IEEE 11073 SDC and HL7 FHIR – Emerging Standards for Interoperability of Medical Systems

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I. Purpose

Manufacturer-independent interoperability is fundamental to meet the challenges of clinical environments, which consist of an increasing number of medical devices (MD) and clinical information systems (CIS). Communication paradigms and protocols have been developed to address their specific needs and are currently being standardised. For digital operating rooms (ORs) and intensive care units (ICUs), the most important current evolutions are IEEE 11073 SDC and HL7 FHIR. Although these emerging standards have different core objectives, they partly overlap in functionality – particularly concerning the accessibility of measurements and parameters of medical devices (Fig. 1). This overlap motivates the analysis of the differences between the two standards that is given in this article. Resulting from a comparative classification of the advantages based on different common component interaction scenarios, it provides suggestions as to which standard should be used for which purpose.

II. Methods

The established IEEE 11073 family of standards aims for manufacturer-independent interoperability of medical devices. Its original series on Point-of-Care Medical Devices (PoCD) focused on single point-to-point communication. As the transport mechanisms are not suitable for multi-point connections, the IEEE 11073 Service-oriented Device Connectivity (SDC) sub-family has since been developed. It is based on contemporary web service technologies and an extended domain information model [1]. SDC targets the interoperability gap in device-to-device communication and does not aim to compete with or replace standards like HL7 or DICOM, which have different foci, but rather to interact with them meaningfully at system boundaries.

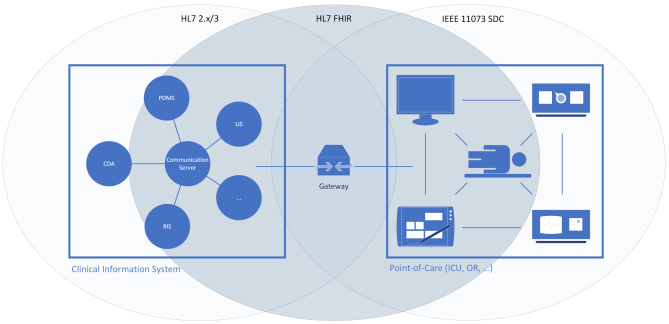

Fig. 1: Schematic representation of the intended fields of application of IEEE 11073 SDC, HL7 FHIR, and HL7 v2

HL7 Fast Healthcare Interoperability Resources (FHIR) [2] is a new draft standard for the exchange of healthcare information. Based on modern design patterns like RESTful communication and the concept of *Resources*, FHIR covers a broad range of clinical use cases by providing modular building blocks that can be combined without jeopardising information integrity. The built-in methods for extending a Resource allow FHIR to provide flexibility and adaptability in the clinical environment. Due to the support of multiple communication paradigms, FHIR can cover various interactions that are insufficiently supported in other HL7 standards, for example medical device communication. Thereby FHIR helps to bring together domains that were previously separated.

Both emerging integration technologies differ in their networking approach. The service-oriented medical device architecture (SOMDA) of SDC [1] implements a SOAP-based communication with service discovery and peer-to-peer messaging. In contrast to SDC, FHIR supports multiple communication paradigms, especially RESTful environments. Usually, one or multiple repository server components, which distribute and may persist Resources, structure the integration architecture.

The suitability of the integration technologies highly depends on the addressed technical use case and needs to be

TABLE I: Comparison of properties and features of IEEE 11073 SDC and HL7 FHIR

	IEEE 11073 SDC	**HL7 FHIR**
Web service realisation	SOAP	(typically) RESTful
Communication topology	end-to-end	(typically) centralised repositories
Dynamic discovery	WS-Discovery	not intended
Synchronous communication	request-response	request-response
Asynchronous notifications	WS-Eventing	yes
Semantic annotations	coded values	coded values
Remote control	built-in	not intended
Safety mechanisms	Medical DPWS: SafetyContext, DualChannel	not applicable
Data compression	optional (EXI)	optional (gzip for RESTful)
Data streaming	Medical DPWS: Streaming	not intended
PHR management	not intended	built-in
Data traceability	optional (distributed)	built-in (repository-based)

assessed with regard to the targeted application.

III. Results

In an integrated clinical environment, communication takes place between multiple MDs, multiple CISs, and between both MDs and CISs. Herein, the suitability of FHIR and SDC is discussed for these three interaction scenarios. Table I provides an overview.

Regarding **MD-to-MD communication** in dynamically changing environments, such as ORs or ICUs, the discovery of devices and provided services is crucial. SDC therefore uses the well-known WS-Discovery functionalities provided by the underlying communication standard Devices Profile for Web Services (DPWS). Whereas both SDC and FHIR provide suitable mechanisms for a machine-interpretable exchange of medical data including alerts and notifications, remote control functionality is currently out of scope for FHIR. One conceptual reason is the typically repository-based communication architecture. SDC, in contrast, explicitly defines mechanisms for safe remote control, enabling both a safe flexibility in a multi-manufacturer environment and an effective risk management of the controlled MDs.

Regarding **CIS-to-CIS communication**, where complex information systems exchange data over various message-based interfaces, the environment is rather static. Therein, an extensive amount of personal health records (PHR) must be managed efficiently. SDC is not designed to store or manage PHRs. In contrast, FHIR's repository approach offers a suitable solution to govern and transfer large amounts of PHR data. The functionality of referencing Resources in other repositories reduces both the quantity and the payload of the messages compared to HL7 version 2. Furthermore, the built-in history feature allows for each change to be tracked and thereby to fulfil the requirements of data persistence and traceability.

The **communication between MDs and CISs** used to be intrinsically complicated as most devices, especially if resource-constrained, would not implement an HL7 v2 stack in addition to the IEEE 11073 communication. It was therefore necessary to transform e. g. patient demographics and order data from a CIS before it could be transferred to an MD. In the same way, device observations needed to be transformed before they would be useful for a CIS [3]. Due to the fundamentally different data structures, a loss of detail and/or contextual information could easily occur.

With the introduction of FHIR, however, the complexity of mediating between both worlds decreased significantly. The mutual influence FHIR and SDC had on one another during development as well as the flexibility that is inherent to both standards allow for consistent expression of information in SDC *and* FHIR [4]. Therefore, devices can use FHIR for communication with a CIS just as well as a CIS component can fetch data from devices via SDC.

IV. Conclusion

HL7 FHIR and IEEE 11073 SDC both have their respective areas of excellence. For each use case, it should therefore carefully be evaluated which standard is to be applied. In addition, the interoperability between both data structures will enable seamless data flow between the medical device domain and clinical IT systems. In order to leverage the full benefit of this interoperability, we intend to extend existing mappings into an *implementation guide* that allows for fully automatic conversion of a device containment tree into a set of Resources.

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