A Comparison of Data Traffic in Standardized Personal Health Monitoring Solutions

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ABSTRACT:
The publication of the HL7-FHIR standard offers new possibilities for integrated applications in healthcare. Although trial implementations have only recently started, the application of FHIR in context of a Personal Health Monitoring solution is worth investigating. Most of the existing telemonitoring solutions in healthcare rely on guidelines defined by the Continua Health Alliance (CHA). This paper compares CHA and HL7-FHIR in respect to data traffic between client devices and server side applications. Therefore an existing CHA-compliant solution is extended towards supporting HL7-FHIR. Both approaches were simultaneously evaluated in a live system with 68 participants. The results of the evaluation show that the FHIR approach offers the possibility of reducing data traffic in comparison to the CHA solution.

1 INTRODUCTION

Personal Health Monitoring (PHM) in connection with the „quantified-self“ movement has recently drawn a lot of attention towards a healthier lifestyle. This is a positive development considering that cardio vascular diseases in connection with high blood pressure are estimated to cause 7.5 million deaths every year [1, 2]. The Continua Health Alliance (CHA) offers guidelines for the development of a PHM solution by defining a vendor neutral architecture that relies on HL7v2 messages together with the Simple Object Access Protocol (SOAP) for exchanging measured data. This paper proposes an adaption of the interoperable CHA-compliant mobile telemonitoring solution already introduced in [3, 4] using HL7-FHIR, to offer a resource efficient handling of web service connections while still preserving the stipulated interoperability through the use of standards connected to HL7.

2 METHODS

The adaption of the CHA compliant approach includes extending the WAN-Interface located between an Aggregation Manager (AM) and a Telehealth Service Center (THCS) [5] to send measured data according to the HL7-FHIR specification [6]. This is achieved through a set of well-defined data structures, so called FHIR-Resources. These resources enable the development of interoperable web services in healthcare based on a RESTful architecture. As proposed in [6] and [7] the Observation and the DeviceObeservationReport defined by [6] where chosen to resemble the CHA approach. The architecture of the telemonitoring solution from [3, 4] was extended to add support for transferring both of the FHIR-Resources described above, along with the existing HL7v2 via SOAP implementation required for CHA conformance.

3 EVALUATION

To evaluate this approach a test under real conditions for the duration of 5 months was conducted. In sum 68 people participated in the test, with medical conditions ranging from high blood pressure, to pulmonary hypertension. Each of the participants was equipped with a weight scale and an Android-based smartphone with an app pre-installed that implements the architecture of the AM. The goal of the evaluation was to compare the amount of data transferred for each of the implemented transport mechanisms (HL7v2 via SOAP, FHIR Observation and FHIR DeviceObservationReport), based on real user behavior, thus answering the question, whether

the FHIR based approach helps to reduce data traffic in an environment with limited resources, compared to the HL7v2 via SOAP-based messaging implementation. Therefore the measurements sent from the smartphone (AM) to the server (THCS) were intercepted at the service endpoints located at the THCS. For each request and its subsequent response the payload size was determined. Furthermore the collected data was grouped by interface (HL7v2 via SOAP, FHIR Observation and FHIR DeviceObservationReport), date and device type.

4 RESULTS

For the data collected during the evaluation of the approach, the cumulative totals for each specific interface were calculated (figure 1). The results confirm the initial statement about the HL7v2 via SOAP approach responsible for the highest data traffic. Specifically the amount of data transferred in case of the HL7v2 via SOAP approach for the duration of 5 months is 3.2 times higher as the traffic resulting from the use of FHIR Observation resources and 2.6 times higher for FHIR DeviceObservationResources.

To get an insight on how the divergent user behavior affected the overall data recorded during the test period three different user categories were defined. Based on the monthly frequency of measurements available, each person was assigned to one of the defined categories. The rules for the three categories are given below with *x* being the average number of monthly weight measurements carried out by each person:

(1) Minimal-user: $\{x \in \mathbb{N} \mid 0 < x < 10\}$

(2) Frequent-user: $\{x \in \mathbb{N} \mid 10 \leq x < 20\}$

(3) Heavy-user: $\{x \in \mathbb{N} \mid x \geq 20\}$

Although the category for minimal-users consist of 82,3% of the overall users participated and is thus by far the largest category, it is only responsible for 43,9% of the overall recorded traffic, the rest being associated with the categories frequent- and heavy-user.

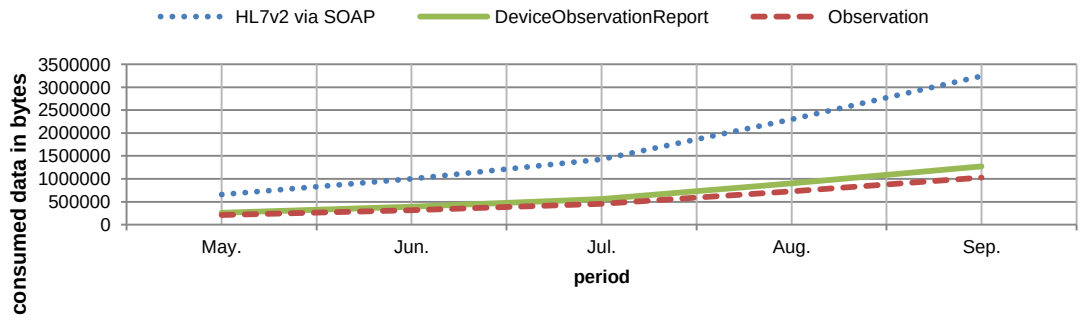

Figure 1. Cumulative total data recorded during test period.

5 CONCLUSION

The PHM introduced in [3, 4] and its extension presented in this paper, offers a lightweight alternative to existing CHA compliant solutions. Given the results of the evaluation, it can be concluded that there is a significant decrease in data traffic when relying on a RESTful architecture in combination with HL7-FHIR. Furthermore due to the decreased amount of data transferred it can be assumed that the battery life on a device with limited resources is increased, which would confirm findings of [8]. The presented solution allows for flexibility when developing applications in healthcare while still maintaining interoperability. Nevertheless security related concerns have not been taken into account. In order to answer the question whether the security mechanisms offered by HL7-FHIR can compete with the security requirements defined by CHA, additional research has to be carried out.

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