PAMAP

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User Requirements Report

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EXECUTIVE SUMMARY

PAMAP project aims at developing a system that enables the accurate monitoring of the physical activities of aging people. This deliverable provides the reader with information related to the end user requirements related to the PAMAP System.

In Chapter 1.1 a storyboard is proposed, which illustrates a possible use of the PAMAP System. Afterwards, in Chapter 1.2, the overall functionality of the PAMAP system is described, while in Chapter 1.3 functional details related to specific components of the PAMAP system architecture are described. In Chapter 1.4 some additional features for further expansion are quoted.

In Chapter 1.5, the system actors are specified by the project technical partners according to the end-users specifications. Then, in Chapter 1.6 the consolidated user requirements are presented as well as their mapping to components of the PAMAP System Architecture. Finally, in Chapter 1.7, the high level system use cases are identified.

This document will serve as a basis for the User Requirements Task and the corresponding deliverables that are also part of Work Package 2: PAMAP System Requirements and Design.

1.1 Storyboard Creation

Thomas is an early retired man in his 60s with a chronic heart disease. He lives at home but is in need of frequent medical care. Marie is Thomas's contact nurse at the hospital. Marie is usually responsible for 10-15 patients in Thomas's situation. In order to avoid frequent hospital visits for the patients, especially for those who live far from the hospital like Thomas, the hospital is using an e-care system.

This morning, Marie arrives at the hospital. She opens her PC and accesses a web based EHR application. Each patient has his/her own dedicated EHR containing his/her medical history; a label shows the time-stamp of last measurements.

At this time Thomas is at home reading his newspaper while eating his breakfast. He hears a knocking sound from the e-Collaboration station in the living room. Marie's photo is shown on his TV screen. A videoconference is set up between Thomas and Marie. They have a short chat and Marie brings up the measurements visualization window by touching an icon. Together, they review the Thomas' last health record and the data collected from the physical activity monitoring sensor.

Because of his cardiac disease it has been recommended to Thomas to have a good diet habits and to practice regularly exercise. At the beginning of the program Thomas has noted his height and weight in the EHR. Each week, Thomas must specify his weight and his waist circumference. Yesterday, he also entered the results of the last blood test that was prescribed to him.

Before each physical activity session, he must also specify his resting heart rate, his resting blood pressure, the time he took his drugs and other information.

His 6 weeks exercise program was planned by the hospital staff. This program that Mary has to supervise contains:

Aerobics exercise with 3 x 40 minutes sessions a week, 2 sessions of walking and one of cycling. In each case, he must maintain a heart rate between 110-130 beats per minute during walking and 120-140 beats per minute during cycling. In any case, he must exceed the heart rate of 145 beats per minute. Each session must begin with 10 minutes of warm up with a progressive increase of heart rate (less than 110 bpm), 20 minutes of "work" with the target heart rate previously specified and with the possibility to have an accepted talk if needed (talk test), and a cool-down period (10 minutes) with a progressive decrease of the exercise intensity. At the end of each session Thomas must specify the intensity level perceived with visual scales (from 0-10) one for fatigue, one for pain one for breathless.

Resistance exercise with 2 x 30 minutes sessions a week. During each session Thomas must perform stretching and low-level of calisthenic movements, arms and legs for warm-up (10 minutes); then 20 minutes of resistance exercise with a 40 % of maximal voluntary force '1 repetition maximum) for arms and 50 % of maximal voluntary force for legs. A total of 10 exercises must be performed during the working part of the session. Each exercise consists of 8 repetitions. 2 minutes of rest should be respected between each exercise. During exercise, movement of extension and flexion must be permanent without any static phase. Thomas must

breathe normally without any breath-holding (i.e. a Valsalva manoeuvre) phase. At the end of each session, the time duration of the session, the mean heart rate with the peak of heart rate must be known. In addition, Thomas must specify the intensity level perceived with visual scales (from 0-10) one for fatigue, one for pain one for breathless.

Every two weeks Thomas must perform physical tests, 6 minutes walk test and arms (biceps curl) and legs (leg curl) maximal voluntary force. The intensity's level of the physical program will be adapted with the results of these tests by Marie in accordance with the physician.

After this rehabilitation program, Thomas will be recommended to maintain physical activity with at least:

- a minimum of 30min of physical activity by day (can be done in bouts of 10 to 15 min) of activities such as walking, climbing stairs, washing the car, cleaning windows, gardening, or cycling
- 45 to 60 min 2 or 3 times a week of aerobic activity
- 45 to 60 min 2 or 3 times a week of muscle strength

1.2 End-Users viewpoint of PAMAP System Overall Functionality

The system should cover two different aspects of rehabilitation monitoring, an "assessment" aspect and a "tutorial" aspect. The first aspect implies establishing assessments of the patients' rehabilitation. The second implies helping the patient in the realisation of specific movements required by the rehabilitation program by providing him online tutorials and feedback.

The specific data presented below that should be provided by the system are based on the application depicted in the scenario namely, the rehabilitation of patients suffering of hypertension. However, these data should also apply to cardiac or stroke patients having to follow rehabilitation, populations representing a high percentage of cases in ageing people.

1.2.1 Basic Features of the system

These features represent basic information needed when controlling hypertensive, cardiac, or stroke patients' rehabilitation.

Data of the EHR

- **Data to be entered by the patient**: The data to be entered in the EHR each day by the patient are the following:
    - resting heart rate
    - resting blood pressure
    - sleep
    - drug schedule
    - consumption of cigarettes
    - consumption of alcohol
    - self-report on sensation during physical activity: by default, the Borg's scale and Visual Analog Scales (Figure 1) for (1) exertion, (2) breath, (3,) global pain; also comparison of pain level between the two sides when performing resistance

training

- abnormal sensation (palpitations, thoracic pain, marked breathless, dizziness, abnormal fatigue)

- The data to be entered in the EHR weekly/periodically by the patient are the following:
  - waist length
  - weight (for a computation of the BMI)
  - results of blood tests (cholesterol etc...)
- Data to be measured by the system and sent to the EHR
  - Quantitative parameters
    - the kilometres walked during a day
    - the duration
    - the hearth rate mean/max
    - the ventilation rate mean/max (if applicable)
    - the energy expenditure
    - the velocity mean
    - The resting hearth rate, the resting blood pressure, and the weight could also be measured automatically.

Reports should then be automatically generated each weak/day, by level of exercise intensity (low: 50-60% HearthRatemax -moderate: 60-75% HRmax -high: equal to or greater than 75% HRmax) or walking speed (low -moderate -high)

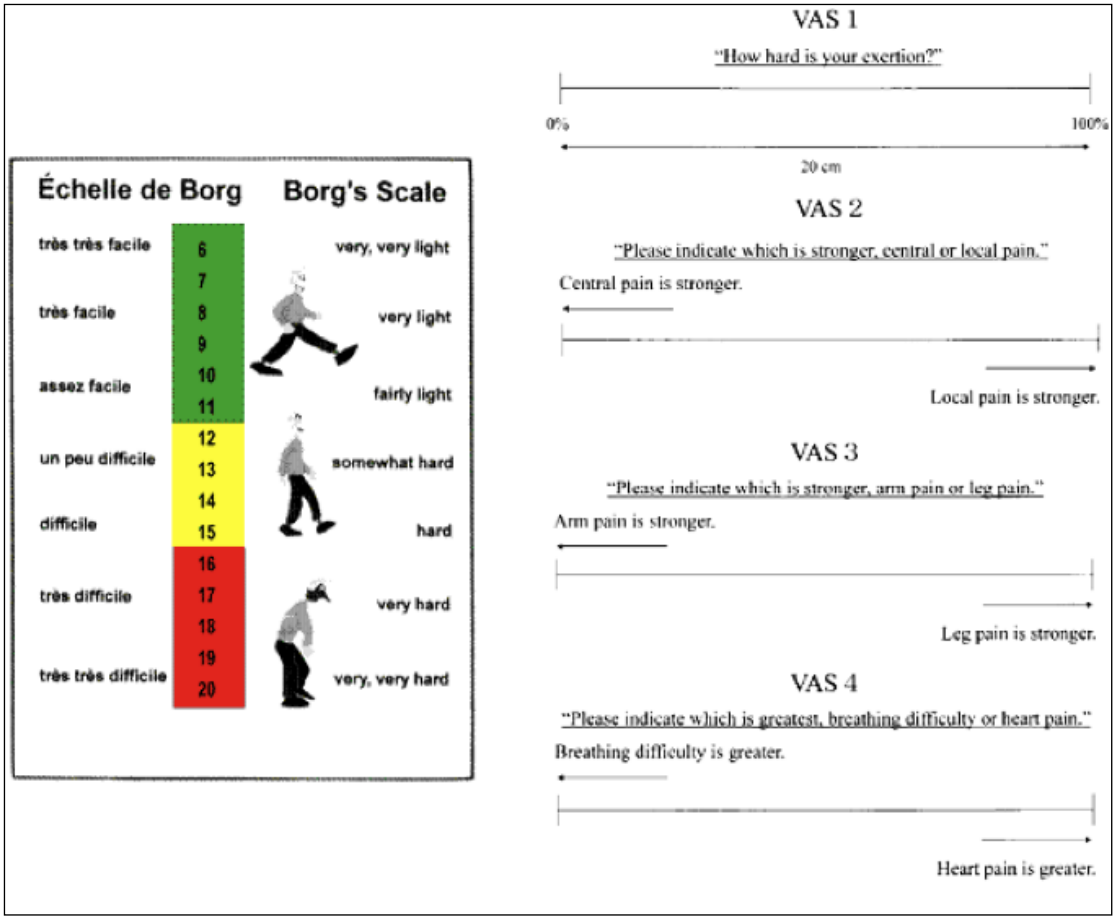


Figure 1: On the left, the Borg's scale of perceived exertion reprinted from the Scandinavian Journal of Rehabilitation Medicine (Borg 1970). On the right, the Visual Analog Scale, reprinted from the Japan Society of Physiological Anthropology (Ueda et al. 2006).

Data of the I-TV interface

These data represent the information given to the patient to help him following his rehabilitation plan. They might be the same one as for the EHR, namely:

- Quantitative parameters
    - the kilometres walked during a day
    - the duration
    - the hearth rate mean/max
    - the ventilation rate mean/max (if applicable)
    - the energy expenditure
    - the velocity mean

Reports should then also be automatically generated each weak/day, by level of exercise intensity (low: 50-60% MHR -moderate: 60-75% MHR -high: equal to or greater than 75% MHR) or walking speed (low -moderate -high). These reports should underline the improvements eventual discrepancies between the reached data and the goal data.

•Data of the measurement system: These data represent information that might help the patients during the realisation of the physical activity. They are:

- the hearth rate
- the ventilation rate (if applicable)
- the energy expenditure
- the velocity
- the exercise duration

Challenges

If these basic features seem easy to obtain since many other devices propose to measure such data, an important challenge persists regarding the energy expenditure estimation. The estimation of energy expenditure should be improved by the development of a new methodology that should not overburden the users and make the system too bulky.

1.2.2 Advanced Features of the system

These features represent data that are needed to provide a really accurate control of the cardiac or stroke patients' rehabilitation and that are more complex to obtain.

Data to be measured by the system and sent to the EHR

- Qualitative parameters for the monitoring of gait
    - duration of the gait cycle
    - step length
    - symmetry
    - walking condition
- Qualitative parameters for the monitoring of other movements

- type of activity
- number of repetitions
- movement duration
- difference in trajectory relatively to a "movement of reference" (this movement might be performed and recorded at the beginning of the rehabilitation program in presence of a medical staff member)

Data of the I-TV interface

- Qualitative parameters for the monitoring of gait
  - duration of the gait cycle
  - step length
  - symmetry
  - walking condition
- Qualitative parameters for the monitoring of other movements (stretching and resistance training)
  - type of activity
  - number of repetitions
  - movement duration
  - difference in trajectory relatively to a "movement of reference" (this movement might be performed and recorded at the beginning of the rehabilitation program in presence of a medical staff member)

The tutorial mode aforementioned should be used here. This tutorial mode corresponds in helping the patient when performing his rehabilitation program, in particular when performing unusual exercises (such as for the resistance training part of the rehabilitation program)

A particular attention should be brought to upper-extremity movements. Indeed, upper-extremity movements are particularly complex and not as easy to monitor as lower-extremity movements due to the complexity of the upper-extremity joints (trunk, shoulders). Moreover, the loss of suppleness, arthrosis but also the lack of training to perform such movements can lead ageing people to perform movements in a incorrect manner. In such a case, stretching or resistance training could occasion more damages than benefits.

When using the tutorial mode, a program should have been first established by the clinical staff. The patient can have access to the tutorials explaining the different exercises he has to perform at this stage of the rehabilitation program.

1. The patient selects the exercise he is going to perform. The tutorial shows him how he should do it by providing:

- general recommendations about security/clothes/hydratation etc
- a representation (video) of the movement to perform
- recommendations about posture
- the weights to take
- the movement velocity

- the number of repetitions

2. The patient performs this movement and the I-TV interface displays feedback about:

- the movement velocity
- the number of repetitions
- the diversion between the movement performed and the movement of reference performed with the clinical staff.

Challenges:

For these advanced features, three main challenges exist. The first one consists in providing a full-body model for the measurement of the orientation of the lower and upper-extremities. The second one is related to the activity classification and the last one to the development of an algorithm for the estimation of the diversion between the movement performed and the movement of reference.

1.3 End-Users viewpoint of PAMAP System Components

Following is the description of how the end users perceive the components related to the different PAMAP system interfaces namely, the educational material, the Electronic Health Record, the I-TVinterface, the Measurements visualization component, and the video-conference application.

Educational Material

- What?
    - Multimedia files (ppt, quicktime, mp4 etc). See http://www.nlm.nih.gov/medlineplus/tutorials/cardiacrehabilitation/htm/_no_50_no_0.htm as an example. A non linear multimedia file is interesting because the patient can read it as fast as he wishes and one can create interaction with the patient. These multimedia files are tutorials helping the patients to:
        - understand the benefits of physical activity
        - receive general recommendations on physical activity, endurance training, and strength training
        - understand the rehabilitation program
        - know how to measure the different data (resting heart rate/blood pressure, waist length, weight, etc...) and how to use the different scales
        - manage the EHR
        - manage the PAMAP
        - manage the I-TV interface
- Who should be responsible for uploading new content and assigning it to patients?
    - A member of the staff in charge of the technical part should take care of it.
- Will this assignment be done on a per patient or patient profile basis?
    - This should be done on a per profile basis, such as hypertensive/cardiac/stroke patients,with the possibility to include other data.
- Should the assignment of educational material to patients or patient profiles be static or

dynamic

- It would be dynamic. Indeed, the educational material might change according to the patient's response to the rehabilitation program.

- Will the educational material upload to the corresponding database be done once, in the beginning of the project, or rarely, or frequently?
  - It should be done once at the beginning of the rehabilitation. However, problems inducing a new upload might occur.

Web based Electronic Health Record

- From a clinical point of view, who are the actors/users of the EHR?
  - The clinicians, physiotherapists, and general practitioners, actually all the actors of the rehabilitation, are the actors and users of the EHR.
- EHR Information blocks that are necessary:
  - a functional capacity test performed in a clinical environment: the shuttle walking test, the six minute walking test or a test on a bicycle ergometer.
  - two functional capacity tests performed by the patient at home: number of stair steps before exhaustion, time to cover a calibrated route.

  The functional assessment info should be included in the visit tab since they are part of the clinical evaluation of the patient whereas the rehabilitation plan should be included in the treatment pan. The results of the tests could be entered by the clinical staff but also by the patient for the functional capacity tests performed by the patient at home.
- What tests should be added to cover PAMAP specific needs?
  - Tests assessing the psychology of the patient, his quality of life, his nutritional status but also his functional capacity, should be included. A list of the tests to be offered by default is proposed. However, it should be possible for the clinical staff to load other tests since each rehabilitation centre might be used to employ certain tests. The tests to include:
    - a psychological test: the Dartmouth COOP
    - a quality of life test: the Quality of Life after Myocardial Infarction (QLMI) questionnaire.
    - a nutritional status questionnaire: the Mini Nutritional Assessment (MNA)
- How should the test results be presented?
  - Tables to provide qualitative data and simple plots to provide a better visualisation of the evolution should be presented. See Table 1 for an example.

COOP chart	Post-op 1	Post-op 2
Physical fitness	5	3
Feelings	4	3
Daily activities	5	3
Social activities	4	3
Change in health	5	3
Overall health	5	3

Social support	4	4
Quality of life	4	3
Pain	4	3

Table 1: Example of result presentation for the COOP chart

- Should we include Quality of Life Questionnaires? Which?
    - Quality of Life after Myocardial Infarction (QLMI) questionnaire or the Cardiovascular Limitations and Symptoms Profile (CLASP) could be included.
- Should the alarming mechanism be incorporated in the web based EHR? Describe the main features of this mechanism.
    - Two types of alarms might be incorporated in the EHR according to their level on a "macro" or "micro" scale. The "macro-alarms" should help the global follow-up of the patient rehabilitation and then provide alarms to the clinical staff when the level of activity/diet/consumption of cigarettes/alcohol etc... is too low/high on a week basis. The "micro-alarms" should favour a more advanced follow-up of the patient, by controlling specific data such as his maximal hearth frequency/ventilation (if measured)/speed/time of inactivity/movement degradation during effort or when supposed to perform specific movements.
- Is there a need for patient relationship management services such as appointment scheduling, remote monitoring session scheduling, etc or such functionality will be provided by other software?
    - It would be better to manage the relationship clinical staff/ patient through the same software to avoid the multiplication of the software.
- Measurements visualization component: What to see? How will the user manipulate the presented information (viewer tools)? Should this component be embedded to the web based EHR?
    - As mentioned earlier, basic tables and plots should be sufficient. ***Figure 2***illustrates an example of the weight data presentation. The visualisation of the data should be set by the clinical staff. The EHR might just provide links towards the information.

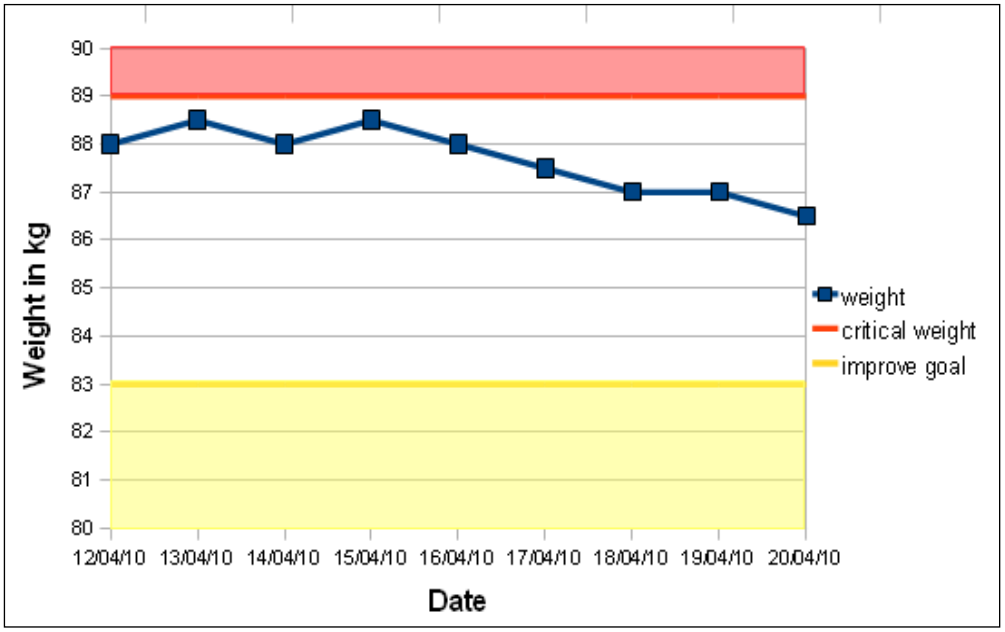


Figure 2: Example of the presentation of the weight data

I-TV interface

- Which subset of the EHR information should be presented to the patient through the i-TV interface (Personal Health Record-PHR)?
    - Almost all of them. Maybe the diagnoses might be hidden in certain cases.
- Should the patient be able to edit/update information fields of her PHR? Which?
    - As mentioned previously, the resting heart rate, resting blood pressure, sleep, drug schedule, consumption of cigarettes, consumption of alcohol, the self-report on sensation during physical activity, the waist length, the weight, the cholesterol data should be set by the patient. The level of physical activity should be automatically provided by the measurement system.
- Should we support fill in of questionnaires, using the TV set and the remote control? Will these be the same as the questionnaires present in the web based EHR?
    - The questionnaires used for the assessment of the patient in the EHR might be filled through the TV.
- Should the system support alerting services (patient specific suggestions / reminders etc). Describe the anticipated features of such a service?
    - Yes, the system should support alerting services. The same as those previously mentioned namely alarms active when the level of activity/diet/consumption of cigarettes/alcohol etc... is too low/high on a week basis. For the patient, these alarms might also be provided on a day basis. In addition alarms that might help him to control his activity such as the hearth rate alarm should be added.

Videoconference application

- We need a use case scenario that indicated when and how such an application will be used, e.g. a video session is established while the clinician reviews the web based EHR and the patient is at home, in front of his TV set equipment.
    - "…At this time Thomas is at home reading his newspaper while eating his

breakfast. He hears a knocking sound from the e-Collaboration station in the living room. Marie's photo is shown on his TV screen. A videoconference is set up between Thomas and Marie. They have a short chat and Marie brings up the measurements visualization window by touching an icon. Together, they review Thomas' last health record and the data collected from the physical activity monitoring sensor. Marie indeed noticed on the EHR that Thomas did not follow his program last week since he only performed one training session. They also discussed Thomas's diet since he didn't lose any waist length since the beginning of the program. "

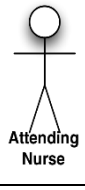
1.4 Further requirements

Additional partners also in charge of the patient's rehabilitation program but not necessary known by the rehabilitation centre such as the general practitioner or the physiotherapist should also be allowed to consult or even to use the EHR.

Another feature of the EHR that should be beneficial to the clinical staff would be the possibility to use the EHR as a database. By interrogating the database, the staff could access the data for information retrieval and report generation. The clinical staff could selectively retrieve and display information on old patient cases, on patients types, or on rehabilitation programs and produce then reports, summaries etc.

1.5 PAMAP System Actors

Table 2 summarizes the Human Actors of the PAMAP System, as occurring in the Storyboard and the end users viewpoint description. It is worth to be noted that in this analysis we do not focus on Machine Actors (e.g. software components, devices, etc).

Ref.Nr.	Symbol	Description
A1		The *Monitored Individual* is a person that undergoes a rehabilitation process.
A2		The *Attending Nurse* is a person who occasionally interacts with the Monitored Individual, using IT tools such as a web based EHR or a videoconference application to assess the quality of the rehabilitation process
A3		The *Care Planner* is an individual (either medical or paramedical hospital staff) who works at the rehabilitation centre and is responsible for planning the exercise program of the Monitored Individual.

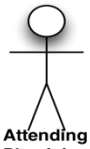
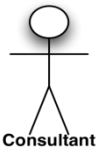
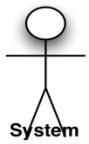
A4		The *Attending Physician* actor is a person who practices medicine. She works for the Rehabilitation Centre or the PAMAP Service provider and uses the PAMAP system for the monitoring and treatment of a patient. The attending physician has the final responsibility for patient care, even when many of the minute-to-minute decisions are being made by subordinates
A5		The *Consultant Physician* actor is a healthcare professional (e.g. general practitioner, physiotherapist) who has supportive role in the treatment of the Monitored Individual. She does not necessarily works for the Rehabilitation Centre or the PAMAP Service provider, but uses components of the PAMAP system for overviewing the medical information of a patient
A6		The *System Administrator* actor is an individual that is responsible for installing, monitoring and maintaining the PAMAP System, and managing PAMAP users and devices

Table 2: PAMAP System Physical Actors

1.6 PAMAP User Requirements Consolidation

The requirements expressed by PAMAP end users have been collected, numbered and mapped to components of the PAMAP System Architectural Model, analysed in D2.1 Architecture Design, and presented in Figure 3.

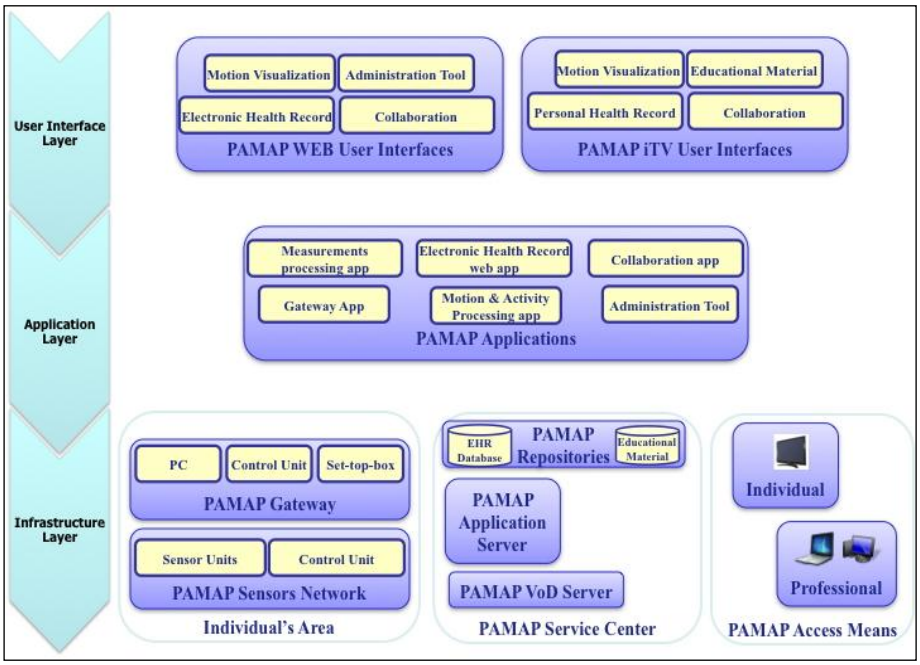


Figure 3: PAMAP System Architecture

ReqID	Requirement	Mapping to PAMAP System Component
FUNCTIONAL REQUIREMENTS		
RQ-01	The System shall enable the identification of different users and their roles	**Application Layer**: intLIFE Admin **Presentation Layer**: intLIFE Admin UI
RQ-02	The System shall support the management of System Actors relationships (mainly Medical Doctors/ Monitored Individuals/ Nurses relationships)	**Application Layer**: intLIFE Admin **Presentation Layer**: intLIFE Admin UI
RQ-03	The System shall allow the administrative management of different types of resources (medical devices used for the monitoring of vital signs and physical activity, health professionals, monitored individuals, educational material)	**Application Layer**: intLIFE Admin **Presentation Layer**: intLIFE Admin UI
RQ-04	The System shall enable the registered healthcare professionals to register new patients	**Application Layer**: intLIFE EHR **Presentation Layer**: intLIFE EHR UI
RQ-05	The System shall enable the registered user to view / edit monitored person's demographics	**Application Layer**: intLIFE EHR **Presentation Layer**: intLIFE EHR UI
RQ-06	The System shall give the healthcare professionals the ability to assign questionnaires to their patients	**Application Layer**: intLIFE EHR **Presentation Layer**: intLIFE EHR UI

ReqID	Requirement	Mapping to PAMAP System Component
RQ-07	The System shall give the individuals the ability to answer questionnaires assigned to them by their supervising healthcare personnel. The System shall support the fill out of questionnaires using either a web interface or the TV monitor and its remote control. In the latter case, the questionnaire layout should be adapted accordingly	**Application Layer**: intLIFE EHR **Presentation Layer**: intLIFE EHR UI, i-TV UI
RQ-08	The System shall support alerting services (patient specific suggestions / reminders etc)	**Application Layer**: intLIFE EHR or Companion Unit app **Presentation Layer**: i-TV UI or Companion Unit UI
RQ-09	The System shall support patient relationship management (PRM) services such as appointment scheduling, remote monitoring session scheduling, etc	**Application Layer**: intLIFE PRM **Presentation Layer**: intLIFE PRM UI and i-TV UI
RQ-10	The System shall support collaboration among healthcare professionals and between healthcare professionals and patients or carers using different tools like videoconference, and instant messaging	**Application Layer**: intLIFE Collaboration tool **Presentation Layer**: intLIFE Collaboration tool web UI
RQ-11	The System must provide a structured view of the care plan of a patient	**Application Layer**: intLIFE EHR **Presentation Layer**: intLIFE EHR UI
RQ-12	The System must allow healthcare professionals from several organizations to access patient's EHR	**Application Layer**: intLIFE EHR, and intLIFE Admin **Presentation Layer**: intLIFE EHR UI
RQ-13	The System shall enable the registered user to manage patient history (capture, review, and manage	**Application Layer**: intLIFE

ReqID	Requirement	Mapping to PAMAP System Component
	surgeries/treatment, hospitalization information, other information pertinent to patient's care)	EHR **Presentation Layer**: intLIFE EHR UI
RQ-14	The System shall support Report Generation, i.e. generation of standard and ad hoc reports	**Application Layer**: intLIFE EHR **Presentation Layer**: intLIFE EHR UI, i-TV UI
RQ-15	The System shall inform healthcare professionals about recent activity, e.g. recent upload of measurements, etc	**Application Layer**: intLIFE EHR **Presentation Layer**: intLIFE EHR UI
RQ-16	The System shall support measurements analysis & graphical representation of the (e.g., weight level over time, level of exercise intensity, etc)	**Application Layer**: Measurements Analysis app **Presentation Layer**: intLIFE EHR UI or Measurements Analysis UI or i-TV UI
RQ-17	The System shall help patients to keep track of health-related goals and "to-do" tasks.	**Application Layer**: intLIFE EHR **Presentation Layer**: i-TV UI
RQ-18	The System shall enable patients to record and track their health-related actions, e.g. (drugs intake, measurement results, daily activity, etc)	**Application Layer**: intLIFE EHR **Presentation Layer**: i-TV UI
RQ-19	The System shall support electronic means of providing the monitored person with educational material like a multimedia resource to be presented in her TV screen	**Application Layer**: intLIFE EHR, STB app **Presentation Layer**: i-TV UI
RQ-20	The System shall support patient self-reporting on sensation during physical activity	**Application Layer**: intLIFE

ReqID	Requirement	Mapping to PAMAP System Component
		EHR **Presentation Layer**: i-TV UI
RQ-21	The System shall allow exchange of information with patient's portable equipment (i.e. companion unit and/or sensors) like alarms, etc	**Application Layer**: intLIFE EHR, Companion Unit app **Presentation Layer**: i-TV UI (indoors), Companion Unit UI (outdoors)
RQ-22	The System shall support the provision of monitored individuals with motivation messages	**Application Layer**: intLIFE EHR **Presentation Layer**: i-TV UI
RQ-23	The System shall guide the patient when performing her rehabilitation program (e.g. the patient gets access to non linear multimedia files, pre-assigned to her, and interacts with them, while executing an exercise	**Application Layer**: intLIFE PHR **Presentation Layer**: i-TV UI
RQ-24	The System shall provide in real time feedback to the patient about the quality of her physical activity program (e.g. execution the movement velocity, the number of repetitions, the diversion between the movement performed and the movement of reference performed with the clinical staff	**Application Layer**: Measurements Analysis app, i-TV PHR app **Presentation Layer**: i-TV UI
RQ-25	The System shall enable the Monitored Individual to specify the perceived exercise intensity level	**Application Layer**: Companion Unit app (outdoors), i-TV PHR app (indoors) **Presentation Layer**: Companion UI (outdoors) i-TV UI
RQ-26	The System shall calculate the energy expenditure, during a session	**Application Layer**: Companion Unit app, or

ReqID	Requirement	Mapping to PAMAP System Component
		Measurements Analysis app **Presentation**: i-TV UI, Measurements Analysis app UI
RQ-27	The System shall calculate qualitative parameters, such as duration of the gait cycle, step length, symmetry walking condition	**Application Layer**: Companion Unit app, or Measurements Analysis app **Presentation**: i-TV UI, Measurements Analysis app UI
RQ-28	The System shall record the time duration of a session, the mean heart rate and the peak heart rate during the session	**Application Layer**: Companion Unit app **Presentation**: i-TV UI, Measurements Analysis app UI
NON-FUNCTIONAL REQUIREMENTS		
RQ-29	The System should support integrity protection of sensitive personal data while it is stored.	
RQ-30	The System should be able to detect unauthorised manipulation of data that is being transmitted.	
RQ-31	The System must protect any stored sensitive personal data from unauthorised access.	
RQ-32	Personal sensitive data must be confidentiality protected while transmitted over open, untrusted communication lines.	
RQ-33	ld be able to log security incidents, such as failed login attempts or unauthorised access attempts to services in order to discover and trace system abuse.	

Table 3: Consolidated end user requirements and mapping to PAMAP System Components

1.7 PAMAP System Use Cases Identification

Use case		Actor	PAMAP Storyboard
UC1	Create EHR	Monitored Individual	
		Attending Nurse	√
		Care Planner	√
		Medical Doctor	
		System Administrator	
		Consultant Physician	
UC2	Create Care Plan	Monitored Individual	
		Attending Nurse	
		Care Planner	√
		Medical Doctor	
		System Administrator	
		Consultant Physician	
UC3	Use EHR	Monitored Individual	√
		Attending Nurse	√
		Care Planner	√
		Medical Doctor	√
		System Administrator	
		Consultant Physician	√
UC4	Upload Educational Material	Monitored Individual	
		Attending Nurse	
		Care Planner	
		Medical Doctor	
		System Administrator	√
		Consultant Physician	
UC5	Assign Home Equipment	Monitored Individual	
		Attending Nurse	
		Care Planner	
		Medical Doctor	
		System Administrator	√
		Consultant Physician	
UC6	Schedule Remote Monitoring Session	Monitored Individual	
		Attending Nurse	√
		Care Planner	
		Attending Physician	√
		System Administrator	
		Consultant Physician	
UC7	Initiate Remote Monitoring Session	Monitored Individual	√
		Attending Nurse	√

Use case		Actor	PAMAP Storyboard
UC1	Create EHR	Monitored Individual	
		Care Planner	
		Attending Physician	√
		System Administrator	
		Consultant Physician	
UC8	Administrate Home Equipment	Monitored Individual	
		Attending Nurse	
		Care Planner	
		Attending Physician	
		System Administrator	√
		Consultant Physician	
UC9	Report Symptoms & Progress	Monitored Individual	√
		Attending Nurse	
		Care Planner	
		Attending Physician	
		System Administrator	
		Consultant Physician	
UC10	Fill Out Questionnaires	Monitored Individual	√
		Attending Nurse	
		Care Planner	
		Attending Physician	
		System Administrator	
		Consultant Physician	
UC11	Report Peripheral's Problems	Monitored Individual	√
		Attending Nurse	
		Care Planner	
		Attending Physician	
		System Administrator	
		Consultant Physician	
UC12	Schedule e-Visit	Monitored Individual	√
		Attending Nurse	√
		Care Planner	
		Attending Physician	
		System Administrator	
		Consultant Physician	
UC13	Send reminders to Monitored Individual	Monitored Individual	
		Attending Nurse	√
		Care Planner	
		Attending Physician	

Use case		Actor	PAMAP Storyboard
UC1	Create EHR	Monitored Individual	
		System Administrator	
		Consultant Physician	
UC14	View Educational Material	Monitored Individual	√
		Attending Nurse	√
		Care Planner	
		Attending Physician	
		System Administrator	
		Consultant Physician	
UC15	Upload Measurements to the EHR	Monitored Individual	√
		Attending Nurse	
		Care Planner	
		Attending Physician	
		System Administrator	
		Consultant Physician	

Table 4: High Level PAMAP System Use Cases