

Agent-based HL7 Interface for Self-Organizing Software Platform'

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Abstract. At present, we almost transmit information by using Infrastructure-based networks. However, it takes much time and money to construct the infrastructures. One of the solutions for solving this problem is Self-Organization Systems. In Self-Organizing System, entities interact with other entities or with the environment for providing services.

SOSp(Self-Organizing Software Platform) needs service functions like service registration/search/update/remove for managing services in its Router. An autonomous behaviors for services should be supported, because Self-Organizing means that service is running by itself, that is, doing jobs autonomously to achieve its goals. And transferring health data to Healthcare Information Systems is required to cooperate with other healthcare providers. The middle ware managing and registering many entities and services is required in Self-Organizing System. For a service of medical domain, clinical data messaging need to comply with related standards in other to ensure interoperability of clinical data exchange across other medical institutes. So, we propose that multi-agent platform is an appropriate choice as SOSp Router's middleware as providing a service management, service autonomy, and communication method between services. And also, it uses a HL7 standard(V2.x message) to send health data to healthcare providers, so it ensures interoperability with diverse Healthcare Information Systems like EMR(Electronic Medical Record), EHRs(Electronic Health Record System), PHRs(Personal Health Record System) etc.

Keywords : HL7, interoperability , Self-organization, Multi-Agent Systems, JADE

1 Introduction

In a distributed healthcare service environment, the need of clinical data exchange among medical institutions is growing. In the current healthcare scenario, patients visit multiple hospitals and various events happen in each medical organization. This

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information is stored in other systems fragmentarily. Healthcare providers have to know all fragmented information to make a correct diagnose. The progress of IT technologies in recent years provides high speed data transmission. Evolving the wireless network technologies, healthcare service providers could send and receive clinical data anytime using mobile device such as Smart phones and tablet PC [1].

At present, we almost transmit information by using Infrastructure-based wireless networks. Mobile entities communicate wirelessly to the base stations connected to a wired backbone network. In this network, we can't communicate other entities not to set up the infrastructures. It also takes much time and money to construct the infrastructure. To solve in this problem, new networks will be able to communicate using temporal communication infrastructure with minimal configuration among entities. One of the solutions is Self-Organizing System. In Self-Organizing System, entities interact with other entities or with the environment to provide services. The Characteristics of the System follows. First, there is not central control. Each subsystem must perform autonomous. Second, it is a high scalability. If more sub systems are added to the system, there is no performance degradation [2]. We need to study this system to solve the problem of current network.

Nevertheless, we need to consolidate the patient information across the numerous systems in a health organization for clinical data exchange. Each clinical data stored in systems have different format and is stored using local terms. In this situation, clinical data exchange across medical institutes is meaningless [3]. To solve the problem, we have to comply with the related standards. Health Level 7 is ANSI-accredited standards developing organization dedicated to providing a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information. HL7 Message and CDA(Clinical Document Architecture) — Release 2 are ISO standards [4]. Accordingly, we are required to comply with HL7 standards for interoperability of clinical data exchange.

Kyungpook National University is carrying out Self-Organizing Software Platform project. This project's goal is the development of software platform for self-organizing function implementation between well-being information devices. In this study, we developed the interface transmitting HL7 Version 2.5 Message in project for interoperability of clinical data exchange.

2 Method

SOS(Self-Organization Software) Client communicate with SOS Router for requesting a service. SOS Router recognizing the location and status of SOS Client searches for SOS Service and requests the service. SOS Service offers the service the service SOS Client want (Fig. 1).

SOS Router of SOS Platform needs a middleware to manage SOS Clients around itself and interact with SOS Service. Furthermore, standardized messaging in clinical data transmitted from SOS Client is required for interoperability of clinical data exchange. JADE(Java Agent DEvelopment Framework) is a frameworks that programmers can implement software agents without having to study the related standards specifications in great detail. We implemented a middleware using JADE framework

for managing SOS Clients and SOS Services. We also implemented HL7 Interface for messaging HL7 Message including clinical data transmitted from SOS Client.

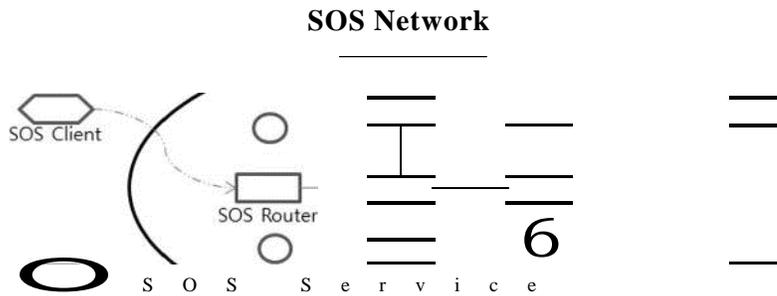


Fig. 1. The architecture of SOS Platform

2.1 JADE(Java Agent DEvelopment Framework)

JADE(Java Agent DEvelopment Framework) is framework to develop multi-agent systems in compliance with the FIPA(the Foundation for Intelligent Physical Agents) specification [5]. FIPA specifications represent a collection of standards which are intended to promote the interoperation of heterogeneous agents and the services [6].

JADE have a Container that is each running instance of the JADE runtime environment (Fig. 2). It can contain several agents. And the set of active containers is called a Platform. A single special must always be active in a platform. In Platform, first container must be a main container while all other containers must be normal containers. A main container has two special agents that automatically started. AMS(Agent Management System), one of the two special agents, provide naming service that ensures that each agent in the platform has a unique name) and represent the authority in the platform. And DF(Directory Facilitator) provides a Yellow Pages service by means of which an agent can find agents providing the service [5].

In this study, we implemented a middleware of SOS Router using JADE. We registered a SOS Service agent in middleware of SOS Router. SOS Client transmits clinical data recoded by well-being devices to SOS Router, and HL7 Interface of SOS Router converts clinical data into HL7 Message and transmits to SOS Service agent. SOS Service agent parses HL7 Message and SOS Service provides service for SOS Client.

2.2 HL7 Interface

HL7 Interface is an agent that converts clinical data from SOS Client into HL7 Version 2.5 Message. A HL7 Message is a collection of segments and each segment consists of fields. A field is consists of components that contains subcomponent group. Field and Component, subcomponents use data types that HL7 defines.

We use ORU RO1 Message for transmitting clinical data. ORU RO1 Message is a message for transmitting observation record and includes 4 required segments (MSH, PID, OBR, OBX). MSH segment is information of message, PID segment is infor-

mation of Patient OBR segment is information of order and OBX segment is information of observation results [7].

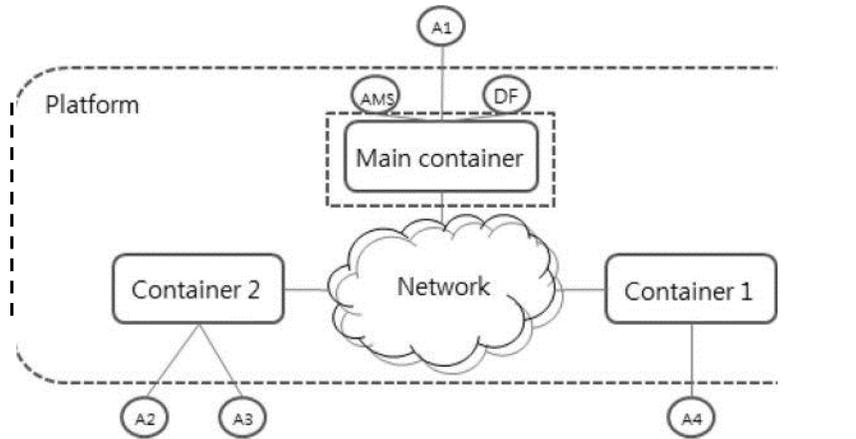


Fig. 2. The structure of JADE framework

In this study, we used HAPI library to process HL7 Message. HAPI provides API for creating and/or parsing the HL7 version 2.5 Message. Thus, we created and parsed ORU RO1 Message and ACK A01 that is acknowledgement message using HAPI.

3 Result

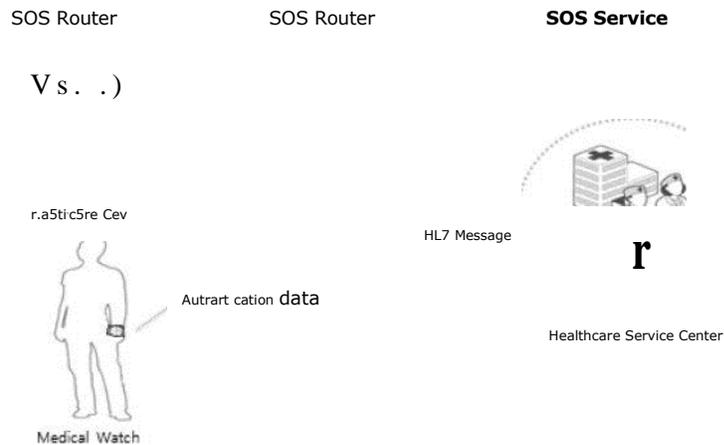


Fig. 3. The Overview of SOS platform project

A person measures his bio-signal and the clinical data is authenticated as his data by his medical watch in SOSp project. SOS Router generates HL7 Message including the clinical data and sends Healthcare Service center able to HL7 Message (Fig. 3).

In this study, we implement a middleware of SOS Platform using JADE framework (Fig. 4). SOS Client transmits recoded clinical data to HL7 Interface of SOS

Router. HL7 Interface creates HL7 Version 2.5 Message containing the clinical data and transmits HL7 Message to the agent of SOS Service that offers a service SOS Client requires. SOS Service uses the information parsed by HL7 agent and provides a service.

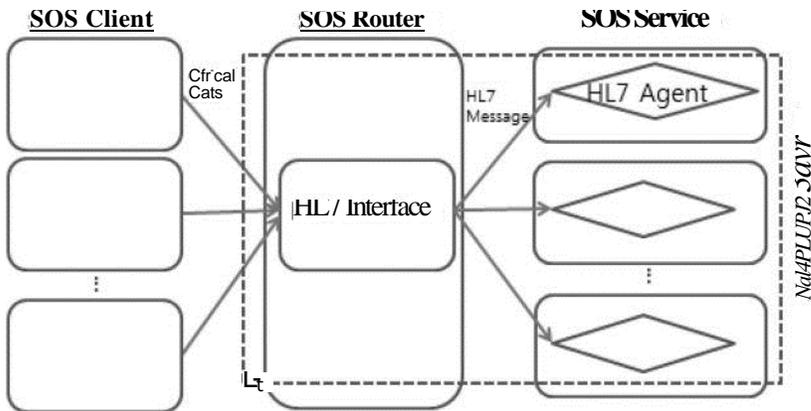


Fig. 4. The structure of SOS platform using JADE framework

JADE provides JADE management GUI (Fig. 5). DF agent providing the Yellow pages service is active when the main container is launched. JADE framework offers API for registration to DF agent. So, we registered the service easily as we had implemented the middleware in JADE framework. From now on, various Service will be registered in SOS platform. If JADE framework is used for implementation of middleware, we can register and manage the services easily. Accordingly, SOS platform will have high scalability.

rma0155.230.210.240:1094/JADE - JADE Remote Agent Management GUI 2

File Actions Tools Remote Platforms Help

"C⁴ 11 n ig E", 03 E di a5l CE El 11 1211m 114 4:11:1:1 Idaij

name	addresses	state	owner
SOS Service a..		active	NONE

? in AgentPlatforms
 9 In "155.230.210.240:1099/JADE"
 9 Main-Container

HI SOS Service agent@155230

g ams@1 55230.210240.1099/
 93 df@155.230.210.240:1099/JA
 2 rma@155.230210.240:1099/J

Fig. 5. The JADE management GUI of JADE framework

There is a sample of HL7 Version 2.5 Message that HL7 Interface transmitted to HL7 agent of SOS Service (Fig. 6). It contains Diastolic blood pressure data of the person whose Id is SEC003. SOS Interface of the SOS Router created and transmitted HL7 Message that includes clinical data transmitted by SOS Client. We implemented ORU RO1 message of HL7 Version 2.5 Message and transmitted a message to an

agent that processes HL7 Message. So, SOS platform ensures interoperability of clinical data exchange. Now, a lot of medical institutes can't process the HL7 standards. The medical institutes have to modify legacy system. Most medical institutes don't want to do. If they use the HL7 Interface, we will be able to exchange clinical data by modifying less part of legacy system.

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MSH|^~\&HL7 Interface|HL7 Agent|1201205111017110RUAR01^0RU_R0111111P12.511INEIAL
PID|SEC003^^^SOS Platform|A^P11AARAAAU
OBX|1111111^1-1L7 Agent|34566-0^Vital signs panel|ALN|I201205111100
OBR|11NM|I8462-4^Diastolic blood pressure|ALN|I90Imm(hg)|I11IR
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Fig. 6. This sample message contains Diastolic blood pressure data of the person whose Id is SEC003. Cooperating with health device, SOS Client (Medical Watch) sends a clinical data. This sample based on it was generated by HL7 Interface of SOS Router.

However, we didn't consider the physical environment in SOSp. Accordingly, we have to anticipate the problem which may happen in the physical environment and take the measures to solve the problem. We also considered only two clinical data, glucose and blood pressure. We will develop SOSp to process more various clinical data for various services.

4 Conclusion

JADE is a framework to develop the multi-agent system. JADE is able to communicate between agents and to offer and receive the service that an agent wants. So, JADE is adequate to apply to middleware of SOS platform. HL7 Interface implemented as an agent was able to process HL7 Message including clinical data. As a result of, SOSp ensures the interoperability of clinical data exchange. If the medical institutes not to process HL7 Message use the HL7 Interface, they will be able to process the HL7 Message without large modification of their legacy systems.

Self-Organizing System is different than the current networks. So, we think that we need to study it in medical domain. Implementing the HL7 Interface as an agent is many advantage and it is worth studying about that.

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