Serums

Project no. 826278

SERUMS

Research & Innovation Action (RIA)
SECURING MEDICAL DATA IN SMART-PATIENT HEALTHCARE SYSTEMS

Report on Initial Smart Health Centre System Software
D6.1

Due date of deliverable: 31st December 2019

Start date of project: 1st January 2019

Type: Deliverable
WP number: WP6

Responsible Institution: University of St Andrews
Editor and editor's address: Juliana Bowles (jkfb@st-andrews.ac.uk)

Version 1.0

Project co-founded by the European Commission within the Horizon H2020 Programme	
Dissemination Level	
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Release History

Release No.	Date	Author(s)	Release Description/Changes made
V0.1	26/12/19	Jose Mendoza Santana	Scenario of interaction, mock-ups for the system integration and UI of the Smart Health Centre System (SHCS)
V0.2	31/12/19	Juliana Bowles	Added document structure, introduction, overview, etc

SERUMS Consortium

Partner 1	University of St Andrews
Contact Person	Name: Juliana Bowles Email: jkfb@st-andrews.ac.uk
Partner 2	Zuyderland Medisch Centrum
Contact Person	Name: Mark Mestrum Email: m.mestrum@zuyderland.nl
Partner 3	Accenture B.V.
Contact Person	Name: Bram Elshof, Wanting Huang Email: bram.elshof@accenture.com, wanting.huang@accenture.com
Partner 4	IBM Israel Science & Technology Ltd.
Contact Person	Name: Michael Vinov Email: vinov@il.ibm.com
Partner 5	Sopra-Steria
Contact Person	Name: Andre Vermeulen Email: andreas.vermeulen@soprasteria.com
Partner 6	Université Catholique de Louvain
Contact Person	Name: Axel Legay Email: axel.legay@uclouvian.be
Partner 7	Software Competence Centre Hagenberg
Contact Person	Name: Michael Rossbory Email: michael.rossbory@scch.at
Partner 8	University of Cyprus
Contact Person	Andreas Pitsillides Email: andreas.pitsillides@ucy.ac.cy
Partner 9	Fundació Clínic per a la Recerca Biomèdica
Contact Person	Name: Santiago Iriso Email: siriso@clinic.cat

Table of Contents

Executive Summary

Securing Medical Data in Smart Patient-Centric Healthcare Systems (SERUMS) is a research project supported by the European Commission (EC) under the Horizon 2020 program. This document is the first deliverable of Work Package 6: "*Integration and Testing*". The leader of this work package is USTAN, with involvement from ZMC, Accenture, IBM ISRAEL, SOPRA STERIA, UCL, SCCH, UCY, FCRB.

The purpose of this work package is to integrate the Serums technologies into a coherent Smart Health Centre system that will be used as a central access point to the different techniques developed over the course of the project.

We will develop a front end for the Smart Health Centre system which takes into account different perspectives from which the data can be accessed, e.g. patient, specialist, insurer and administration (T6.1). We will then integrate smart patient records, data analytics mechanisms, secure and privacy-preserving communication infrastructure and authentication mechanisms from WP2, WP3, WP4 and WP5 into this system (T6.2). Over the course of the integration, we will test the interoperability of the Serums technologies on synthetic data that is produced by the data fabrication mechanisms from WP4 (T6.3). We will identify any interoperability issues and produce guidelines on how to address them. The testing done in this work package will be from the system implementors' perspective. In WP7, in contrast, we will evaluate the use cases from the user's perspective.

1 Introduction

1.1 Role of the Deliverable

This deliverable entitled "*Report on Initial Smart Health Centre System Software*" is the first deliverable of WP6. It reflects initial work on T6.1, and focuses primarily on the development of a front end for the Smart Health Centre system considering the different perspectives from which the data there can be accessed, e.g. patient, specialist, insurer and administration. How the different SERUMS technologies will be integrated will be carried out in T6.2. More concretely, for T6.1 we will produce central software infrastructure for Smart Health Centres, that will be used as the main front end for medical practitioners, health centre administration and possibly patients. It will also serve as a main point from which Serums technologies will be accessed. This task deals with the design and implementation of the "skeleton" of the system, into which different technologies developed over the course of the project will be integrated in T6.2. It will be centred around the concept of smart patient records that will be developed in WP2, keeping a database of them and allowing different views of the data associated with these records and different operations on the data, depending on the party that is using the system. This task will proceed in three phases. In the first phase, we will develop an initial prototype of the system, based on the analysis of requirements that such system will need to satisfy (T7.1). Our work in this direction is described in this deliverable D6.1.

1.2 Relationship to Other SERUMS Deliverables

WP6 entitled "Integration and testing" brings together work done across all WPs of the project. Overall, WP6 will consequently integrate smart patient records, data analytics mechanisms, secure and privacy-preserving communication infrastructure and authentication mechanisms from WP2, WP3, WP4 and WP5 into one holistic system.

Over the course of the integration, we will test the interoperability of the Serums technologies on synthetic data that is produced by the data fabrication mechanisms from WP4, and we will identify any interoperability issues and produce guidelines on how to address them. The testing done in this work package will be from the system implementors' perspective. In WP7, in contrast, we will evaluate the use cases from the user's perspective.

Deliverable D6.1 describes work on the initial Smart Health Centre System Software, and it is associated to Milestone MS6.

1.2 Structure of this Document

This document describes the overview of the SERUMS toolchain, followed by the architecture of the software system, first versions of mock-ups for the system integration and the user interface (UI) of the Smart Health Centre System. The user interface (UI) takes into account different perspectives from which the data can be accessed, e.g. patient, specialist, insurer and administration, and is illustrated with a few examples.

2   Serums Tool-chain and Integration System

Our recent paper gives a description of the SERUMS tool-chain [1]. The following text, taken from [1], describes the overall process of accessing data across a distributed healthcare system. The core of it is a centralised data lake that holds the smart patient records.
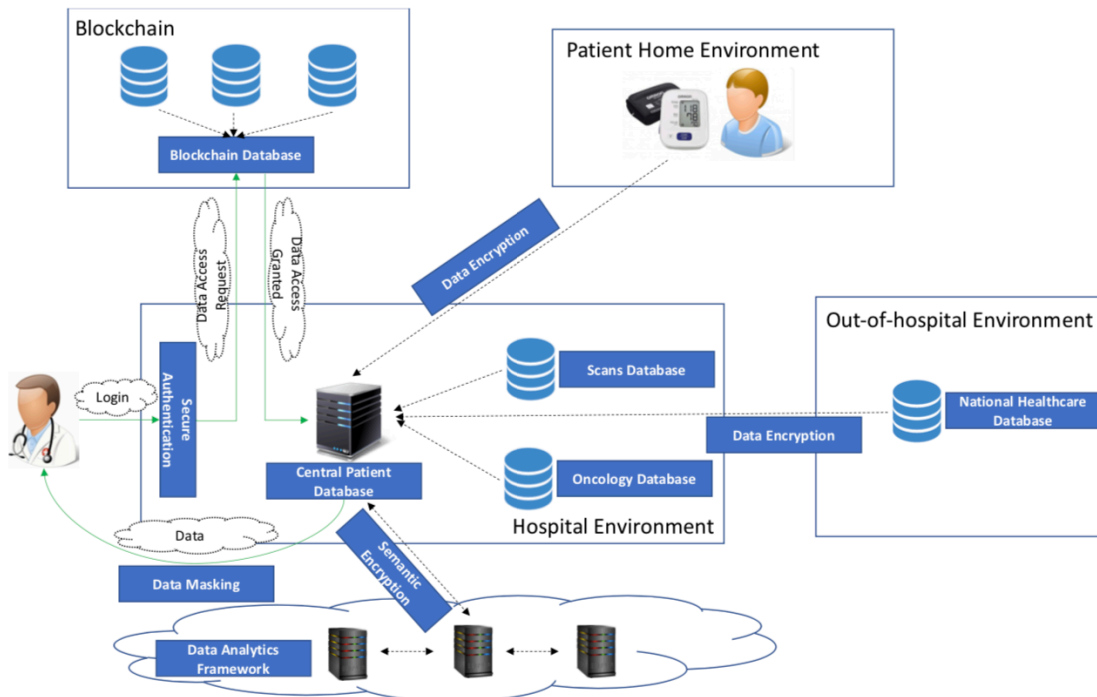
Figure 1 The overview of the SERUMS toolchain

Note that, while the patient records are centralised, the data in them may refer to databases distributed inside and outside of the hospital environment. These records contain all information about the patients, from static information such as date of birth, gender and contact information, to vital information such as weight, body mass index, allergies, to dynamic information about treatments and examinations. Some of the data for the records will be collected from within the healthcare system over trusted networks, while other may be collected from personal health monitoring devices, etc. Data sent over untrusted networks must be secured using data encryption mechanisms.

When staff needs to access patient data, they first log in to the central healthcare system using secure authentication mechanisms. In the SERUMS project, our aim is to develop personalised and adaptive multi-factor user authentication schemes. Once the user logs in, their access rights are checked using the blockchain backend which is linked to a distributed blockchain database. Different classes of users (e.g. patients, GPs, specialists, insurers) will have different levels of permissions, according to GDPR and other legal and ethical regulations. For example, the patient has full access to their record, while a specialist can only access parts of the record that are relevant to them. The blockchain ensures that only authorised agents can access the data, and depending on permissions, possibly only be part of the data. The blockchain contains all access rules and transitions, and keeps a record the data access history. Note, however, that no actual data is stored in the blockchain.

Once the user is authenticated and the access rights are checked, the requested data from the smart patient records data lake is sent back to the user. If the user does not have full access rights to the record, the data transfer may involve masking parts of the data, i.e., hiding parts of the record that the user has no access right to see. The access transaction itself is stored in the blockchain database.

2.1 Architecture of the Integration

We have described how the serums technologies come together. We now focus on an initial integration for the different components required for the Smart Health Centre System. Figure 2 shows the overall envisaged architecture for the integration.
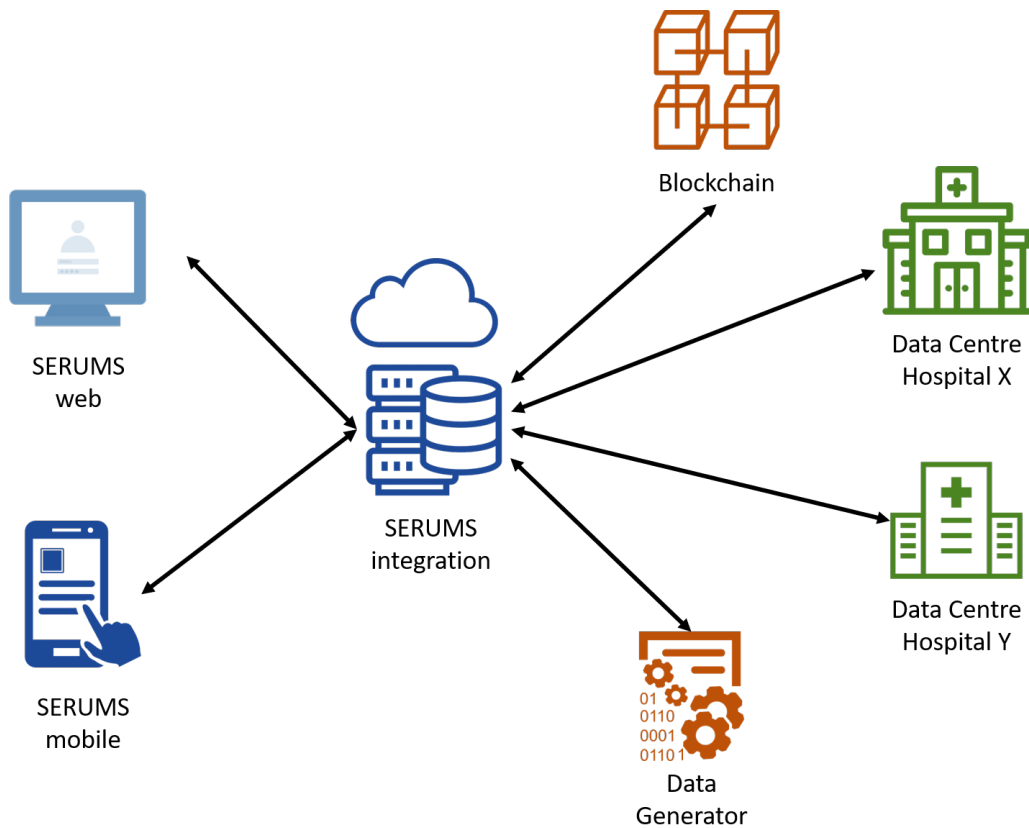
Figure 2 Overall architecture of the system integration

2.2 Sequence Diagrams

To show how the different components will be used and combined, we show a scenario given as a sequence diagram and enabling different user actions. This will then be used to show the front end of the Smart Health Centre System.

2.2.1 Record Access

The following sequence diagram depicts the interaction between different components of the SERUMS project in order to allow a user (e.g., doctor, insurance agent) to query a patient's record.
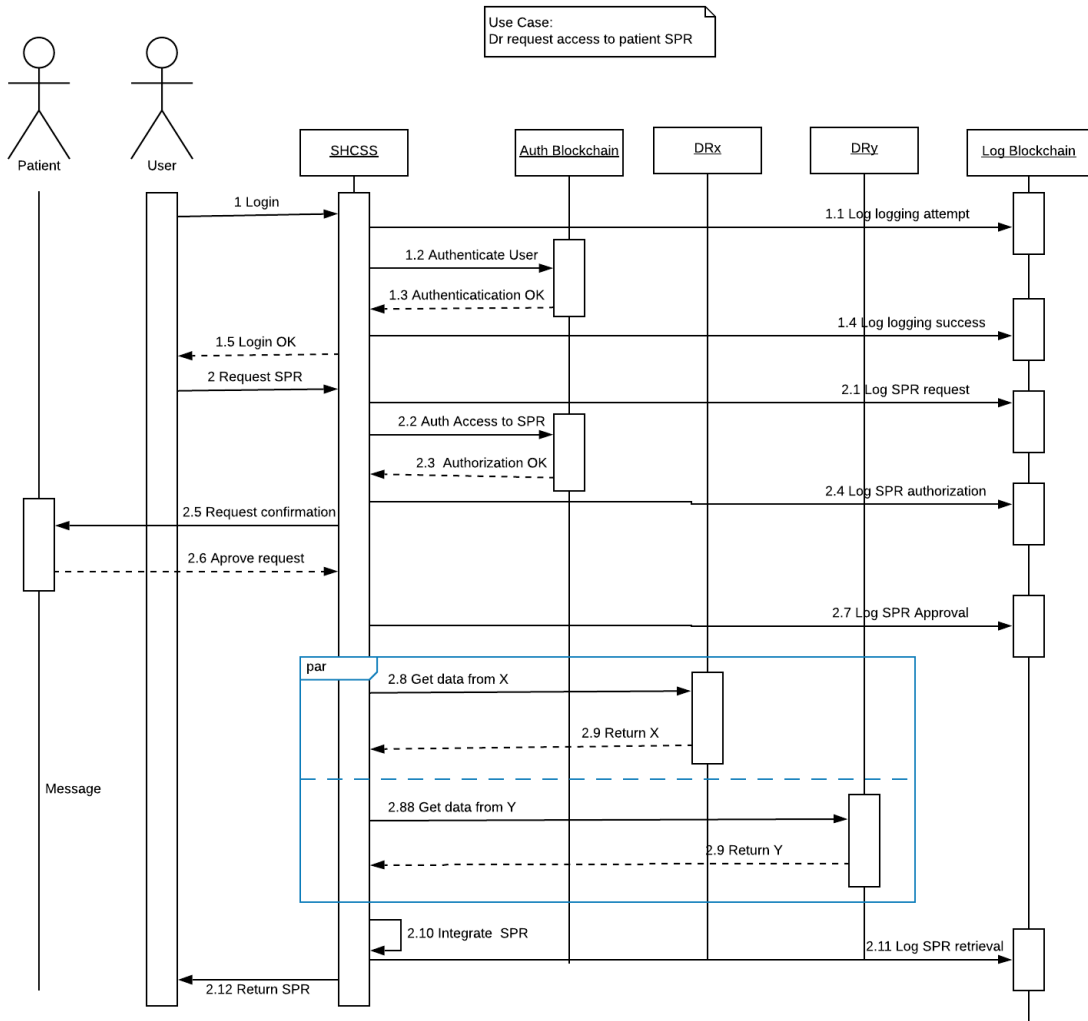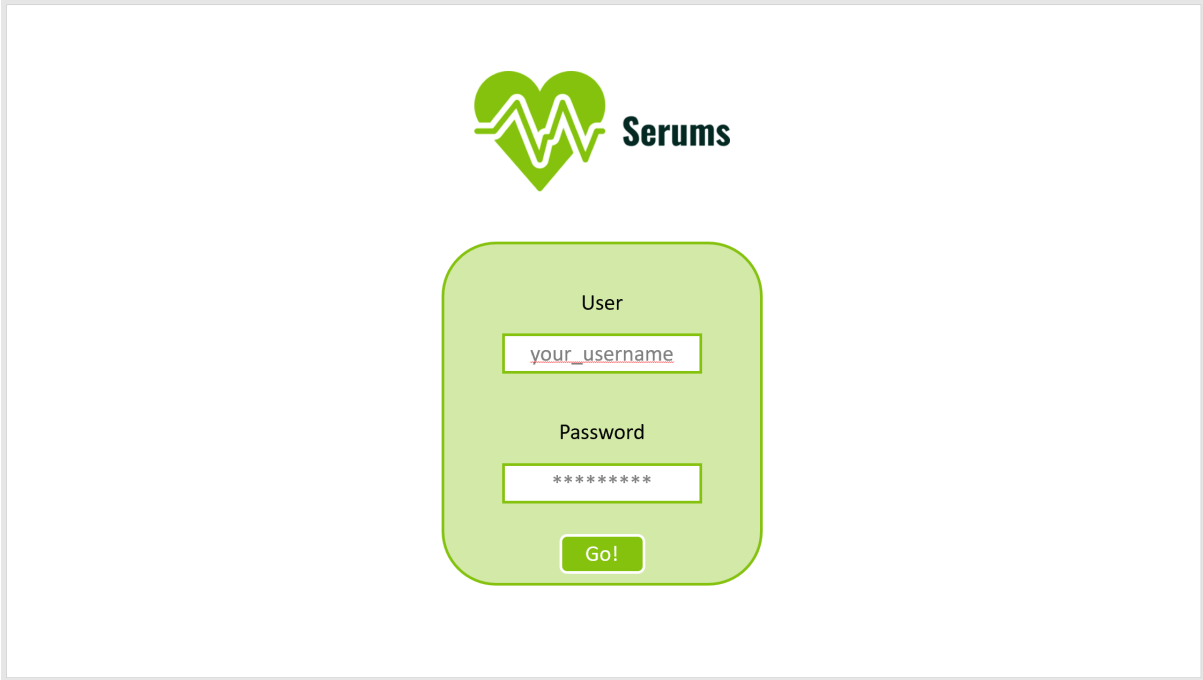
Figure 3 Accessing a patient record

2.3 Mock-ups

The following mock-ups illustrate the sequence of screens to be accessed along the process described in the sequence diagram shown in Figure 2.

Login screen

In this screen the user will be authenticated in order to get access to the main system. The user will have assigned a role such as doctor, insurance agent, etc. The credentials will be sent to the backend encrypted and checked against the Serums database.

Welcome screen

This is the welcome screen after the user has been successfully authenticated. From here, the user can search the record of some patient by username, user id, or name.

Welcome Forename Surname!!

Good bye!! 👋

Serums

Whose records do you want to retrieve???

(name / user id)

Some name or user id

Search...

Results screen

This screen will show a list of the entries matching the search parameter. If the search is done by user id, then only one result will be shown. From this list the user can choose the right patient to query. Once the user has chosen the person whose records will be accessed, a push notification will be sent to that person. He or she has to grant access to his/her data through a mobile application, and at the same time, the person can choose for how long and what data will be accessible through that particular request. After the access has been granted, the Serums system will display the data of the patient as shown in the following screen.

Patient's record screen

In this screen the history of the patient will be shown. On the left a summary of the patient's personal info will be displayed, including (but not limited to) full name, age, height, weight, and a photo if available. On the right side there will be a timeline showing the years and months in which new entries have been added to the patient's record. In this way doctors can find specific events easily.

In the main section of the screen, a summary of each even within the chosen month will be listed chronologically, enabling the access to the details of each event.

Event details

This screen shows the details of one event. In it, the problem is fully described, together with the treatment. If any drugs are prescribed, further details such as dosage and frequency are included.

Related events are listed in this screen, and resources such as images, or recordings can be accessed too. From this screen it is possible to go back to the month's event list, to add new events, and so on.

Welcome Forename Surname!!

Good bye!! 👋

Serums

This is Person 1's record

⊕ Add Entry

Person 1 Name

- Age: 31
- Gender: Female
- Nationality: Scottish
- Height: 1.70
- Weight: 65kg

Whose records do you want to retrieve???
(name / user id)

Some name or user id

Search...

When? **15 December 2019 – 10:23 H**
Where? National Hospital, Edinburgh, Scotland 🏴
Who? Dr Someone Something
What? GP visit due to skin irritation

Problem:
The patient visited the hospital with a rash on her knee, it was red and with small dots, as depicted in the picture 1

Resources

- picture 1

Treatment:
The patient was told to take put 100ml of cream on her skin.

Antecedents

- 2019/12/10
- 2019/12/01

Medication:
100ml – cream – every 8 hours – 2 weeks

X Close

2019

December
November
June
February

2018

December
November

2016

January

▽

New event screen

In this screen the user can add the details of a new event. Fields such as date, location, author, and so on, will be filled automatically based on the credentials of the user. The other fields will be open for the user to enter the corresponding details.

Welcome Forename Surname!!

Good bye!! 👋

Serums

This is Person 1's record

Person 1 Name

- Age: 31
- Gender: Female
- Nationality: Scottish
- Height: 1.70
- Weight: 65kg

Whose records do you want to retrieve???
(name / user id)

Some name or user id

Search…

When? (filled automatically) **17 December 2019 – 18:51 H**
Where? (filled automatically) National Hospital, burgh, Scotland
Who? (filled automatically) Dr Someone Something
What?

Problem:

Treatment:

Medication: (Dosage – Drug – Frequency – Period)

| – | – | – |

Resources
➕

Antecedents
➕

Save

2019
December
November
June
February

2018
December
November

2016
January

Conclusions

This document is the first deliverable of Work Package 6: "Integration and Testing" focusing on the front end of the Smart Health Centre System software. It shows a sequence of screens that will be visible to a user based on different possible actions performed. This deliverable reflects work in progress and will need further input from the owners of the three use cases (USTAN, FCRB and ZMC) to be as realistic and feasible as possible, and will thus be refined over the next couple of months. It will also be integrated with the work done on WP2 concerning the smart patient record and access permissions underlying the blockchain solution.

Deliverables D6.2 (due month 24) and D6.3 (due month 36) will describe more refined and advanced versions of the integration and testing of all the SERUMS technologies and their application for the development of the Serums Smart Health Centre System.

References

[1]   "The SERUMS tool-chain: Ensuring Security and Privacy of Medical Data in Smart Patient-Centric Healthcare Systems", Janjic, V., Küster Filipe Bowles, J., Vermeulen, A. F., Silvina, A., Belk, M., Fidas, C., Pitsillides, A., Kumar, M., Rossborry, M., Vinov, M., Given-Wilson, T., Legay, A., Blackledge, E., Arredouani, R., Stylianou, G. & Huang, W., 2019 IEEE International Conference on Big Data, 9-12 December 2019, Los Angeles, USA.