A Personalised Integrated Care Platform

(Grant Agreement N. 689209)

D7.5 First PICASO Integrated Care Platform

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Version 1.0

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Index:

1 Executive Summary

The integrated care platform referred to within this document includes the first set of PICASO functional components with end user tools, user interfaces and their deployment in the cloud-based run-time architecture. Thus, this deliverable represents the integrated results from the technical development work package tasks with their corresponding deliverables. For details of individual components, we refer to the accompanying deliverables D7.1, D7.2 and D7.4.

The platform will be used in the first PICASO clinical trial, involving two different hospitals and clinics, as reported in deliverables D8.4 and D8.5.

2 Introduction

2.1 Content and structure of this deliverable

This document accompanies the Demonstrator deliverable D7.4 and describes the integrated PICASO platform. The PICASO Private Care Cloud and the Public Cloud are implemented in two deliverables,

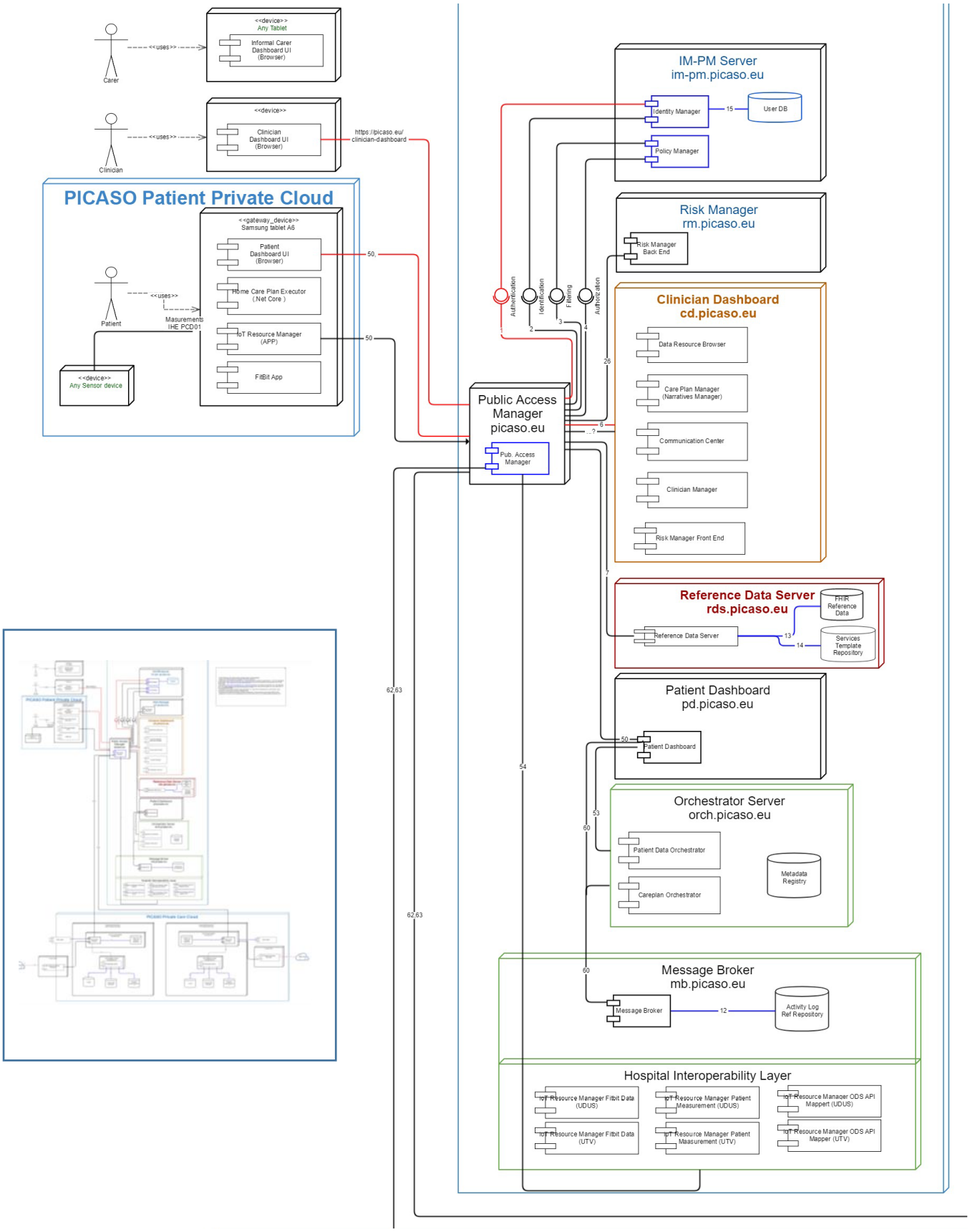
- D7.4 – First Private and Public Cloud Integration
- D7.5 – First PICASO Integrated Care Platform (*this deliverable*)

Task 7.4 “Care System Private Cloud Integration” and Task 7.5 “PICASO Integrated Care Platform” have contributed to this deliverable.

3 Integrated care platform

3.1 Cloud deployment for Trial 1

The PICASO platform for trial 1 includes one Private Care cloud per clinical partner (UTV, UDUS) and a single Public cloud configured to integrate the set of Patient Private clouds of the trial patient users.


Carer
<<uses>>
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Any Tablet
Informal Carer Dashboard UI (Browser)
Clinician
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<<device>>
Clinician Dashboard UI (Browser)
https://picaso.eu/clinician-dashboard
PICASO Patient Private Cloud
<<gateway_device>>
Samsung tablet A6
Patient Dashboard UI (Browser)
Home Care Plan Executor (.Net Core)
IoT Resource Manager (APP)
FitBit App
Patient
<<uses>>
Masurements IHE PCD01
<<device>>
Any Sensor device
50,
50
IM-PM Server
im-pm.picaso.eu
Identity Manager
15
User DB
Policy Manager
Risk Manager
rm.picaso.eu
Risk Manager Back End
Authentication
Identification
Filtering
Authorization
Clinician Dashboard
cd.picaso.eu
Data Resource Browser
Care Plan Manager (Narratives Manager)
Communication Center
Clinician Manager
Risk Manager Front End
Public Access Manager
picaso.eu
Pub. Access Manager
Reference Data Server
rds.picaso.eu
FHIR Reference Data
Reference Data Server
13
14
Services Template Repository
Patient Dashboard
pd.picaso.eu
50
Patient Dashboard
Orchestrator Server
orch.picaso.eu
Patient Data Orchestrator
Careplan Orchestrator
Metadata Registry
Message Broker
mb.picaso.eu
Message Broker
12
Activity Log Ref Repository
Hospital Interoperability Layer
IoT Resource Manager Fitbit Data (UDUS)
IoT Resource Manager Patient Measurement (UDUS)
IoT Resource Manager ODS API Mappert (UDUS)
IoT Resource Manager Fitbit Data (UTV)
IoT Resource Manager Patient Measurement (UTV)
IoT Resource Manager ODS API Mapper (UTV)
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62,63
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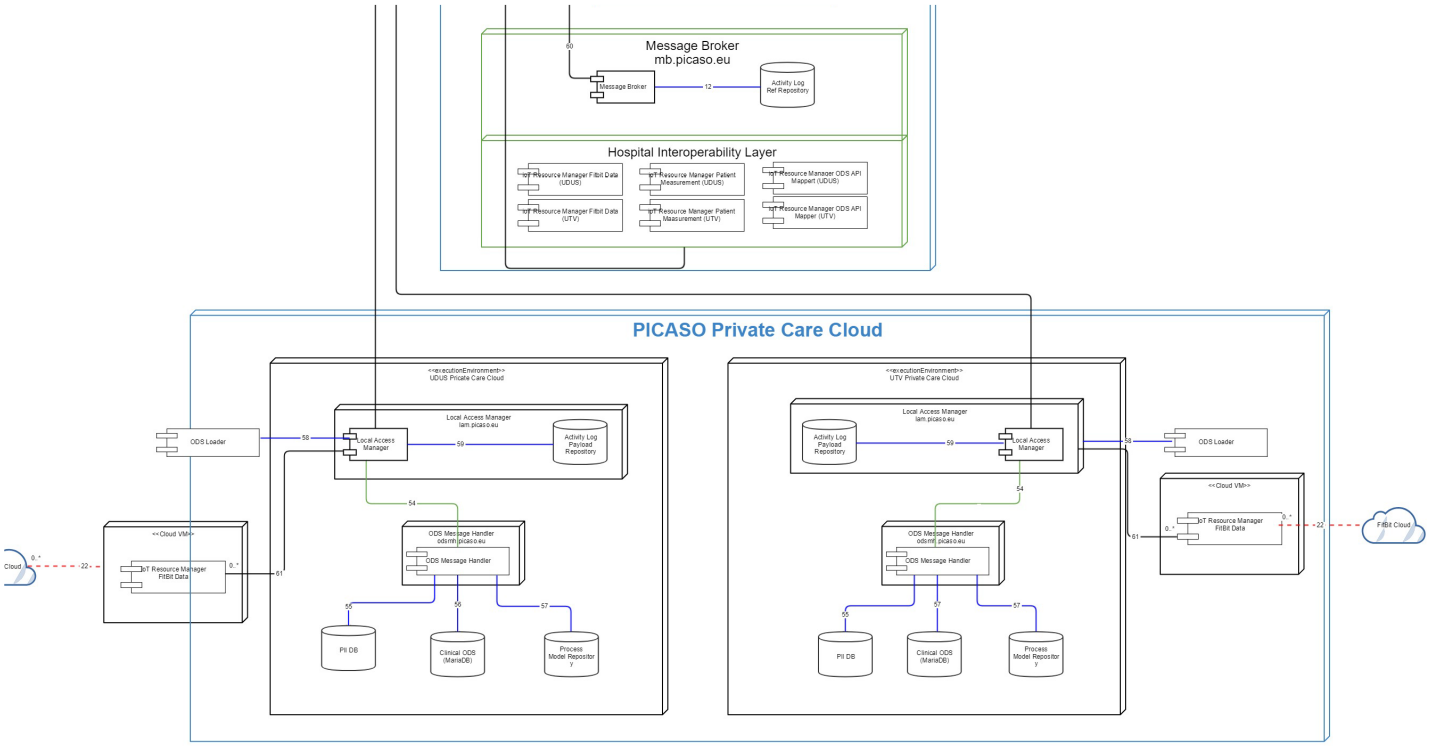


Figure 1: Deployment of components to clouds

The Private Care Cloud is designed to store sensitive patient data on the premises of the participating hospitals in a format suitable for PICASO (see the Operational Data Store/ODS component). Further, it provides the necessary services for data retrieval via the Public Cloud. Figure 2 illustrates the architecture of the PICASO Private Care Cloud deployed at the University of Rome hospital. The cloud consists of seven components, each deployed on separate Virtual Machines (VMs):

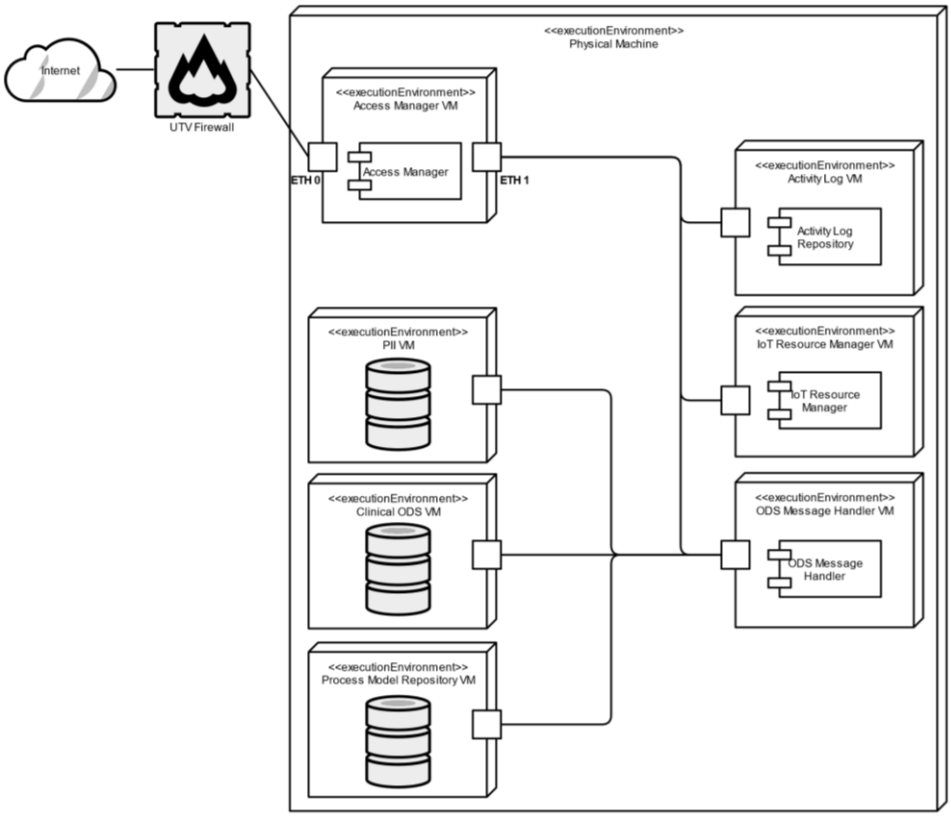


Figure 2: The Private Care Cloud at the University of Rome Hospital

Access Manager: a component which filters all communications by actively monitoring all connections at the application level. Access is granted only if it is allowed by specific access rules. Access rules are coordinated with the PICASO Public Cloud Access Manager Component by means of the Public Cloud Policy Manager.

Activity Log: component designed to store logs which may containing sensitive data.

IoT Resource Manager: component designed to fetch information form the IoT devices of patients.

ODS Message Handler: component designed to provide a common API to access PII, Clinical ODS and Process Model Repository data bases.

PII: component which stores the personal identifiable information of PICASO users who are associated with the institution where the Carer Private Cloud is located.

Clinical ODS: component stores clinical information of PICASO users who are associated with the institution where the Private Care Cloud is located.

Process Model Repository: component stores Process Models.

3.2 Stakeholders

Table 1 presents an overview of the different stakeholders in the project. The list is constrained to the actual end-users of the system in the pilots.

Table 1 - Stakeholders in PICASO

Role	Description
Medical specialist	Medical doctor who is specialized in a certain field in medicine, such as General Practitioner, Rheumatologist, Cardiologist, Radiologist, Nuclear Medicine Physician, Neuropsychologist/ Psychiatrist, Clinical Neurologist, or Occupational Physician
General Practitioner (GP)	Medical doctor, who normally is the first point of contact with a patient and who works together with other medical specialists.
Patient	A person who suffers from an illness or injury and who is the recipient of health care services or treatments. In the PICASO trials patients are chosen who suffer either from rheumatoid arthritis and cardiovascular diseases or from Parkinson's disease and cardiovascular diseases.
Patient's Family	The family of the patient. This includes for example parents, children, grandchildren, nieces, and nephews. Help of family members can cover a wide range: doing little household tasks, helping with formalities such as appointments, driving to the doctors' appointments or in severe cases care for the patient at home.
IT-Administration hospital	Group of people who are responsible for configuration, maintenance and the reliable and secure operation of the hospital information systems.

3.3 Privacy and security

In this section we give a high-level description of the privacy and security provisions implemented in the first release of the PICASO platform.

3.3.1 Clinical data

Clinical patient data is persistently stored only in the Private Care cloud of the participating hospitals in a non-identifying – pseudonymized - way by linking it to a Unique PICASO IDs (UPIDs) for each patient. The UPID is a random, 32-character hexadecimal key. Patient data are collected, passed on, and processed in this pseudonymized way. An important exception is the temporary aggregation of patient data at the client browser through the public cloud processing for presentation to clinicians and patients via the clinician and patient dashboards.

Clinical patient data are provided to the PICASO platform by the participating hospitals via an upload from their hospitals systems or via manual entry. Except for the purpose of uploading data into the operational data store

(ODS) the hospital systems and databases are strictly separated from the PICASO platform. Additional patient data are collected via sensors deployed in home-monitoring devices and transferred over secure SSL/TLS-connections to the ODS servers where the data are persistently stored and processed in pseudonymized form.

3.3.2 Personal Identifiable Information

Personal Identifiable Information (PII - like name, address, contact information) is stored for all users (including patients, formal carers, and informal carers) in a dedicated database at the participating hospitals which is strictly separated from the databases holding clinical data.

3.3.3 Patient access to the PICASO platform

After giving their written informed consent to the hospitals a provided with a tablet device together with a set of home-monitoring devices and their logon credentials. With the account, every patient gets:

- Ability to login to the patient dashboard via the provided tablet device
- Ability to transmit home monitoring data to the hospital via the provided tablet device

3.3.4 Formal carer access to patient data

Formal carer access to patient data is granted based on the written informed consent by the patient. By default, all clinical data of a patient included in PICASO platform are accessible to all formal carers participating in each trial (across participating institutions). Patients have the option to deactivate any formal carer's access to their patient data via the patient dashboard. For this purpose, the patient can access a list of all participating formal carers in the trial and disable/re-enable formal carers individually. Formal carer access is further restricted by access limitations per the formal carers role. Formal carers can access patient data via the clinician dashboard either by using a dedicated tablet device or from inside the DMZ of the hospital.

All relevant formal carer roles (like cardiologist, physical therapist, nuclear medicine physician) have been defined by the participating hospitals and for each role the accessible/non-accessible data categories have been designated by the clinical partners.

3.3.5 Informal Carer access to patient data

Patients may grant informal carers access to their patient dashboard:

1. Patients must request in writing the enrolment of the informal carer
2. The informal carer must agree to her/his personal data stored and processed in the PICASO platform.

A PICASO account for the informal carer is created by INUIT, after the hospitals inform INUIT that steps 1 and 2 have been completed. The hospitals provide the UPID of the patient to which the account of the informal carers must be associated to. Informal carers receive browser-based access via a dedicated tablet device that will be provided to the informal carers.

3.3.6 Patient status (active/inactive)

After a patient signs the informed written consent his/her status in PICASO is "active". If the patient decides to leave the trial, her/his status becomes "inactive" and access to his patient data will be revoked for all users (the patient itself, the informal carers, formal carers). No further home-monitoring data for the patient will be uploaded to the PICASO platform.

3.3.7 Access protections

In general, access to all accounts is protected by username and password. As a second factor access requests must either originate from specified IPs within the DMZs of the participating hospitals or from tablet devices with a valid client certificate.

3.4 Data models and Structures

3.4.1 FHIR data models and extensions

The FHIR data models and the extensions relevant for PICASO are described in detail in deliverable 7.1, section 4.2. The key component of the system is the CarePlan,[1] together with its key components:

- ProcedureRequest[2]
- MedicationRequest[3]
- CommunicationRequest[4]
- DeviceRequest[5]

and the associated FHIR Resources, value sets and code systems. Additionally, the project has defined extensions that cope with the needs and requirements of our pilots (documented in the same deliverable).

3.4.2 ODS - Operational Data Store

This is described in D7.4.

[1] https://www.hl7.org/fhir/careplan.html
[2] https://www.hl7.org/fhir/procedurerequest.html
[3] https://www.hl7.org/fhir/medicationrequest.html
[4] https://www.hl7.org/fhir/communicationrequest.html
[5] https://www.hl7.org/fhir/devicerequest.html

4 Functional View

4.1 Clinician Dashboard

The clinicians window onto PICASO is via the Clinician Dashboard which provides an integrated user interface to the main clinical functions and tools.

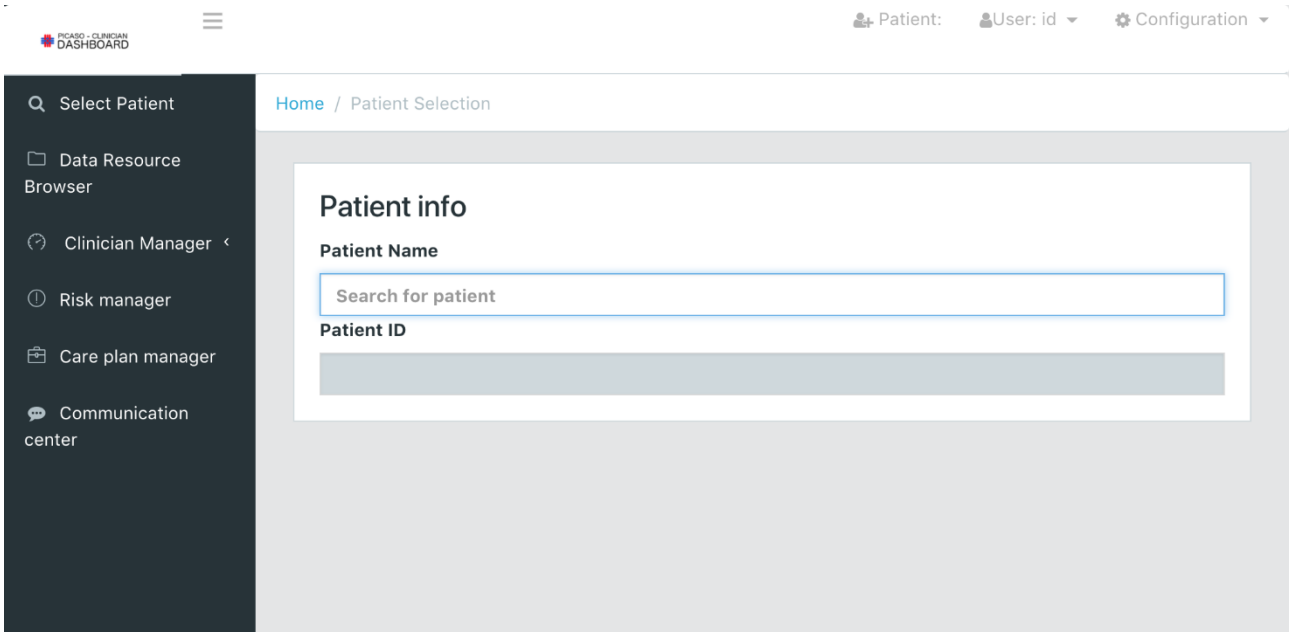


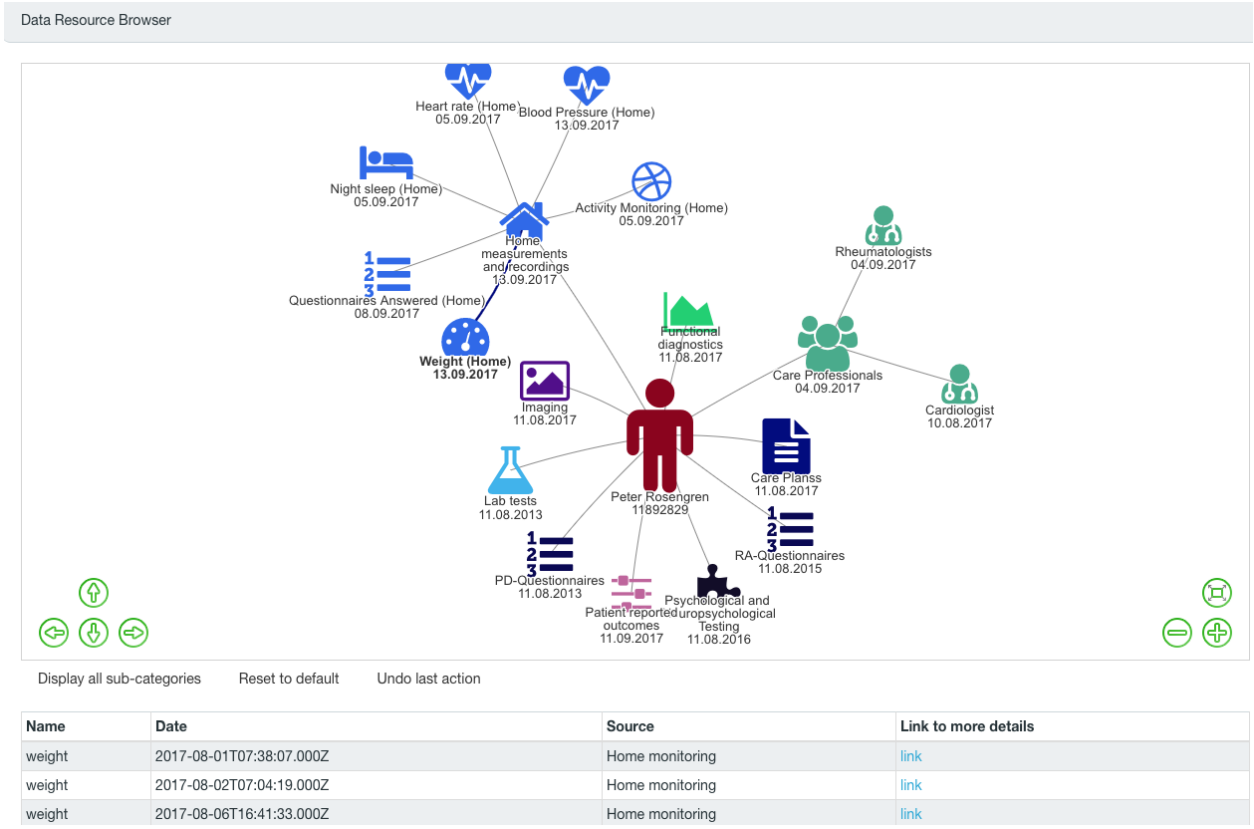
Figure 3: Clinicians window onto PICASO

Clinicians select patients and their related data from one or more connected Private Care clouds of affiliated carers (subject to proper authorization). The entry web page (Figure 3) then provides access to the different PICASO tools.

4.1.1 Data Resource Browser

The Data Browser (DRB) GUI is usable on PCs and Tablets and its purpose is to display any Patient's data based on the Metadata Registry that the specific end user (clinician) has permission to access (see Deliverable D2.3). The DRB displays the integrated heterogeneous patient's data in a structural interactive form. It gives to clinicians an intuitive and quick way to browse and check the integrated information in form of a "mind map", having in the very centre the patient. The mind map (graph) is interactive, thus by clicking on one node, a new sub-graph is shown. Finally, when clinician clicks on a certain specific data type, history of all relevant measurements performed or narratives are displayed (the content is presented by Clinician Manager or Narrative Manager).

Different care professionals would need to follow different pathways in order to obtain a good overview of what data are available for a patient (see Deliverable D5.3). Also, the DRB is capable of adaptation of the mind map based on user roles, so only information relevant to the specialist can be presented. DRB together with Clinician Manager and Narrative Manager enable clinicians to grasp an overall (holistic) picture of the patient from data perspective.



Name	Date	Source	Link to more details
weight	2017-08-01T07:38:07.000Z	Home monitoring	link
weight	2017-08-02T07:04:19.000Z	Home monitoring	link
weight	2017-08-06T16:41:33.000Z	Home monitoring	link

Figure 4: Data Resource Browser

Figure 4 shows the DRB with expanded home measurements and recordings and the care professionals category. The selected Weight node shows a list with historic measurements and links that navigates and display interactive Weight chart below the mind map.

4.1.1.1 Technologies employed

The protocols employed by DRB are HTTPS/REST. The technologies include Web technologies, vis.js, AngularJS, NodeJS.

4.1.1.2 Interfaces

The preconditions for DRB to display the integrated data are services that provide such data in a suitable (for DRB) form. The ODS provides services over the stored data. These data comes from HISes, Patient's home monitoring as well as from Narrative Manager. Therefore, patient's data are already integrated in ODS. However more ODSes can contain data about patient (as there is one ODS per hospital in the private cloud). The Patient Data Orchestrator compose such services of ODSes including the privacy restrictions and wrap particular services as one service suited for DRB. The DRB, as part of the Clinician Dashboard, delegates the call of the service to this wrapping component (Patient Id used in the call has been chosen there). The signature of this service is following:

API name	Parameter (I/O)	Type	Description
patient/forDRB	patientId (I)	string	The patient identifier (obtained after user has chosen it in Clinician Dashboard)
	startDate (I)	date-time	The start date

	endDate (I)	date-time	The end date
	X-PICASO-RequesterUPI (I)	string	Non-standard header for Requester UPID (obtained after user hes logged in into Clinician Dashboard)
	resultForDRB (O)	resultForDRBtype	Structured data response that suit to the structure of the predefined DRB mind map

The JSON schema used for data response (Output) as well as JSON sample of such response of such service are provided in the accompanying deliverable D7.4.

Once the mind map is presented and the clinician chooses concrete data to be shown in detail (e.g. from the list below the mind map or by double-clicking on the leaf node) the navigation towards the Clinician Manager or Narrative Manager is done. Clinician Manager provides the following specific interface for DRB supporting such navigation in case of data belonging to “Home measurements and observations”:

API name	**Parameter (I/O)**	**Type**	**Description**
/clinician-manager/observations/	NodeName (I)	string	Name of the subcategory of “Home measurements and observations”

The navigation towards Clinician Manager in case of data belonging to other data category is about to be displayed using following link: /clinician-manager/treatments/all

The navigation towards Narrative Manager in case of data belonging to data category Care plan is about to be displayed using following link: /narratives-manager.

4.1.2 Clinician Manager

The Clinician Manager provides a graphical and tabular overview of patient’s clinical data. This component is a subcomponent of the Clinician Dashboard web interface.

Figure 5: Presentation styles provided by the Clinician Manager

More detailed information is provided in the deliverable D6.2.

4.1.3 Risk Manager

The Risk Manager is a subcomponent of the Clinician Manager. It provides personalized risk scores forecasting over a period of 20 years for a given patient.

Figure 6: Risk Score UI

This component is running in the public cloud. More detailed information is available in section 6.7 of deliverable D6.2.

4.1.4 Care Plan Manager

The aim of this tool is to allow the creation, integration and effective sharing of a Patient pathway between all involved professional carers. Every organisation/physician uses a number of standard care plans for various diseases management actions. These care plans are expressed in a narrative form and are stored as care plan templates in the Process Model repository through the Care Plan Orchestrator component. A care plan template uses in a specific arrangement standard services stored in the service catalogue with open data fields for specific service parameters. In order to develop a Patient Pathway, a physician or an assistant instantiates one of the existing templates and fills the missing services' data with specific patient data.

Its functionalities are described in more detail in deliverable 7.1, section 5.3 and in deliverable 7.2.

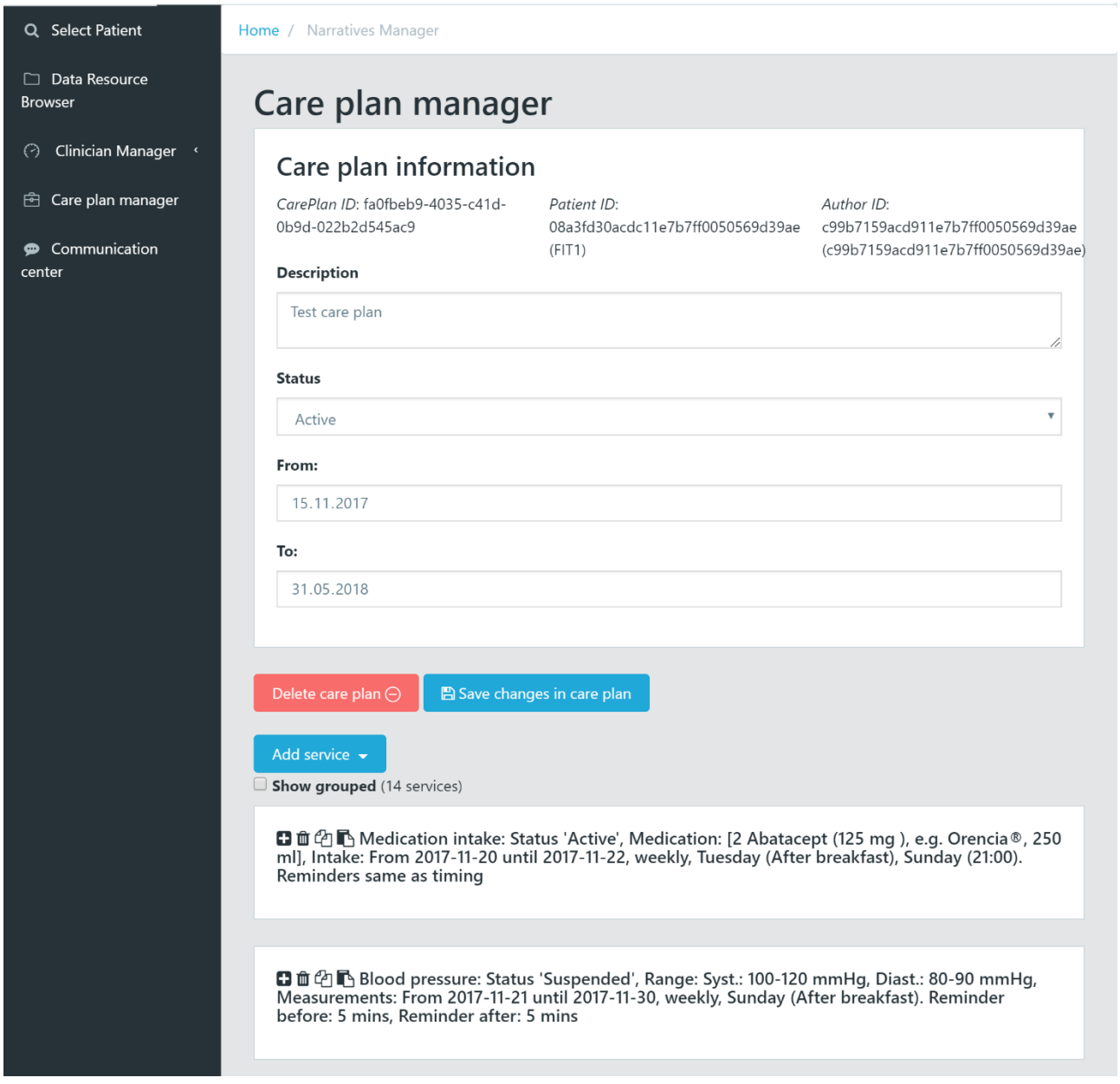


Figure 7. Care plan manager entry page after loading a fictitious care plan.

4.2 Patients and informal carers views

4.2.1 Patient Dashboard

For PICASO Trial 1 the Patient Dashboard is deployed on a tablet PC, with the user interface adapted to each patient group.

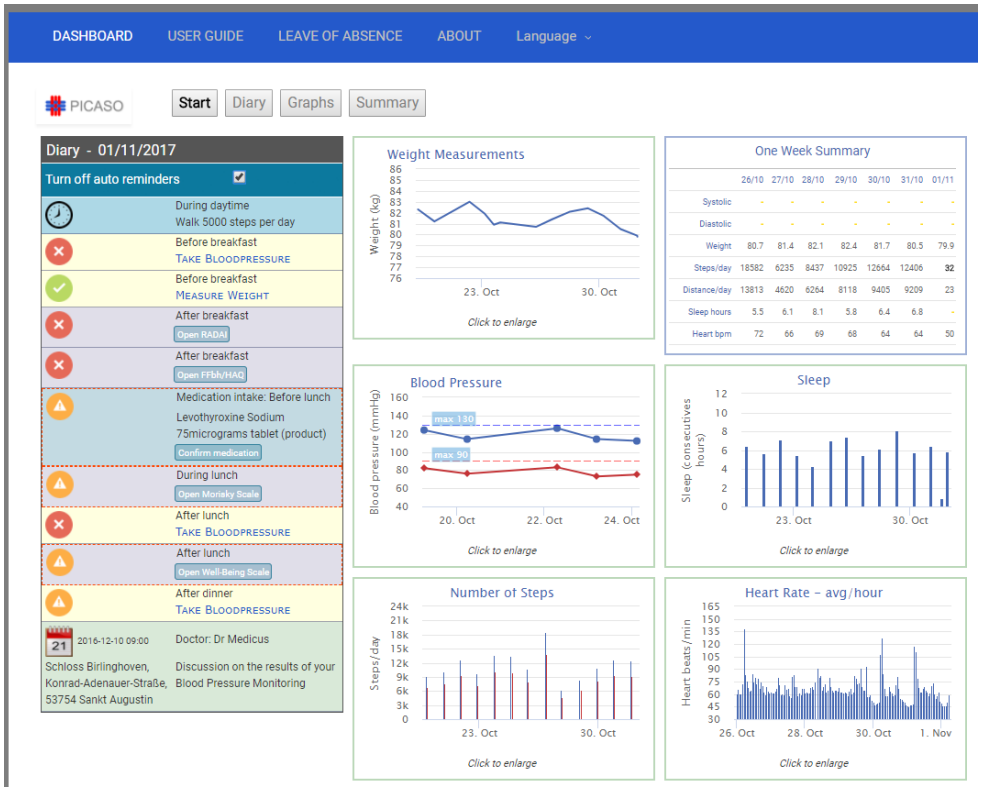


Figure 8: Patients and informal carers view of PICASO

The Patient Dashboard user interface and functionality is describe in Deliverable D4.3. For Trial 1, the informal carers and patients will uses the same dashboard interface.

5 Future work

The following points are currently being pursued and will be provided as part of the second version of the PICASO platform:

- Administration Support
- Configuration and commissioning of equipment
- Help and Guidelines for patients and carers
- Adaptation of the Patient Dashboard user interface
- Online Demo