



D4.12

Libraries for remote and D2D HR exchange - V1

ABSTRACT

This deliverable describes a demonstration of the initial version of the libraries offered by the InteropEHRate Framework as a reference implementation of the device-to-device (D2D) and the remote-to-device (R2D) health record exchange protocols. It also outlines for these libraries their description regarding their current version and the used licences, as well as specific information regarding their development, followed by specific guidelines regarding the installation and the usage of these libraries, through a detailed guide.

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ACRONYMS

Acronym	Term and definition
D2D	Device-to-Device
R2D	Remote-to-Device
HCP	Healthcare Practitioner
HR	Health Record
S-EHR	Smart Electronic Health Record
FHIR	Fast Healthcare Interoperability Resources
SW	Software
IDE	Integrated Development Environment

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1. INTRODUCTION

1.1.Scope of the document

The main goal of this document is to deliver a demonstration of the initial version of the libraries offered by the InteropEHRate Framework as a reference implementation of the device-to-device (D2D) and the remote-to-device (R2D) health record exchange protocols. In more detail, the current document outlines for these libraries their description regarding their current version and the used licences, as well as specific information regarding their development (e.g. programming languages, supported platforms, etc). Moreover, this document includes specific guidelines regarding the installation and the usage of these libraries, through a detailed guide. It should be noted that this document is a SW accompany report, a pointer to the actual deliverable, regarding the design of the libraries for remote and D2D HR exchange [D4.4].

1.2.Intended audience

The current document is mainly intended for developers and manufacturers who are interested in designing and building either S-EHR applications or HCP applications, and desire to exploit and reuse either the D2D or the R2D or both these two functionalities offered by the InteropEHRate framework, in the context of their applications. Apart from that, the document is intended for researchers and developers as well, as they may be interested in installing and using the designed libraries.

1.3.Structure of the document

The current document is organized in the following Sections:

- Section 1 (current section) introduces the overall concept of the document, defining its scope, intended audience, and relation to the other project tasks and reports.
- Section 2 outlines the description of the software regarding the offered libraries, including details such as their licences, their programming languages, and their supported platforms.
- Section 3 describes for each library an installation guide, as well as a user guide.

1.4.Updates with respect to previous version (if any)

Since this document is the initial version of the demonstration of the libraries for the D2D and the R2D health record exchange, there does not exist any update with regards to previous related documents.

2. SW DESCRIPTION

2.1. D2D Libraries

2.1.1. S-EHR side D2D Library

SW TITLE	Mobile D2D HR Exchange (M-D2D-E)
SW VERSION	1.0
LICENCES AND PATENTS	Apache License
PROGRAMMING LANGUAGES	Java SE 8.0
SUPPORTED PLATFORM(s)	Android (5.0 - Current Version)
SOURCE CODE	http://iehrgitlab.ds.unipi.gr/interopehrate/s-ehr-mobile-app/d2d-hr-exchange
EXECUTABLE	N.A.

Table 1 – S-EHR side D2D library description

2.1.2. HCP side D2D Library

SW TITLE	Terminal D2D HR Exchange (T-D2D-E)
SW VERSION	1.0
LICENCES AND PATENTS	Apache License
PROGRAMMING LANGUAGES	Java SE 8.0
SUPPORTED PLATFORM(s)	Windows OS
SOURCE CODE	http://iehrgitlab.ds.unipi.gr/interopehrate/reference-hcp-app/terminal-d2d-hr-exchange
EXECUTABLE	N.A.

Table 2 – HCP side D2D library description

2.2. R2D Library

SW TITLE	Mobile R2D Exchange (M-R2D-E)
SW VERSION	1.0
LICENCES AND PATENTS	Apache License
PROGRAMMING LANGUAGES	Java SE 8.0
SUPPORTED PLATFORM(s)	Android (from API Level 14 – 15, named Ice Cream Sandwich)
SOURCE CODE	http://iehrgitlab.ds.unipi.gr/interopehrate/s-ehr-mobile-app/r2d-hr-exchange
EXECUTABLE	N.A.

Table 3 – R2D library description

3. OVERVIEW

3.1. D2D Libraries

3.1.1. S-EHR side D2D Library

The current release of the library (i.e. M-D2D-E), contains all the operations that are needed from the side of the S-EHR application developer to initially interact with the library and finally with the HCP application. This library contains different operations that have to be invoked in a specific sequence for implementing the purposes of the D2D protocol, regarding the S-EHR application. This library is a Java-based component that can be nested in any Android application. It offers a set of Java operations for establishing a D2D connection, and allowing a mobile app of a Citizen to exchange her personal health records using the D2D protocol. More details regarding these operations can be found in deliverable D4.4 [D4.4].

3.1.1.1. Installation guide

The installation guide of the D2D library inside the S-EHR app contains necessary information for the process that has to be followed in order to add the library to the S-EHR app Android project, and make sure that every component of the S-EHR app is able to use the library. This guide is used to install the version of the library released in December 2019, and may be no longer valid for more recent versions. The only requirement for this process is for the developer to have an Android project application running with the min-sdk version properties upper or equals to 15.

Installation steps of the S-EHR side D2D library:

1. Go to the gradle file of the project for using the libraries on all project, or in the module one for using libraries in a specific module. Add the following lines of code inside the repository section:

```
repositories {
    google()
    jcenter()
    maven {
        url 'http://213.249.46.206:8081/repository/maven-releases/'
        content {
            includeGroup 'eu.interoperhate'
        }
    }
}
```

By adding this code, someone adds to gradle a new repository to retrieve libraries, referring to the one created specifically for the InteropEHRate project.

2. After adding to gradle the repository, add the following code to the dependencies section:

```
implementation(group: 'eu.interoperhate', name: 'md2de', version: '0.0.1')
```

3. Refresh the gradle project.

3.1.1.2. User guide

This user guide is available for the version 1.0 of the S-EHR side D2D library. The main flow of the functionality of this library is the following:

1. Open the connection with the HCP application, using the Bluetooth MAC address of the HCP app running machine. In the case of the S-EHR app, this information is contained in a QR code provided by the HCP app. In more detail, the bluetooth connection is triggered with the HCP application using the operation `broadcastConnection` provided by the `BluetoothConnection` class. This will take in parameter the Bluetooth MAC address of the HCP app running machine, combined with two listeners. The first one is the `D2DHRExchangeListeners` and will be explained afterwards, while the second one is a Listener that is used to detect when the connection is closed.

```
public ConnectedThread broadcastConnection(String address,
D2DHRExchangeListeners listeners, D2DConnectionListeners listenersConnection)
```

This operation returns the thread that will contain the read process, and all the operations used to send information to the HCP app. In the S-EHR app, the communication with the D2D library is regrouped into a Service class, which is called `BluetoothService`.

Regarding the following user guide, it should be mentioned that the first Listener of the `broadcastConnection` operation is the `D2DHRExchangeListeners`. This listener regroups all the operations that will be used by the connection thread, when information from the HCP app is received.

```
public interface D2DHRExchangeListeners {
    void onHealthOrganizationIdentityReceived(Practitioner var1);
    void onConsentRequested(String var1);
    void onEvaluationDataReceived(Bundle var1);
}
```

2. Once the connection is accepted, identity information is being exchanged for:
 - a. **Sending information to the citizen from the S-EHR app:** Using the `sendPersonalIdentity` operation provided by the `ConnectedThread` class, the parameter of this operation is a Patient object from the FHIR library.
 - b. **Receiving information from the HCP app:** In order to receive the HCP identification information, this is done through the `D2DHRExchangeListeners`, that returns a Practitioner object from the FHIR library.
3. Once the involved parties are identified, the consent result is being provided. This is done using the `sendConsentAnswer` operations provided by the `ConnectedThread` class, taking as a parameter a String.
4. The next step includes the sending of Health Data, of the citizen by using the `sendPatientSummary` operation provided by the `ConnectedThread` class, taking as a parameter a Bundle object from the FHIR library.
5. The step of health data reception deals with receiving health data through the operation `onEvaluationDataReceived` of the `D2DHRExchangeListeners`.

3.1.2. HCP side D2D Library

The current release of the library contains all the operations that are needed from the side of the HCP application developer to interact with the library and finally with the S-EHR application. This library contains different operations that have to be invoked in a specific sequence for implementing the purposes of the D2D protocol, regarding the HCP application. This library is a Java based component that can be embedded in any Java based application. It offers a set of operations for establishing a D2D connection and enabling the application used by a HCP to send and receive data of a Citizen near her. More details regarding these operations can be found in deliverable D4.4 [D4.4].

3.1.2.1. Installation guide

The installation guide of the D2D library inside the HCP contains necessary information for the process that has to be followed in order to add the library to the HCP Java project and make sure that every component of the HCP is able to use the library. This guide is used to install the version of the library released in December 2019 and may be no longer valid for more recent versions. The only requirement for this process is for the developer to have git installed and a Java IDE to open the D2D project.

Installation steps of the HCP side D2D library:

1. Access the library's Java Project repository that is located on GitLab iEHR private repository and clone the Terminal D2D HR Exchange.
2. Change the branch of the project to the desired one that corresponds to the current version of the HCP app.
3. Open the cloned project using the Maven opener menu of the desired IDE.
4. Build the project by generating the jar file and ensure that is located in the Maven repository of libraries of the computer that the HCP App project will be located.
5. Include the necessary dependencies for the D2D library jar file inside the HCP App project.

A future plan of extensibility for the HCP side D2D library will include the conversion to an open source approach. In this case, the installation process would be different only regarding the way of cloning the project, since the location of the library would need to change if the open source approach would be taken.

3.1.2.2. User guide

This user guide is available for the version 1.0 of the HCP side D2D library. The flow that is being followed is described in **Section 3.1.1.2**, hence in the current user guide this flow is not being mentioned in deep detail again. Shortly, the main flow of the functionality of the D2D library inside the HCP app is the following:

1. Open the Bluetooth connection using the `open` operation.
2. Check the connection state each time that a change is performed inside the HCP app.
3. Exchange of information between the HCP app and the S-EHR app are performed using the operations `sendPractitioner` and `lastPatient`.
4. The Bluetooth connection is closed using the `close` operation.

Regarding the aforementioned operations, the functionality of the D2D library was embedded by the developers of the HCP App inside a class called `CurrentD2DConnection`. This class offers the following functionalities as public operations to the rest of the HCP app components:

- `open()` : Opens the Bluetooth connection.

- `close()` : Closes the Bluetooth connection.
- `connectionState()` : Returns the connection state (ON, OFF, or PENDING_DEVICE).
- `sendPractitioner (Practitioner p)` : Sends the information of the Practitioner to the S-EHR App.
- `lastPatient()` : Receives the last information from the current patient.

3.2. R2D Library

3.2.1. R2D Library

The subject of current release is the version 0.1.1 of the Android library implementing R2D. This library enables client apps to use R2D without specific knowledge of technical details of the R2D protocol. The library is compatible with Android environment, it has been developed using Java Technology and is released as an Android Archive format (.AAR extension). The file is named: `mr2de-0.1.1-release.aar`.

This version provides various operations for allowing a client app to download an instance of Patient Summary in FHIR format according to International Patient Summary specifications defined by HL7 [FHIR IPS].

3.2.1.1. Installation guide

The process to integrate the R2D library library is the same explained in **Section 3.1.1.1**, where the difference lies in the implementation line given to the second point, regarding the adding of the gradle to the repository. Hence, for the R2D library, the following line needs to be inserted in the gradle file:

```
implementation(group: 'eu.interoperhate', name: 'mr2de', version: '0.1.0')
```

3.2.1.2. User guide

All the features provided by the R2D library are provided by the class that implements the interface MR2D. In that case, the first step to use the R2D library is to use the `create` operation of the `MobileR2DFactory` class. This operation returns an object from a class, implementing the MR2D interface. The returned class depends on the country of the Patient FHIR object, which is passed as a parameter of the `create` operation. In more detail, the MR2D interface provides multiple operations:

- `getLastRecord`: Returns the last record of the patient based on the resource type given, and the response format.
- `getRecord`: Returns a FHIR Resource object based on the resource id and the response format passed as a parameter of the operation.
- `getAllRecords`: Returns a `HealthRecordBundle` object that can be used as an iterator to retrieve all the records of the patient.

All these operations execute input and output operations. Consequently, these operations should not be used in the main thread of the application as they will block the user interface.

REFERENCES

1. **[D4.4]** InteropEHRate Consortium, Design of libraries for remote and D2D HR exchange, 2019. www.interopehrate.eu/resources
2. **[FHIR IPS]** International Patient Summary Implementation Guide. Web site: <https://build.fhir.org/ig/HL7/fhir-ips/>