A Novel Software Development Kit (SDK) to Foster Adoption of Health Informatics Standards in Personal Health Device (PHD) Communications

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Abstract. As health care becomes distributed and wireless (home monitoring, M-Health, AmI), system interoperability becomes a challenge. The solution seems to be to use international health informatics standards. Among these, ISO/IEEE 11073 (X73PHD) is the best suited for interoperability of Personal Health Devices (PHDs). Nevertheless, given that low cost, wearable PHDs have limited hardware resources, it is required a deep control to adapt a base source code and generate a fully highly-optimized X73PHD-compliant device.

This article presents a novel Software Development Kit (SDK) that generates X73PHD source code for fully-optimized, X73PHD-compliant agents. The developer defines the objects of the Domain Information Model (DIM), its attributes, and the Finite State Machine (FSM) in the initial modeling phase. After that, the SDK automatically generates an optimized source code in additional phases: model checking, construction, transformation, optimization, and generation. Finally, during the integration phase, the developer manually incorporates the generated source code in its implementation. Given that the SDK follows the Patterns-based Methodology previously presented by the authors, the results are highly optimized in terms of processor usage (latency) and memory requirements (footprint). If the SDK was used by developers, it could accelerate the adoption of X73PHD.

Keywords: Ambient Intelligence (AmI), Health Informatics, Home monitoring, ISO/IEEE 11073 (X73), low cost wearable agents, Low-Voltage Low-Power (LV-LP), Patterns-based Methodology, Personal Health (P-Health), Personal Health Device (PHD), Point-of-Care (POC), Software Development Kit (SDK), standardization.

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1 Introduction

The decentralization of the Point-of-Care (PoC) promoted by the deployment of incipient Information Technologies (IT) is becoming a reality [1–3]. Its evolution to new balanced, user-centered designs could raise the efficiency of health care resources (human, mobiliary, medication, knowledge/learning, etc.) to deliver better quality to a broader number of subjects [4]. In the Ambient Intelligence (AmI) paradigm, smart sensors around the patient gather information continuously. The resulting data can be used in many different ways by the patient, familiars, or specialists [1, 5].

An open issue in this paradigm is the lack of interoperability between heterogeneous systems. In order to overcome this situation several standards such as DICOM, MFER, FEF, EN13606, SPC-ECG and HL7 have been proposed. For Personal Health (P-Health), the best approach seems to be ISO/IEEE11073 for Personal Health Device (PHD) (X73PHD) [6]. This standard is an evolution of the classic ISO/IEEE11073 for PoC (X73PoC) focused in Intensive Unit Care (ICU) scenarios [7–10]. In this way, this new light-weight version simplifies the classic Domain Information Model (DIM) and Finite State Machine (FSM) of X73PoC, and incorporates new communication technologies: Universal Serial Bus (USB), Bluetooth and ZigBee [11]. During its development, X73PHD has gathered positive results [12]. Therefore, Continua Health Alliance, the leader private sector alliance that promotes the use of interoperability standards, adopts X73PHD for communications between PHDs of its interoperable ecosystem [13]. Nevertheless, this ecosystem has not fulfilled its expansion prospects. Several factors could be influencing. First, although its specifications have been simplified enormously, learning its details is still a time-consuming activity. Moreover, the optimization of the resulting implementation requires even further work and supplementary know-how. Furthermore, implementing a fully X73PHD-compliant device and passing conformance tests requires additional time.

The authors presented the Patterns-based Methodology previously in [14, 15]. This methodology could allow implementing X73PHD-compatible agents using limited-resource microcontrollers (processor and memory) [16]. The methodology is based on two main points. First, the particularization of the implementation to a specific agent, and hence, a specific DIM configuration. Second, Application Protocol Data Units (APDUs) can be processed very efficiently using specialized analysis and synthesis algorithms based on decision trees (APDU-patterns). Nevertheless, this methodology is still difficult to implement [15]. This leads the authors to propose a novel Software Development Kit (SDK) to facilitate the whole process.

The novel proof-of-concept SDK presented in this work generates X73PHD source code following Patterns-based Methodology. The particularization of the Patterns-based Methodology principles to the SDK are explained in Section 2. Then, the SDK's 7-phase model is explained in Section 3. A discussion about the SDK is given in Section 4. Finally, the conclusions are drawn in Section 5.