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Experience from the Development of HL7 FHIR IG for Gatekeeper Project

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Abstract. The GATEKEEPER (GK) Project was financed by the European Commission to develop a platform and marketplace to share and match ideas, technologies, user needs and processes to ensure a healthier independent life for the aging population connecting all the actors involved in the care circle. In this paper, the GK platform architecture is presented focusing on the role of HL7 FHIR to provide a shared logical data model to be explored in heterogeneous daily living environments. GK pilots are used to illustrate the impact of the approach, benefit value, and scalability, suggesting ways to further accelerate progress.

Keywords. HL7 FHIR, SNOMED, LOINC, AI models, living environments, interoperability standards, health and wellness

1. Introduction

Population aging is linked with increased healthcare costs, it is thus fundamental to develop strategies to promote wellness and prevent diseases following a multidisciplinary team approach, supported by advances in science and technology [1]. Although in literature many solutions are presented, a large proportion of them is not adopted in clinical practice and relevant innovation never reaches the population at large [2,3]. For this reason, in 2012 the European Commission (EC) launched initiatives to drive the adoption of innovations towards improvement of healthcare systems and outcomes [4,5]. The result is the Communication on Digital Transformation of Health and Care in the Digital Single Market, which identified as priorities: Citizens' secure access to health data, personalised and precision medicine through shared European data infrastructure, Citizen empowerment with digital tools for user feedback and person-

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centred care [6]. The GATEKEEPER (GK) Project has been funded to develop an open, trust-based platform to connect all the actors involved in the care circle of elderly citizens and to share and match ideas, technologies, user needs and processes with the final aim to ensure a healthier independent life for the aging population. The execution of independent pilots in 8 regions of 7 European countries demonstrates the effect, benefit value, and scalability of this platform in 9 connected medical use cases.

The scope of this paper is to report the GK experience in the development of a HL7 FHIR (Health Level Seven Fast Healthcare Interoperability Resource) IG (Implementation Guide) and in its adoption in pilots supporting 6 use cases.

2. Methods

GK Project intends to create a platform where the patient data collected during the pilots and recorded by heterogeneous data sources in proprietary format are harmonized to be processed by inductive and deductive artificial intelligence (AI) models to allow early prevention and intervention. FHIR, combined with SNOMED and HeLiFit Ontologies, LOINC Vocabulary, was chosen as common reference data model.

2.1. The GK platform architecture

The data sources through the core platform components (Figure 1), store in the GK DATA FEDERATION (GDF) Server data in HL7 FHIR to be used by the AI services and applications. All applications are managed and available through the GK Developer Portal and Marketplace directly connected with the WoT (Web of Things) THING MANAGEMENT SYSTEM to map the resources in the GDF Server. Every pilot is independent: is on its own cloud infrastructure and premises and can choose what devices to use. The pilot can also decide to fill the GDF Server either directly with HL7 FHIR resources or interacting with the GDF Integration Engine.

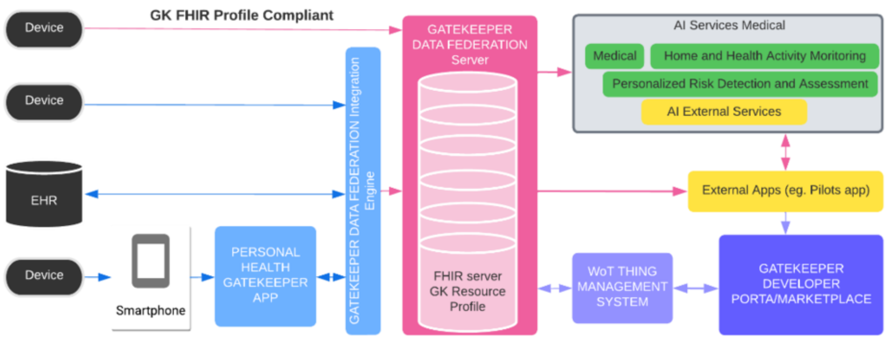

Figure 1. The architecture of GK platform. The arrow color corresponds to the data exchange format: blue arrows for proprietary format, pink arrows for HL7 FHIR resources and violet arrows for WoT.

2.2. The GK Reference Use Cases (RUC)

Among the 9 medical use cases, the 6 considered by the authors are: Lifestyle-related early detection and interventions (RUC1), COPD exacerbations management (RUC2), Diabetes, predictive modelling of glycaemic status (RUC3), Predicting readmissions and decompensations in Heart Failure (RUC5), Primary and secondary stroke prevention (RUC6), Multi-chronic elderly patient management including polymedication (RUC7).

3. Results

3.1. The GK FHIR IG

After a deep analysis of all data that must be managed by the AI services the IG was implemented. It defines more than 40 FHIR profiles, covering different aspects (e.g. appointment, device measurements, self-assessments, questionnaires, scheduled services, conditions, etc.), in which, LOINC and SNOMED codes were adopted where possible. To manage any concepts not present in the selected standard terminologies, 2 specific code systems were defined. The profiles were adopted to model the data collected in the pilots with a common logical representation.

3.2. Aragón (224 patients) and Basque Country (1000 patients) Pilots (Spain)

For these RUC1 pilots, a citizen app and a clinician dashboard were implemented and integrated with the GK platform. The app is directly connected with the GDF Server and allows to monitor the physical activity recorded by the smartwatch, to test the health status through questionnaires. The app provides information on events which are organized nearby and offers resources to educate the users to all app functionalities. The app usability was evaluated through the mHealth App Usability Questionnaire (MAUQ) for Standalone mHealth Apps Used by Patients. The clinician dashboard allows to monitor the physical activity and the health status of patients and to manage the activities proposed by the app.

3.3. Puglia Pilots (Italy)

In these pilots a GK App interacts with the Samsung Health App and daily communicates with the GDF Integration Engine to send data automatically collected by the Samsung smartwatch or by the smartphone sensors, or manually entered by the user. In the first pilot (RUC 1, 300 patients) the daily number of steps and the nutritional diary are recorded. In the second pilot (RUC 3, 100 patients) in addition to the data collected by the smartwatch (number of steps, distance, walking time, type of activity, burned calories, sleep duration and characteristics, heart rate, and heart rate variability), the values contained within laboratory tests stored within the EHR are collected. These values are sent to GDF Server through the GDF Integration Engine, to predict Glycated Haemoglobin value through AI-based techniques. In the third pilot (RUC2, RUC3, RUC5, RUC6, RUC7, estimated 500 patients) depending on each disease, specific devices were selected from the ones provided by the GK Partners. The data sent to GDF Server through the GDF Integration Engine can be observations of heart rate, stress, blood pressure, glycaemia, body weight, respiratory rate, body temperature and Oxygen saturation (SpO2). Data collected are used by specific AI services to monitor and predict the health status of patients in two clinical use cases.

4. Discussion and Conclusions

In heterogeneous environments, where every device producer adopts a proprietary format optimized for its specific technical requirements, the adoption of HL7 FHIR can enable data sharing allowing an effective comparison essential to AI processing.

In GK, HL7 FHIR is used both as input and output format for the AI models so that the results of the AI processing can be used by both internal and external applications and services. Thus, the role of HL7 FHIR was to take concrete steps toward an open vendor independent GK platform that can instrument the cultural shift needed for any solution and device available on the market to easily harmonize and re-use data in safe and trustworthy manner.

Thanks to the GK Project, this activity was performed at European level, but the target must be extended at global level. Engaging stakeholders worldwide, the GK FHIR IG was well received by the global HL7 community exploring alignment with activities in the HL7 Mobile Health Working Group (WG). At the U.S. level, the Physical Activity Alliance (PAA) sponsored a 2022 initiative to create an HL7 FHIR IG whose physical activity monitoring profiles are well aligned to those of the GK FHIR IG. The intent is to contribute to this initiative with the GK experience, and perhaps pave the way towards a truly global physical activity monitoring HL7 FHIR IG. With the effective collaboration with SNOMED, the International Patient Summary (IPS) Terminology [7] was extended with some concepts, increasing the number of SNOMED concepts free to use. GK has also been requesting a LOINC extension of missing coded concepts.

These initiatives demonstrate how HL7 FHIR can serve as infrastructure of innovation, as FHIR resources mature through shared use, alignment, and adoption across the industry.

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References

[1] Nolte E, Knai C, Saltman R. Assessing chronic disease management in European health systems. Concepts and approaches. 2014;

[2] Gazzarata R, Vergari F, Cinotti TS, Giacomini M. A standardized SOA for clinical data interchange in a cardiac telemonitoring environment. IEEE J Biomed Health Inform. 2014;18(6):1764–74.

[3] Bates DW, Landman A, Levine DM. Health apps and health policy: what is needed? JAMA. 2018;320(19):1975–6.

[4] European Innovation Partnership on Active and Healthy Ageing (EIPonAHA) [Internet]. Available from: https://ec.europa.eu/eip/ageing/home_en

[5] European Institute of Technology for Health (EIT-Health) [Internet]. Available from: https://www.eithealth.eu/

[6] Communication on enabling the digital transformation of health and care in the Digital Single Market; empowering citizens and building a healthier society [Internet]. Available from: https://digital-strategy.ec.europa.eu/en/library/communication-enabling-digital-transformation-health-and-care-digital-single-market-empowering

[7] International Patient Summary (IPS) Terminology [Internet]. Available from: https://www.snomed.org/snomed-ct/Other-SNOMED-products/international-patient-summary-terminology