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Overall Do CHANGE ecosystem infrastructure architecture, including DDS and ecosystem component framework – Version 2

[Deliverable 4.26 (D105), Revision 0.4]

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Description:

This documents is closely linked with related deliverables that provide reviews of the design of subsystems specified in the associated deliverable D4.9 (D60). It presents and overview of the implementation of the Do CHANGE ecosystem, shows that it can meet the requirements of use cases that it was designed for and, is therefore suitable for the Do CHANGE phase 2 clinical field trials.

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0.2	27-Jan-2017	RS	DOC	Updated adding missing content in preparation for internal review.
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Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Executive Summary

This document provides an overview of the implementation of the Do CHANGE ecosystem as presented in the Do CHANGE project deliverable D4.9 (D60) (Ref. [A]). It is closely linked to several other WP4 deliverables that describe in detail the implementation of key elements of subsystems within the Do CHANGE ecosystem. In its conclusion, this document shows how the implementation of the ecosystem meets the requirements of the use cases specified in D4.9 (D60) (Ref. [A]) and it therefore provides a sound platform for the second phase of Do CHANGE clinical field trials.

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References

[A]	Do CHANGE project document D4.9 (D60) Overall Do CHANGE Ecosystem Infrastructure Architecture.
[B]	Do CHANGE project document D4.11 (D62) The Identity and Permissions Management Framework Phase 1 Implementation Report
[C]	Do CHANGE project document D4.15 (D66) Do CHANGE Data Dictionaries and Third Party Interfaces Implementation Report
[D]	Do CHANGE project document D4.17 (D68) Do CHANGE Data Analysis and Big Data Analytics Phase 1 Implementation Report
[E]	Do CHANGE project document D4.21 (D72) Do CHANGE Application Programming Interfaces Phase 1 Implementation Report
[F]	Do CHANGE project document D4.10 (D61) The Identity and Permissions Management Framework Design
[G]	Do CHANGE project document D4.14 (D65) Do CHANGE Data Dictionaries and Third Party Interfaces Design.
[H]	Do CHANGE project document D4.20 (D71) Do CHANGE Application Programming Interfaces Design – Phase 1.
[I]	D4.16 (D67) Do CHANGE Data Analysis and Big Data Analytics Design

1. About This Document

Do CHANGE aims to develop and provide a health infrastructure for integrated disease management of citizens with high blood pressure and patients with ischemic heart disease or heart failure. In this context, it aims to give them access to a range of personalized health services that are intended to encourage behaviour change and to allow their behaviour and clinical parameters to be monitored. The information is shared amongst the health services in a manner that reflects the citizens wishes and, aims to optimise their health and well-being. This document presents an overview of the implementation of the Do CHANGE ecosystem and shows that it is able to meet the requirements of use cases for which it was designed.

Deliverable context

Project item	Relationship
Objectives	This document is linked to the following WP4 objectives: To Specify and develop the overall Do CHANGE Ecosystem Architecture, both the services & component infrastructure, the data infostructure and its semantics. • The data collection, storage, management and communication will take place in a secure patient controlled environment and feedback on transactions will be fed back to the individual. • All incoming data will be semantically tagged such that background knowledge, context and precise meaning are stored with the data and will inform any use of the data and its analytics.
Exploitable results	This part of the project is service ecosystem design. It is anticipated that the services developed from this design would be further developed to commercially exploitable systems.
Work plan	This deliverable is associated with Task 4.1 in Work Package 4.
Milestones	This deliverable is not linked to an overall project milestone but does mark the submission of D4.26 (D105).
Deliverables	This document presents and overview of the implementation of the Do CHANGE ecosystem and shows that it can meet the requirements of use cases that it was designed for. It is closely linked with related deliverables that provide reviews of the design of subsystems specified in the associated deliverable D4.9 (D60).
Risks	The review conclusions from this document available, contribute to mitigating the risk of failure of the technology supporting the Do CHANGE phase 2 clinical trials due to incompatibility of its components.

2. Implementation of the Do CHANGE Ecosystem

Overview

Figure 1 presents an overview of the implantation of the Do CHANGE ecosystem that will be taken forward to the phase 2 clinical field trials.

The community patients indicated at the centre of the figure have a diagnosis of hypertension, heart disease or chronic heart failure, this order indicating an increasing level of clinical severity. These diseases have the common characteristic that the outcome for the patient can be significantly influenced by lifestyle factors. The patients may have one or more supportive technologies or sensors. These may include mobile phone data recording / data synchronisation applications such as Moves, Vire, sensors provided by Do CHANGE project partners such as MySleeve and SAL, or those provided by commercial sensor vendors such as Beddit or Fitbit. They may also have dedicated telehealth data collection provision through a Docobo CarePortal device or application as well as appropriate clinical measurement devices. The applications may include support for analysis of their lifestyle, activity, social and clinical data as well as that of photographs of the meals that the patients will eat. Patient can control access to the wide range of clinical, lifestyle and social data is collected from them, with this being achieved through web based portals provided by the custodians of the data (that is, the relevant "data controllers"). The patients receive Dos, which are short textural messages aimed at encouraging them to change lifestyle factors such that their health outlook is improved. These Dos may be fixed (referred to as "Core Dos") in that they follow pre-defined logic applied to information gathered when they join the ecosystem. Alternatively, they may by be responsive (referred to as "Responsive DOs") in that their content is dynamically adjusted in accordance with the flow of diverse information collected from the patients. The patients may also review education feedback which aims to help them understand how lifestyles and treatment compliance impact their health. The Dos and educational information may be delivered through different channels including SMS messages, mobile phone applications and dedicated telehealth devices.

The patients are under the care of clinicians as indicated in the top, right-hand corner of Figure 1, with these clinicians based at one of the three Do CHANGE clinical trials sites, which are:

- Badalona Serveis Assistencials (BSA) in Spain;
- Elisabeth TweeSteden Ziekenhuis (ETZ) in the Netherlands;
- Buddhist Tzu-Chi Dalin General Hospital in Taiwan.

These clinicians provide traditional clinical care including interventions via the Docobo telehealth systems. In doing this, where the patient has consented, they have access to raw data from third party sensors through the Docobo system and to the results of rich data analysis through services provided by Eurecat (based on the whole set of data gathered) as well as services provided by OMNI, which are focused on the data analysis related to the generation of "Responsive Dos".

The various subsystems and services in the ecosystem indicated in Figure 1 work together to provide information to the clinicians and patients such that best practice data security is followed and the wishes of the patients with respect to who is permitted to access their information are honoured. The following sub-sections explain at a top-level how this is achieved, while more details are provided in the following related deliverables:

- D4.11 (D62) The Identity and Permissions Management Framework Phase 1 Implementation Report (Ref. [B]);
- D4.15 (D66) Do CHANGE Data Dictionaries and Third Party Interfaces Implementation Report (Ref. [C]);
- D4.17 (D68) Do CHANGE Data Analysis and Big Data Analytics Phase 1 Implementation Report (Ref. [D]);
- D4.21 (D72) Do CHANGE Application Programming Interfaces Phase 1 Implementation Report (Ref. [E]).

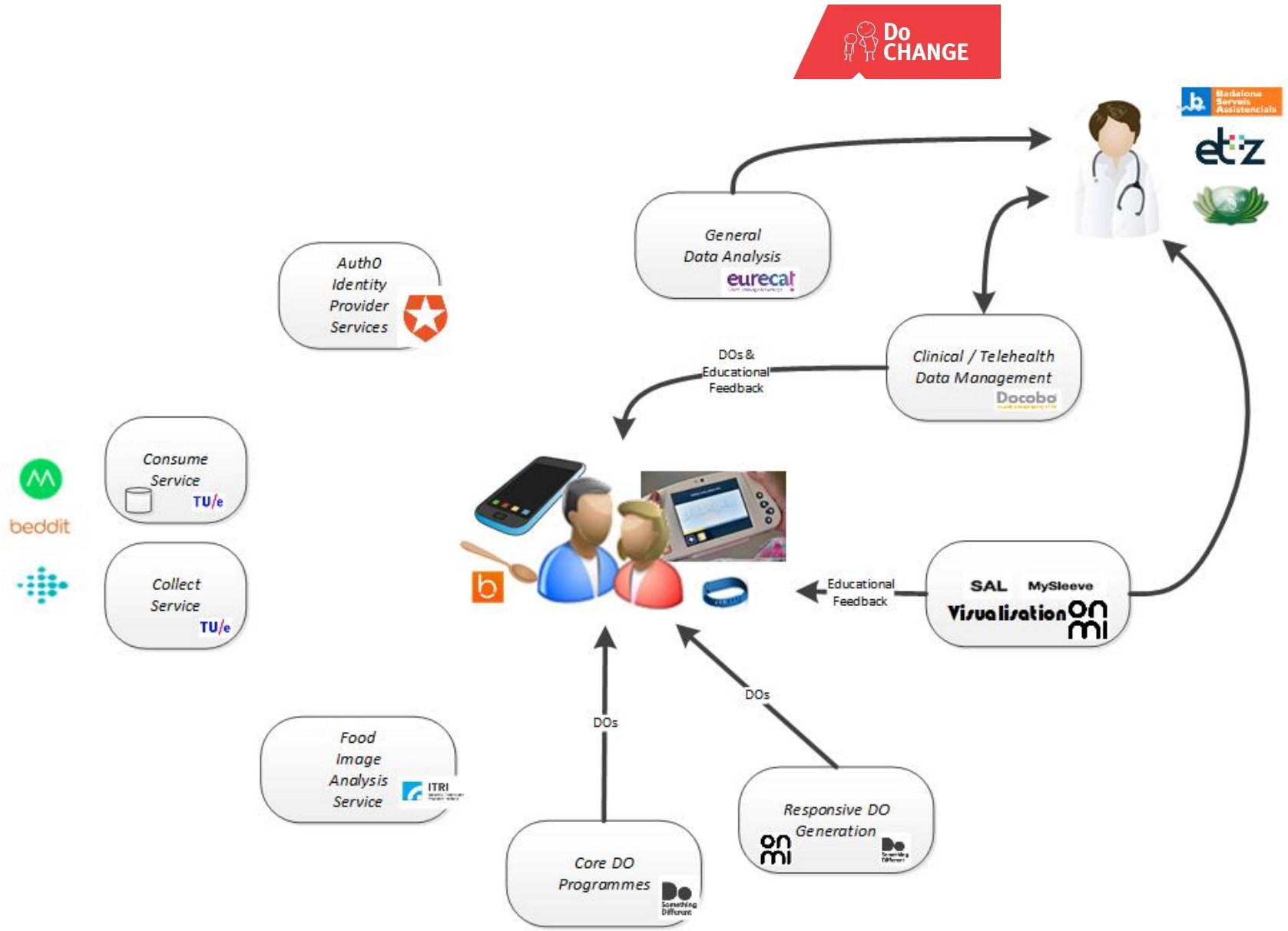

Figure 1 Do CHANGE ecosystem

The Patient's Control of Access to their Data

To enable the patients to control access to their data, the identity and permissions management framework presented in Do CHANGE project deliverable D4.10 (D61 - Ref. [F]) has been implemented. Some key aspects of this implementation are:

- the use of Auth0 as a federated identity provider within the ecosystem;
- the use of a combination of fixed mapping by some systems of the identity framework model, which the patient manually consents to, through to a fully patient configurable implementation;
- the use of a specific pseudonymisation identifier for data and information made available outside the ecosystem to prevent the patient's identity being compromised by correlating information from different sources.

More details are provided in Do CHANGE project deliverable D4.11 (D62 - Ref. [B]). In summary, relevant data categories are combined with a mechanism to allow patients to control the access that an individual, those with a specified role, an organisation or a service / subsystem has to data in each category. This allows for example, a patient to grant or revoke access to their Fitbit activity and sleep data by their clinical care providers, where this supplementary information is presented in the context of the patient's normal clinical data. It also allows patients to be automatically signed up to a Do programme when there are enrolled in a clinical system.

Use of Data from Third Party Sensors

An significant use case for DO CHANGE is to allow applications within the ecosystem to have access to data from third-party systems such as Beddit sleep data, Fitbit activity and sleep data and the Moves activity and location history mobile data. To facilitate this, the Do CHANGE ecosystem implements the third-party systems interface presented in Do CHANGE project deliverable D4.14 (D65 - Ref. [G]). In the design presented in this document, the third-party data is brought into the ecosystem by the Consume service and then distributed to other services / subsystems by the Collect service. A patient authorises access to their third-party data via the Consume / Collect services, which upon first use directs them on to the respective third-party's system where they are authenticated and asked to approve the access. This authorisation is normally only required once, unless the patient changes the authorisation through a Do CHANGE or third-party system patient / user portal. OAuth2 protocols, using JSON Web Tokens are employed in the implementation. More details are provided in Do CHANGE project deliverable D4.15 (D66 - Ref. [C]).

Integration of Services

Introduction

The Do CHANGE ecosystem utilises the Application Programming Interface (API) approach presented in Do CHANGE project deliverable D4.20 (D71 – Ref. [H]). This allows information to flow between subsystems and functionality to be published by subsystems to the ecosystem, with these interactions honouring the patient's wishes with respect to access to their data. Details of the implementation are presented in Do CHANGE project deliverable D4.21 (D72 - Ref. [E]). Some specific uses of this are presented below.

The Generation and Delivery of "Responsive Dos"

The initial implementation for the generation of "Responsive Dos" is presented in Do CHANGE project deliverable D4.17 (D68 - Ref. [D]). This uses the Do CHANGE API approach to channel a wide range of activity data from different sources to the service that implements the algorithms for the generation of "Responsive Dos". This services is then able to use the same mechanism to distribute the generated "Responsive Dos" to patients via the diverse channels available within the Do CHANGE ecosystem. The architecture also supports on-going development of the algorithm for the generation of "Responsive DOs", and so that for example, its will allow clinical data to be considered as input data during the course of the phase 2 clinical study.

Big Data Analysis

The approach adopted for the development of big data analysis within the Do CHANGE ecosystem is presented in deliverables D4.17 (D68 - Ref. [D]) and D4.16 (D67 – Ref. [I]). Key aspects of the implementation of the ecosystem that facilitate such analysis are:

- the use of HL7 based data formats, employing standard data coding where available and supplemented by a Do CHANGE specific data coding where required as described in Do CHANGE deliverables D4.14 (D65 – Ref. [E]) and D4.15 (D66 - Ref. [C]);
- the use of the Do CHANGE API for data distribution as described in Do CHANGE deliverables D4.20 (D71 – Ref [H]) and D4.21 (D72 - Ref. [E]).
- The use of a pseudonymisation identifier specifically for export to the pseudonymised databased used as the input to the data analysis pre-processing.

This facilitates the continuous processing of diverse data from diverse sources which is relevant to the well-being of patients. For more details refer to Do CHANGE project deliverables D4.16 (D67 – Ref. [I]) and D4.17 (D68 - Ref. [D]).

Access to ITRI Food Analysis Services

Within the Do CHANGE ecosystem, project partner ITRI specialise in the analysis of pictures of meals immediately before they are consumed. This analysis generates measures of the composition of the meal. Patients can take pictures of their meals using the Do CHANGE Smartphone application. Using the Do CHANGE API approach, the picture can then be submitted to the food picture analysis service running at ITRI and the result passed back for use in determining automated interventions. The analysis results may be presented to patients as educational information or to clinicians as information that supplements the clinical data they use.

3. Conclusion / Future Work

A set of use cases that the Do CHANGE ecosystems is required to support is presented in related project deliverable D4.9 (D60 – Ref. [A]). The table below shows the implementation of the Do CHANGE ecosystem as presented in Figure 1 is able to meet the requirements of each of these use cases.

Use Case	Test Strategy
The Collection of Clinical Data from Community Based Patients	This is achieved through the Docobo Telehealth system.
The Collection of Food Related Sensor Data	This is achieved through the OMNI salt and fluid sensors and the ITRI food analysis service.
The Collection of Personality and Lifestyle Data	This is achieved through Pre-Dos patient profiling questionnaires that can be completed by the patient in several ways including directly on a web portal and on their dedicated telehealth device.
The Collection of Activity Data	This is achieved through the Consume / Collect services that allow Moves App, Fitbit and Beddit data to be made available within the ecosystem in a coordinated manner matches to a consistent patient identifiers.
The Collection of Sleep Data	This is achieved through the Consume / Collect services that allow Fitbit and Beddit data to be made available within the ecosystem in a coordinated manner matches to a consistent patient identifiers.
The Delivery of Core DOs	This is achieved by integration of the DSD services within the ecosystem.
The Delivery of Responsive DOs	This is achieved by the collection and routing of relevant data to the "Responsive Dos" generation service, which is then able to deliver the Dos over the different channels available in a coordinated manner.
Access by Care Providers to Data from Different Sources in One Place	This is achieved by allow clinicians to view raw sleep and lifestyle data in the context of clinical data and to view the results of applying complex analysis to relevant, non-clinical data.
Control of Access to a Patient's Data in Accordance with their Wishes	Using the Docobo web-based Patient Portal, patients are able to control who or what (organisation or role) can access each of their types of data and whether this is full of anonyms access.
Making Pseudonymised Version of All Relevant Data Available for Analysis and Research	Using the Consume / Collect subsystems, the data collected and available within the Do CHANGE ecosystem can be shared in a consistent health industry standard format (HL7) using bespoke coding only where required and with a pseudonymisation identifier of sound integrity. A specific application of this within the Do CHANGE phase 2 trial is to be the big data analysis activity.

Based on the table presented above, it is concluded that the implementation of the Do CHANGE ecosystem is ready to move forward to the Do CHANGE phase 2 clinical field trials.