the activities

During this quarter (1st November 2007-31st January 2008) the management of the Consortium has focused on the following tasks:

T 0.1 Overall management of the Consortium

The overall management activities of the Consortium have mainly been characterized by the handling of the relevant deliverables of the interim period and the coordination of the organization and management of the MB&STAB meetings of the interim period.

T 0.3: Management of contractual, legal, financial and administrative procedure of the consortium

- Preparation for the reporting period in terms of practical aspects, collection of contribution, financial information for the 2nd periodic management report, filtering information between the Consortium and the Commission
- Project meetings and internal WP0 meetings: a face to face interaction has been essential for the management during this quarterly in order to clarify key issues and collect suggestions and feedbacks from all partners, a joint coordination with hosting partners for MB & STAB meetings has also been established
- Continuous interaction and communication with the Consortium.
- Overall management of Deliverables of all WPs, collection of all related material with the contribution of all WPs and of the entire Consortium

T 0.2: Co-ordination of the Consortium technical activities

The coordination of the scientific and technical activities has been further consolidated, by a more efficient tuning of the procedures for the effective collaboration among the several partners involved within each WP.
In particular, each WP Leader is responsible to:

- plan and organise the overall internal work;
- coordinate the contribution from the relevant partners;
- define the roadmap for the development of the deliverables;
- collect feedbacks from the WP group as far as Quarterly Reports are concerned.

Finally, each partner will be responsible for all other direct issues with the coordination unit within the deadlines.

T 0.4: Internal Communication infrastructure

The internal communication infrastructure has been mainly realized by the extensive use of e-mails, audio conference services and the services and functionalities provided by the Internal side of the Project Web Site.

Forecasted activities

During next three months management activities will mainly focus on the coordination of the issues related to the organisation of the second periodic report and to the management aspects of future Consortium Meetings. Frequent

communication with the Consortium and the Commission, if necessary, is foreseen at this stage of the Project through direct meetings and update information.

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Ongoing workpackages progress: WP2

WORK PACKAGE: 2
TITLE: BIOMEDICAL DATA IDENTIFICATION AND COLLECTION
START DATE: MONTH 3
WORK PACKAGE LEADER: VMWS
PARTNERS INVOLVED: UNICAL, UNICZ, UNIMIB, JUMC , FORTHNET, SYNAP, AUXOL

STATUS OF TASKS DUE IN THIS PERIOD

TASK	TITLE	COMMENTS
T 2.3	Data Collection	The task is progressing as expected. No deviations from the work plan are noticed.

FORECAST STATUS OF TASKS DUE IN THE NEXT 3 MONTHS

TASK	N°		COMMENTS
Data Collection	T 2.3		In the next 3 months, the activities related to collection of the data will be continued.

Description of the activities

The activities in this period are related to the collection of the relevant biomedical data in all the identified environments. According to the DoW the task was split in two sub-tasks, T2.3.1 and T2.3.2. The activities of the partners in these tasks are reported in the following paragraphs.

T2.3.1 Homecare data collection

As it was agreed between clinical partners during the HEARTFAID MB & STAB Meeting in Krakow on November 8-9th 2007, JUMC (although not officially involved int the Task) performaed a daily collection of a very few clinical parameters in a small group of patients which might be of particular importance for CHF decompensation prediction in home setting. Every day patients were collecting in standarized manner, according to questionnaires, the data including blood pressure values, heart rate, weight, respiratory frequency, changes in CHF symptoms and treatment. JUMC will continue the biomedical data collection throughout next phases of the project and both sets of patients will help also in future HF platform testing and validation.
Also, regarding the collection of homecare data, UNICZ continued to collect, every two weeks, in a smaller group of patients the following parameters: systolic blood pressure, heart rate, respiratory rate, % of body water, body temperature, in order to achieve an early diagnosis of heart failure decompensation, so as indicated in deliverable 5.

T2.3.2 Healthcare Data Collection

In collaboration with other clinical and technical partners JUMC have continued our work collecting the biomedical data according to the electronic Case Report Form (eCRF). The following results of tests are being collected: cardiopulmonary exercise test, echocardiography, chest X-Ray, laboratory tests, 24 h ECG monitoring, quality of life assessment and for some cases tests important for

further research development (continuous noninvasive blood-pressure monitoring). The eCRF application has been deployed at a JUMC's server and is accessible for registered clinical partners on the Internet. Up to now about 50 cases have been enrolled from JUMC site and the appropriate forms for baseline and follow-up visits for these patients are being fulfilled.

Also, in this period UNICZ has continued to enlist patients in the HF project and a lot of clinical data have been collected. Some patients are historical patients, already followed in our heart failure ambulatory; other patients have a recent diagnosis of heart failure. The data of this population have been introduced in a database that contains all available list of biomedical signs and symptoms, list of parameters of selected tests so as: Electrocardiogram, Holter electrocardiography, Chest X-ray, Echocardiography, Clinical chemistry, and so on, that are useful for heart failure domain. All these data have been filled also in electronic CRF, both basal assessments and additional clinical visits. The clinical assessment in these patients is scheduled every one-two months, and also earlier if clinical conditions are worsening. Finally, UNICZ are providing the storage of digital ECG files in SCP format and the storage of echocardiography images in DICOM format. Thus, the data collection has been amplified and it will be useful for the HEARTFAID project further activity.

Ongoing workpackages progress: WP3

WORK PACKAGE: 3
TITLE: MIDDLEWARE,INTEROPERABILITY AND INTEGRATION
START DATE: MONTH 2
WORK PACKAGE LEADER: SYNAPSIS
PARTNERS INVOLVED: VMWS, FORTHNET, CNR, FORTH

STATUS OF TASKS DUE IN THIS PERIOD

TASK	TITLE	COMMENTS
T 3.3.2	Prototype Refinement	The subtask T3.3.2 was started in the previous reporting period with a slight delay with respect to Gantt of the project, due to some delays of the previous task T3.3.1. Nevertheless, the activities of this subtask have been concluded during the reporting period. According to the refinement issues discussed at the General Assembly Meeting held in Krakow on November 2007, the Integration Middleware prototype has been refined. Adequate standards for data encoding and standard protocols for information exchange, have been selected and adopted to guarantee the correct integration of the different modules into the HEARTFAID platform of services.
T 3.4	Interoperability Middleware	The activities of Task T3.4, started at month M8, have been carried out during the reporting period. Although from the Gantt of the Project it was expected this task to be completed within the reporting period, the activities will be carried out also during the beginning of the next reporting period, with a slight delay on the timetable. According to the outcomes of Subtask T3.3.2, the Interoperability Middleware architecture is being refined. Some troubles have been encountered while integrating the different services available from the external/pre-existing modules into the platform. However, these problems will be overcome within the next review of the project.

STATUS OF DELIVERABLES DUE IN THIS PERIOD

		DATE	COMMENTS
DELIVERABLE	N°		
Integration and Interoperability middleware prototype	D28	31/01/08	Expected to be delivered within 45 days from the deadline.

STATUS OF MILESTONES DUE IN THIS PERIOD

		COMMENTS
Milestone	Title	
M.S.3.3	Middleware prototype	Expected to be achieved with a slight delay of a couple of months due to the problems encountered in defining all the protocols and standards for integrating the different modules into the platform.

Description of the activities
During the reporting period, the activities of subtask T3.3.2, started at month M19, have been completed, while the activities of task T3.4, stated at month M8, have been continued and will be completed in the next reporting period. The progress of the work carried out is described in the following paragraphs.

During the reporting period, the activities of subtask T3.3.1, started at month M6, have been completed, the activities of task T3.4, stated at month M8, have been continued, whereas the activities of subtask T3.3.2 have been started. The progress of the work carried out is described in the following paragraphs.

T3.3: Integration Middleware
This Task, has the goal to design and develop a Data Management System that is responsible to guarantee the following features:

- all the data flowing within the entire platform is compliant with the standards identified in Task 3.2
- management of the heterogeneous repository allowing the organization of raw data, laboratory data, structured information (EPR, data entry services, and so on), multimedia/other data (reports, images, ultrasound signals, and so on).

These objectives will be achieved through the following two subtasks:

T3.3.1: Early mock up prototype implementation
The early prototype developed during the previous RP has been finalised and it will be presented at the General Assemply meeting to be held in Krakow on November 2007.

The issues related with the interoperability with the other modules to be integrated in the HF platform, will be faced within task T3.3.2 – Prototype refinement.

T3.3.2: Prototype refinement
Due to the delay of the previous subtask T3.3.1, the activities of subtask T3.3.2 have been completed with a slight delay with respect to the Gantt of the project.
During the General Assembly Meeting held in Krakow on November 2007, the technical aspects of the integration have been finalised and it has been possible to refine the Integration Middleware prototype. Afterwards, the integration of the other modules of the system, such as the CDSS, the Alarm System, the Ambient Intelligence platform, and the eCRF, with the core system of the platform, has been completed.
The prototype will be shown during the next period at the second project review to be held in Milan on April 2008.

T3.4: Interoperability Middleware
As reported in the DoW, the Interoperability Middleware will be responsible of guaranteeing a seamless integration among the end-user services of the HEARTFAID Platform. The activities of this task, started at month M8, have been continued during the reporting period and will be completed in the next reporting period.

After having analysed in deep details the computer science literature that represents the state of the art in arguments like *Message Oriented Middleware,*

Service Oriented Application, Enterprise Portals and Enterprise Service Bus which represent the key concerns in *Enterprise Application Integration*, we have implemented the technologies that have been considered suitable for the purpose of the HF project.

The technologies to be adopted have been proposed to the project Consortium and agreed among all the partners. This way, it has been possible to integrate the following module:

1. The **AmI-platform:** an Ambient Intelligence framework that handles the storage and monitoring of observational data acquired by sensors. It has been developed by SYNAP in conjunction with FORTHNET and VMWS who delivered the sensing infrastructure, and with FOTH that investigated in deep details the formats of data provided by the medical devices and the transmission protocols, as well as the algorithms needed to pre-process the row data.
2. The **eCRF:** a web based Electronic Patient Record (EPR) that offers native user interfaces for input and edit patient related demographic and clinical information. It has been developed by JUMC. This module will contain part of the clinical data needed by the CDSS (both the Knowledge Bases and the Model Bases) to provide decision support to the doctors.
3. The **groupSMS:** an application for sending short messages to mobile phones with handling of addresses lists and accounting. It is developed by FORTHNET. This module will be used to generate a two levels alarm, according to the response of the CDSS on the acquired data. The first level alarm will send an e-mail to the responsible doctor, while the second level alarm will send and SMS to a set of pre-defined recipients (either doctors of parents of the patient) by using this module.
4. The **CDSS:** a Clinical Decision Support System developed by CNR in conjunction with RBI who designed the clinical ontology of the system. The prototype includes two different Knowledge Base services related to, respectively, the home-care monitoring scenario and the clinical data acquired after the patient enrolment, and a Model Base operating on the measurements acquired with the clinical devices selected for this purpose.
5. The **HFP:** an image analysis and archiving toolkit used at CNR for implementing algorithms for the analysis of clinical images. This module is based on the DICOM standard for data encoding and exchange.

In addition to the external modules, specialized modules have been developed to guarantee the correct functioning og the Middleware: a *Master Patient* Index to guarantee the unique identification of the patients, a *Documental Repository* to store the reports produced within the platform, a *Meta-data Registry* to locate the available resources, an *Orchestration service* to control the workflows within the platform and the *Heartfaid Enterprise Portal* to integrate the different functionalities and exhibit them to the final user in a friendly fashion.

The following functionalities have been implemented:

- User authentication and profiling
- Global patient enrolment and consistent identification
- Acquisition of demographic and clinical data

- Patient search according to different search criteria
- AmI sub-enrollment
- DSS sub-enrollment
- Managing of available devices for Home monitoring
- DSS activation with alerting functionalities
- Handling of imaging data (to be completed in the next reporting period)

Deviation from the plan

Task T3.4 will be completed in the next reporting period with slight delay with respect to the Gantt of the project. This delay was caused by the delay in completing the Task T3.3.1 and by some problems that had to be faced concerning the adoption of suitable standards and protocols for the integration of the external modules into the prototypes and for the exchange of data among the components of the HEARTFAID platform of services.

Ongoing workpackages progress: WP4

WORK PACKAGE: 4
TITLE: KNOWLEDGE, REPRESENTATION, DISCOVERY AND MANAGEMENT
START DATE: Month 8
WORK PACKAGE LEADER: RBI
PARTNERS INVOLVED: UNICAL, SYNAP, CNR, FORTH

STATUS OF TASKS DUE IN THIS PERIOD

TASK	TITLE	COMMENTS
T 4.3	Implementation of Knowledge Discovery in database processes	A lot of knowledge discovery experiments have been done on the available retrospective ANMCO dataset for a broad range of differently defined medical goals. We have used all available methodologies including survival analysis, SVM, Markov-Blanket techniques, Bayesian Network, decision tree learning, and subgroup discovery. The results are a substantial part of D29. Significant effort has been done in order to visualize the results and present them in the form understandable and interpretable by medical experts.

STATUS OF DELIVERABLES DUE IN THIS PERIOD

		DATE	COMMENTS
DELIVERABLE	N°		
Models and Methods for Knowledge Discovery	D 29	31/01/08	Prepared on time. The deliverable has about 120 pages.

FORECAST STATUS OF TASKS DUE IN THE NEXT 3 MONTHS

TASK	N°	COMMENTS
Implementation of knowledge discovery in database processes	T 4.3	Up to now we have used different tools independently. Now we should start to compare their performances for medical applications. At the first place a comparative analysis of the attribute ranking and selection properties has to be done. Additionally an effort in the appropriate visualization of the results is necessary.

STATUS OF MILESTONES DUE IN THIS PERIOD

		COMMENTS
Milestone	Title	
M.S. 4.2	KDD implementation	The work has been done on time. The results are: analysis and upgrading of kernels for the Support Vector Machine algorithm, implementation and testing of Random Forest algorithm, formalization of contrast set mining approach, and testing of Subgroup Discovery algorithm. Extensive experimental work on different HF domains has been done on the retrospective datasets and the data already collected by the platform. Random Forest and Subgroup Discovery algorithms have been prepared for inclusion into the web based KD service.

Description of the activities

The activities have been concentrated on the preparation of the deliverable D29 reporting on the models and methods for knowledge discovery. At first place it is description of the work related to upgrading of kernels for the Support Vector Machine algorithm and implementation and analysis of the Random Forest algorithm. Significant effort has been invested also in the preparation of a general presentation of the KD process for medical applications. It summarizes experience of UNICAL and RBI on very different medical domains. Special attention has been devoted to the problems of evaluation and interpretation of models obtained by machine learning algorithms.

Extensive experiments with all available methodologies on the retrospective ANMCO data set have been performed in parallel. The first step has been definition of medical goals like severity models and prognostic models that can be achieved from the available datasets. For each of these goals we have used different algorithms in order to extract most relevant relations that are interesting and potentially useful in respect to HF. Additionally, some experiments have been performed also with the patient data already collected in the platform database. The work has been done by UNICAL, FORTH, and RBI. Some of the results have been evaluated by UNICZ.

Up to now partners have used different tools independently. In the next period we plan to collect the results obtained on same datasets with intention to compare performances of different approaches. At the first place a comparative analysis of the attribute ranking and selection properties has to be done. This is essential for the implementation of KD tools into the web service in which identification of most relevant patient properties for some target classification will be one of the most relevant tasks. Additionally, an effort in the appropriate visualization of the results both for the web service implementation as well for off-line presentation to medical experts is necessary.

Ongoing workpackages progress: WP5

WORK PACKAGE: 5
TITLE: DATA PROCESSING AND DECISION SUPPORT DEVICES
START DATE: MONTH 5
WORK PACKAGE LEADER: CNR
PARTNERS INVOLVED: UNICAL, UNICZ, SYNAPSIS, FORTH, RBI

STATUS OF TASKS DUE IN THIS PERIOD

TASK	TITLE	COMMENTS
T 5.2	Design and development of models and methods for signals and images processing	▪ Analysis of the integration problems in the development of the comprehensive showcase ideated in conjunction with UNICZ ▪ Evaluation of open source DICOM web-viewers ▪ Development of a simple and easy-to-use web-viewer for clinical access to patients and studies ▪ Testing of software libraries for the realization of signal and image processing application modules (Matlab, ITK, VTK, FLTK, ImageJ) ▪ Testing and adaptation of the QRS algorithm to the files acquired by the Archimed 4210 cardiograph used in Catanzaro. ▪ Finalization of the QRS classification for the dominant beats on the MIT-BIH Arrhythmia Database. ▪ Testing of the algorithms for left ventricle segmentation in US apical image sequences for the extraction of quantitative parameters. ▪ Preparation of the Deliverable D30.
T 5.4	Implementation of the Decision Support System	An implementation and testing activity has been carried out for developing the CDSS functionalities for the comprehensive showcase that should be finalized at the end of the third year. The following issues were addressed: - Ontologies: ▪ integration and improvement of the ontologies developed within WP4; ▪ implementation activity in Protégé and Swoop; - Rule-based Knowledge Base: ▪ elicitation and refinement of the inference rules; ▪ evaluation of representation capability of SWRL language for defining rules; ▪ preliminary tests with Jena for the inference engine; - Model Base: ▪ development of computational reasoning methods for prognosis assessment, by analyzing the ANMCO dataset; - Platform: ▪ development of a web-based platform for simulating the functioning of the CDSS including a test user interface. Moreover, a coordination activity has been undertaken for integrating the CDSS components for the development of the showcase of the second year. Work has consisted in: ▪ definition, test and development of a computational reasoning method for the early detection of patient's decompensation, based on the integration of several models, namely a Support Vector Machine and a Decision Tree;

		▪ development of a web-based user interface for integrating the telemonitoring and the hospital visit workflows; ▪ integration of the DICOM server.

STATUS OF DELIVERABLES DUE IN THIS PERIOD

		DATE	COMMENTS
DELIVERABLE	N°		
Models and Methods for Signals and images processing	D 30	31/01/08	First draft of the report

FORECAST STATUS OF TASKS DUE IN THE NEXT 3 MONTHS

TASK	N°		COMMENTS
Design and Development of models and methods for signals and images processing	T.5.2		Finalization of the deliverable D30
Implementation of the Decision Support System	T 5.4		In the next months, all the components under development will be integrated and tested for implementing a preliminary version of the final showcase.

MEETINGS OF THE PERIOD

PARTNERS	COMMENT	DATE/PLACE
CNR-SYNAP		Pisa, 28 November

Description of the activities

Task 5.2 - Design and development of models and methods for signals and images processing

The comprehensive showcase ideated in conjunction with UNICZ was analyzed in order to obtain integration of the modules for signal and image processing. These modules, activated during the examination reviewing workflow, should be smoothly integrated so as to achieve easy access to the platform services, without altering substantially the routine workflow or increasing the operators' workload. In particular, the problem of accessing echocardiographic images (and more generally DICOM images) within a web-browser was addressed. Existing open source DICOM web-viewers were evaluated, including ConQuest WADO service, DCM4CHEE WADO service, Xero and Oviyam. None of them was fully satisfying for deployment inside HEARTFAID platform. For this reason, a simple though efficient web-viewer was developed by using the JAVA implementation of DICOM standard provided by DCM4CHE. This application can be called from other applications inside HEARTFAID platform and will allow for the selection of the patient context (i.e. direct visualization and retrieval of the studies of a particular patient).

The algorithms for ECG waveform modeling, ECG pre-filtering and QRS detection already investigated and partially developed were tested and adapted to the ECG files provided by the hospital of Catanzaro (data set of 74 ECGs). The results were excellent with no real FP or FN.

At the same time an algorithm based on a two-step decision tree was designed and implemented for the identification of the dominant beats in the recording. The algorithm tested on the MIT-BIH Arrhythmia database produced very satisfactory

results with a Sensitivity of 98.84%, a Specificity of 95.12%, a Positive Predictive Value of 99.45% and a Negative Predictive Value of 90.22%.
Future activities will consist on the test and adaptation of the QRST classification algorithm on the data set provided by Catanzaro, the evaluation of the averaged dominant beat and its saving in the SCP-ECG format.
Further, the deliverable D30 is being prepared and it is expected to be submitted on time. This deliverable is intended to cover the aspects of signal and image processing related to the management of chronic heart failure. It will describe the software prototypes developed during this task and, in particular, 1) segmentation of echocardiographic images, 2) extraction of linear, area and volume measurements from echocardiography, 3) QRS detection and 4) construction of the average heart beat. Integration issues of these prototypes in the platform will also be addressed.

Task 5.4 - Implementation of the Decision Support System

The activity mainly dealt with the implementation of the comprehensive showcase that should be finalized at the end of the third year.
CNR and UNICAL implemented some functionalities by profiting of UNICZ support for data collection and knowledge elicitation.
As to the ontological knowledge base, the need for an extension of the taxonomical ontology developed within WP4 appeared important for formalizing all the pieces of knowledge relevant for the showcase and for better exploiting the capabilities of the tools selected for development. A careful activity was then performed for defining a suite of core ontologies related to patients, diagnostic procedures, therapeutic suggestions, and so forth. Data types were considered fundamental for a coherent representation of the domain concepts and properties. Also, terminology and definitions were checked and matched with existing, well-known medical ontologies (e.g., Medical Subject Heading, Unified Medical Language System, ...). The work is still in progress since, so far, focus was given to only some of the rules elicited from the clinical partners. Elicitation was firstly done in natural language, resulting in a set of *if-then* conditions, then formalized by using the concepts contained in the ontologies. Some “logical gaps” among rule *pre-conditions* were highlighted and are being bridged by formalizing additional rules, which will specify missing pieces of knowledge. An investigation on the formal languages and their representation capabilities resulted in the selection of the Jena rules formalism as the best suitable for our purposes.
Preliminary work on the showcase implementation was performed by including other platform components, such as a web-based user interface, developed for testing the CDSS performance. XHTML/JSP, servlet and web services based technologies were used.
Some of the implemented functionalities were also discussed with SYNAP in a meeting hold in Pisa in October for coordinating the cooperative activities. In particular, the interaction between the CDSS and the Middleware was debated and the actions for its implementation were listed up.
A partial demo of the designed functionalities was set up and shown at the Steering Meeting hold in Cracow in November. The current version includes different user contexts and integrates main functionalities of all the CDSS components.
Computational models for difficult decisional problems were studied and tested. A model based on a multiple classifiers approach was devised for the early detection of patient’s decompensation by integrating the results of a Support

Vector Machine (SVM) and a Decision Tree. For the second review demo, the integration within the CDSS was developed and a web service exposed to the outside platform components.

For prognosis assessment, a more thorough analysis of the ANMCO dataset started for accomplishing two tasks:

a. predicting re-hospitalization;
b. predicting the first of any type of adverse event.

The classification task was defined for 3 time thresholds 12, 18, and 24 months: for each threshold *t*, prediction regarded whether a patient would be re-hospitalized (a. above) or have any adverse effect (b. above) before or after time *t*.

The re-analyses included the application of advanced feature selection methods based on Markov-Blanket techniques and Bayesian Network theories, such as HITON. HITON is able to theoretically guarantee (in the sample limit and under certain broad distributional assumptions) that it will select a minimal subset of variables with the maximum predictive power. It has been shown to significantly outperform in biomedical tasks univariate methods and improve the performance of classifiers such as Simple Bayes and Decision Trees. For the analysis, both polynomial and radial-basis SVM classifiers were employed.

The experimental protocol, used to produce the best classification model possible while at the same time provide an unbiased estimation of its performance, included double nested cross-validation. The protocol allowed the simultaneous optimization of the parameters of feature selection and SVM learning and the unbiased estimation of performance.

Also, previous analysis was extended with the production of the Receiving Operating Characteristic Curves (ROC) and calculation of the Area under the ROC curve (AUC) as a metric of performance. The AUC is a measure of performance independent of the prior class distribution and cost of misclassification. The scripts, code and tools for all the above analyses were installed and/or implemented and partial results are already available.

In addition to the above, new methods were investigated for learning prediction models in the presence of survival censored data. This research would hopefully lead to improved methods for learning from the ANMCO dataset and similar learning tasks and to scientific publications.

For integrating the data processing within the CDSS, an easy but efficient web-view interface of the DICOM Image Archive was development. Besides, suitable tools were prepared for facilitating the doctors in properly performing the required measurements on the ECG examinations. In order of doing that, an ECG viewer with zoom and caliper tools was adapted to the “dialectal” SCP-ECG implementation of the ECG files acquired by the Archimed 4210 cardiograph. This viewer has been already installed in the clinical site of Catanzaro.

The goal for the next 3 months is the completion of the integration: ECG acquisition, signal processing for the evaluation and saving of the averaged dominant beat and data transmission to the data repository. The graphical ECG viewer with zoom and caliper will allow the doctors to perform accurate measurements and to properly fill the CRFs.

Other activities for the next 3 months are based on the integration of the MagIC Vest in the HEARTFAID platform. From a signal processing/DSS point of view, the activities will be based on the creation of the HR (heart rate) time series and the RR (respiratory rate) time series with the evaluation of the average RR that will be automatically inserted in the home-measured parameters.

Ongoing workpackages progress: WP6

WORK PACKAGE: 6
TITLE: END-USER APPLICATION AND SERVICES
START DATE: MONTH 10
WORK PACKAGE LEADER: FORTHNET
PARTNERS INVOLVED: UNICAL,UNIMIB, JUMC, CNR,FORTH,RBI

STATUS OF TASKS DUE IN THIS PERIOD

TASK	TITLE	COMMENTS
T 6.2	Development of End-User applications and services	During months M21 to M24 additional tests were performed in order to ensure the interoperability of the various applications. The Alert & Notification system has been completed and official tests were successfully performed in previous project meetings by having the platform send SMS messages to partners' mobile phones
T 6.3	Knowledge discovery system for web-based data extraction and analysis	Development and finalization of the Random Forest algorithm adapted and parameterized accordingly for the KD system. Integration of the Random forest with the web service has been also implemented, using the task scheduler which is responsible to execute and manage tasks.
T 6.4	Integration of services	The integration of applications and utilities started as soon as the first versions of the various HEARTFAID services became available. In order to ensure the primary level of interoperability, a number of different tests were performed, mainly, by exchanging data between the available services and the middleware platform via the Front-End.

STATUS OF DELIVERABLES DUE IN THIS PERIOD

		DATE	COMMENTS
DELIVERABLE	N°		
Knowledge Discovery systems	D 31	31/01/08	This part of the project consists of three principal sections. The first section comprises of the proper identification of the essential features of the Web-Based Knowledge Discovery System (KDS). The second section encompasses the method by which KDS gets embedded into the central middleware while the third concerns the interaction of the KDS with the HEARTFAID platform via the Front End

STATUS OF MILESTONES DUE IN THIS PERIOD

		COMMENTS
Milestone	Title	
M.S.6.1	Early Mock-up prototype of the HEARTFAID web-based platform of services	A first prototype of the HEARTFAID web-based platform is under development, integrating the most recent versions of the already developed HEARTFAID services. In particular, the platform assimilates the electronic Case Report Form (eCRF), the KDS realized with the use of the Random Forest algorithm as well as the unified registration process for the end users

FORECAST STATUS OF TASKS DUE IN THE NEXT 3 MONTHS

TASK	N°	COMMENTS
Development of End-User applications and services	T 6.2	Some design issues still have to be resolved, in order for the provided services to be commensurate with the general Front-End design. The application by which SMS messages will be created and sent, on the fly, to patients by authorized personnel is currently being developed and will shortly be integrated into the Front End
Integration of services	T 6.4	Many integration and interoperability issues between the various HEARTFAID services and the Front-End are still pending. More tests will be performed throughout the integration period.

Description of activities

T6.2 Development of End-User applications and services

The **instant Alert & Notification system** implements an appropriately adapted variant of the Short Messaging System (SMS). The latter, developed and implemented exclusively for mobile devices (mobile phones, PDAs), is being utilized in order to provide the HEARTFAID platform with the enhanced one and two-way communication services for the mobile user, available over a GSM network. An instant communication prototype has been substantiated, examined and validated.

Two Alert & Notification cases have been developed. The first one makes use of an intelligent patient data analysis system whereby when a health risk has been determined, the automatic triggering mechanism is being activated and an appropriately formulated SMS alert is being commissioned. The second case involves a manual composition of an electronic message warning by the medical professional who has access to the on-line SMS generation platform through the Front-End and has valid indications that such an action is necessary and appropriate.

Further, the Front-End's **authorization method** has been reviewed. It should, in principle, be feasible to distinguish between medical staff and simple users and there must be in place a mechanism for realizing an effective and systematic authentication and authorization process. A profiling method, implemented at the electronic Case Report Form, has been actualized.

The **Graphical User Interface** (GUI) of the Front-End has been developed but slight improvements are possible and indeed could lead to a better look and feel of the portal. Finally, the **search functionality** within the HEARTFAID platform will be updated and improved so as to accommodate search queries based on a patient's user ID, name, surname, maiden name (for female patients) or date of birth. Further suggestions will be considered and indeed we anticipate active collaboration on the subject.

T6.3 Knowledge discovery system for web-based data extraction and analysis

The basic requirement on the KD Web service is to ensure that the KD process can be efficiently performed also by people that are experts in the HF domain and not necessarily experts in the KD process itself.

The central part of the KD process is application of some machine learning approaches. Although computationally this is the most complex part, it is relative easy for web implementation. The service should enable user selection of some algorithm dependent parameters and ensure that the process successfully terminates also in the cases of ill-defined data.

The Random Forest (RF) is a relative new data mining tool and its quality comes from the fact that it very efficiently implements a voting scheme of a large number of independent classifiers realized as decision trees. Its immunity to noise and overfitting is outstanding.

The "on-line" knowledge discovery service is implemented as a series of interconnected web pages or web forms. The central part are those pages intended for the starting of new projects, starting new tasks, manipulations with the datasets, and reviewing the results. Auxiliary pages enable registration of new users, their login, and selection of the starting dataset. Additionally, there are a few administrative pages for adding new tools and templates.

T6.4 Integration of services

The **Random Forest** approach has been incorporated into the Web service by making use of the task scheduler which is responsible to execute and manage tasks. The main principle behind the integration of the RF engine into the web interface is the level of intuitiveness of the tool as well as the ease of use and the graspable display of the output. The **Knowledge Discovery** (KD) service is implemented as a series of interconnected web pages or web forms. The task scheduler executes data mining tasks on specified data in a given order and priority. The scheduler has the ability to execute multiple jobs at the same time (multitasking) depending on the number of processors and available memory.

Further, the **KD** system has been integrated into the Front-End by means of iFrames, as the **electronic Case Report Form** (eCRF). That has the advantage of making the Front-End independent of any changes that might occur in the KD. Hence, the latter is invoked 'as is' both preventing any perturbations on the Front-End by possible inflationary development scenarios on the KD system and further allowing full flexibility on the KD progression since the latter won't be hindered by any Front-End's limitations.

iFrames have been introduced into the platform since they solve the problem of a double user registration when the electronic Case Report Form (eCRF) is invoked. That offers not only an enhanced and friendlier to the user interface but also minimizes further security aspects associated with the transmission of sensitive data to a distant location. The users will get authenticated once, at the Front-End,

and their session information will get propagated to the appropriate server. That is an efficient, time saving and indeed secure technique that is being popularly employed and substantiated.

Quite a few **preliminary tests** have been performed on the platform in order to verify the interoperability between the original prototypes of eCRF and KDS systems Those testing procedures need to be systemized and expanded in order to check as many access scenarios as possible. The XML requests which are being exchanged during the interconnection of the services have to be tested in terms of their propagation speed and efficiency. The security of the connection needs to be reviewed and further testing on that subject is currently being designed.

Ongoing workpackages progress: WP8

WORK PACKAGE: 8
TITLE: DISSEMINATION AND EXPLOITATION
START DATE: MONTH 1
WORK PACKAGE LEADER: UNICAL
PARTNERS INVOLVED: ALL

STATUS OF TASKS DUE IN THIS PERIOD

TASK	TITLE	COMMENTS
T 8.1	Dissemination activities	The dissemination activities have been mainly characterized by participation at international conference and clustering activity.
T 8.2	Exploitation activities	The exploitation activities have been developed mainly on the basis of the assessment of the new organization and management model proposed in the deliverable D8.

STATUS OF DELIVERABLES DUE IN THIS PERIOD

		DATE	COMMENTS
DELIVERABLE	N°		
Second Report on Dissemination activities	D32	31/01/08	Completed in line with the Annex I

FORECAST STATUS OF TASKS DUE IN THE NEXT 3 MONTHS

TASK	N°		COMMENTS
Dissemination activities	T 8.1		The activities will carry out with more stressing to collaboration and involvement of the medical professional associations
Exploitation Activities	T 8.2		The activities will continue with the analysis and evaluation of the potential market for the final results of the project.

Description of the activities

UNICAL:
The dissemination activity of UNICAL has focused in this period mainly on the organisation of the joint dissemination/clustering activity at HEALTHINF 2008 event together with the FP6 Project ACGT and MyHeart and the participation of the FP6 Project "@neurIST" (January 30, 2008).

JUMC:
JUMC is contributing to the dissemination of HEARTFAID through presenting its design and preliminary results at scientific meetings.
The information on HEARTFAID is placed on the web pages of the I Cardiac Department at JUMC (http://www.kardiologia1.cm-uj.krakow.pl/) and official JUMC www.cm-uj.krakow.pl websites as dissemination knowledge channel. JUMC is carrying out also internal dissemination activities, by increasing the awareness of Heartfaid project within medical personnel in our institution, within the staff of collaborating Department of Bioinformatics and Telemedicine JUMC, and HF patients/their relatives visiting hospital and ambulatory unit.

Dissemination activities of the period

Date	Channel	Event	Place/ Country	Partner responsible	Nature and size of audience
28 January 2008	Invited talk at Ludwig Boltzmann Institute for Traumatology	"Computational intelligence in healthcare and medicine: examples from HEARTFAID project"	Vienna, Austria	RBI	30 medical doctors
30 January 2008.	Conference presentation at HealthInf 2008	"Medical knowledge representation within heartfaid platform"	Funchal, Madeira, Portugal	RBI	20 conference participants and similar EU project representatives
13-15 December 2008	Paper Presentation	AITIM 2007 National Congress of the Italian Association of Medical Informatics	Bari Italy	UNICAL	About 100 experts among medical informatics and medical doctors
15-18 December 2007	Paper Presentation	National Congress of the Italian Society of Cardiology	Rome, Italy	UNICZ	About 100 medical doctors and cardiologists
18-20 December 2007	Paper Presentation	4th Workshop on Semantic Web Applications and Perspectives (SWAP 2007)	Bari, Italy	CNR – UNICZ-UNICAL	140
22-23 January 2008	Paper Presentation	First Workshop on Image Mining. Theory and Appplications. In conjunction with VISAPP2008	Funchal, Madeira, Portugal	CNR	30
30 January 2008	Paper Presentation + Organization	Int. Conference on Health Informatics HEALTHINF2008 – Special Session on Knowledge Discovery and Decision Support Systems in Health Information Systems	Funchal, Madeira, Portugal	CNR - FORTH-UNICZ-UNICAL	About 30 experts in e-Health issues
13 January 2008		Meeting of Department's staff	PL	JUMC	Medical staff, about 20 persons
09 January 2008		Meeting of Cracow Division of Polish Hypertension Society	PL	JUMC	Physicians, about 100 persons

Future activities and dissemination

Date	Place	Event	Partner responsible	Description
April 2008.	Clinical Hospital Zagreb, Croatia	Invited presentation	RBI	Demonstration of Heartfaid platform