

# Web Services in the health care industry of China

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## Abstract

Data exchange is a key concern in health care industry in China. How to integrate separate heterogeneous Hospital Information Systems (HISs) and how to achieve a true interoperability in different software platforms? These are major problems in reality and also the topics we want to research. Web service is a technology, which makes it easy to reuse components of information systems based on web. It makes it possible to integrate heterogeneous systems. In this paper, we will discuss some of the problems existing in the health care industry in China. Also, we will describe a universal HIS platform based on web service tackling these problems.

**Keywords:** Web Service, HIS, DWS, Agent, HL7

## 1. Introduction

At present, almost all industries are informationising step by step, and so is the health care industry. In China, health care is rapidly improving. Statistic data of the number of health care institutions by the Ministry of health People's Republic of China is shown in Table 1.<sup>[1]</sup>

In Table 1, in 2003, the number of the hospitals increased by more than 30 times than that in 1950. More and more hospitals are developing their own Hospital Information System (HIS). Many hospitals begin to research and try to use Picture Archive and Communication System (PACS) and Electronic Patient Records (EPR) in their HISs. The HIS is becoming increasingly bigger and more complicated. It is common in a big hospital to find that several different HISs are used by different sections. When data is exchanged between HISs in one hospital or among different hospitals, due to the absence of health care information standard, it makes difficult to communicate within hospitals internally and between different hospitals. Thus, how to integrate heterogeneous information systems in a flexible

way, and how to use data resource in various HISs effectively is a big challenge. The reason to build HIS in China is:

- The equipments and devices of hospitals are continually updated. They may use different software platforms. Thus, separate heterogeneous client environments emerged. For example: Microsoft.NET™ and J2EE™, how to achieve true interoperability between them?
- Different hospitals use their own HIS, which make every HIS an information island. The data resources of different hospitals cannot be share and used effectively. A doctor makes a diagnosis depending on his several years' experience or using the expert system of his own hospital. Therefore, small hospitals have lower diagnosis accuracy. Also, young doctors tend to have lower diagnosis accuracy. Meanwhile, hospitals are disinclined to expose their data due to the issues as patients' privacy etc. A better solution for this conffliction is to build a big, rich expert system. Thus, all the data resources are shared. The accuracy of doctor's diagnoses will be greatly enhanced.
- More and more hospitals use their own HIS. In some big hospitals, they have several HISs in different department. Since most of these HISs are not developed by the same company in the same time, how to integrate several legacy systems when we develop new systems becomes the issue. It is quite difficult to integrate different information systems.

Aiming at the current situations in the health care industry, we are building the Doctors Workstation System (DWS) to solve the problems. Parts of the solutions are worked out as using web services in DWS.

	1950	1980	1990	2000	2002	2003
Total	8915	180553	208734	324771	306038	291323
Hospital	2803	9902	14377	16318	17844	17764
of which: General Hospital	2692	7859	10424	11872	12716	12599
TCM Hospital	4	678	2080	2591	2492	2518
Specialized Hospital	85	694	1362	1543	2237	2271
Health Center	-	55413	47749	49777	46014	45204
Outpatient Department & Clinic	3356	102474	129332	240934	219907	204468
Medical Research Institute	3	282	337	405	298	284

Table 1 Number of Health Institutions

## 2. Web Service

Before the application of web service, we always concentrated on the development based on components when we did research on the reusability of the information systems. Web service is the technology, which combined with the component technology and web. In short, web service is the component in web. It makes it easy to reuse components of systems, which based on web. Also, web service provide good solutions to communicate and interoperate among heterogeneous information systems.

According to W3C, “A Web Service is a software application identified by a URI<sup>[3]</sup>, whose interfaces and binding are capable of being defined, described and discovered by XML artifacts and supports direct interactions with other software applications using XML based messages via Internet-based protocols.”<sup>[2]</sup> This definition emphasizes on two points. First, web services are capable to be defined, described and discovered. Second, web service can be accessed using standard web protocols.

Generally speaking, Web Services are software components that are loosely coupled and distributed, encapsulate business functionality and are programmatically accessible using standard Internet protocols. Technically, Web Services are a stack of emerging standards that describe a service-oriented, component-based application architecture.<sup>[4]</sup> Second, DWS will build a rich services pool, a rich expert

Web services have the following features.

- Loosely Coupled
- Cross-platform interoperability
- Universal Accessibility
- Standards Language

## 3. DWS Project Approach and Solution Outline

### 3.1. The Motivation of DWS

As mentioned above, we have started research DWS project. DWS is the project, which is carried out by Renmin University, Peking Union Medical College, Norway Tromsø University and Norway National Hospital. This project has been developed since 2002. The motivation of DWS is to build a universal hospital information system platform.

DWS Motivation

- Build a general HIS platform for hospitals and clinics which has no HIS to save expenditure
- Accomplish the necessary data exchange between different existed HIS
- Build a rich expert system
- Provide patients e-health platform

According to the motivation of the DWS, two main functions are considered. First, DWS is a universal HIS platform, which provide hospitals and clinics with no HIS. system and a rich library, which provide doctors and

patients to search information through data exchange with other HIS. In this paper, more attention is paid to the latter issue.

### 3.2. An Overview of DWS

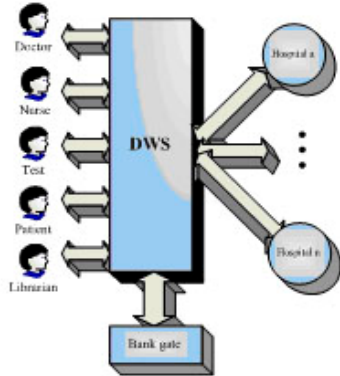


Fig.1: An Overview of DWS

As shown in Fig.1, DWS has different roles with different rights. DWS connects with several hospitals using web services. In addition, DWS has the interface to connect with bank gate. In this chart, it shows DWS is not only a portal of HIS but also an integrated platform.

### 3.3. Web Services in DWS

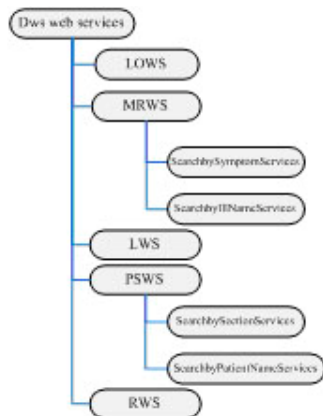


Fig.2: DWS Web Service

In DWS, several web services are designed, which are Log On Web Services (LOWS), Medical Record Web Services (MRWS), Library Web Services (LWS), Patient

Search Web Services (PSWS) as shown in Fig.2.

LOWS authorize different roles different rights as shown in Table 2.

MRWS contains illness name, symptom, order and test. However, there are no information about hospitals, doctors and patients. It suits the situation of Chinese health care industry. It has two web services: one is SearchbySymptomServices, which provide the symptom of illness and return all the medical records about the symptom. The other is SearchbyIllNameServices, which provide illness name and return all the medical records about the illness.

PSWS has two services: one is SearchbySectionServices, which provide the name of the department in hospital and return all patients' information in this department. The other is SearchbyPatientNameServices, which provide the patient's name and return the patient's information.

LWS provide services as inputting illness name and the output is some URL about this illness. The medical standard used is ICD-10.<sup>[12]</sup>

### 3.4. Implementation using Agent

In DWS, several intelligent agents for distributing different questions to different web services. It contains MRAgent, PSAgent, LAgent.

MRAgent means Medical Record Agent. If some users submit some requests about medical record, the system first puts the requests to MRAgent. Then the MRAgent decides which web services should deal the requests.

PSAgent means Patient Search Agent. If users want to know the patient information, the system should put the requests to PSAgent.

LAgent means Library Agent. If users want to know the diseases information, the system should put the requests to LAgent.

When users ask questions in DWS, the DWS will correspond and take action, which use different agent according to different question.

As shown in Fig.3, If one user logon as a doctor, and he wants to know the diagnose to the illness X. He asks the

question Q1. Then first, the question is submitted to the Role&Rights module. And it checks if this user has the

right to get the answer according to the Role&Rights Table as shown in table 1. If he has the right, the Role&Rights module passes the Q1 to Controller module. The Controller module distributes the Q1 to MRAgent according to the xml mapping. The MRAgent post the Q1 to all the MRWSs, which registered in its xml mapping, and it collects all the answers A1 to the doctor.

Another example is also in the figure. Patient A asks HL7 has some segments not fit the situation of China. In our schema, we use some segments of HL7, and also we

the question Q2, “find me out the patient A’s information in hospital n”. It’s the same at the beginning. When the PSAgent gets the Q2, it will post the Q2 to PSWS N in Hospital n, and receives the answer A2 to patient A.

We use the xml schema to standard the communication of web services. Although many countries already set the HL7<sup>[5]</sup> as their standard of health care industry, China has no standard now. add some new segments. An example schema of MRWS communication is s shown in Table 3

Rights Role	Write	Search Patient Info	Search Medical Record	Search Illness Info
Doctor /Nurse /Tester	Only his own hospital, and his own office	Only his own hospital, and his own office	all	all
Patient	No	Own himself	all	all
Other user	No	No	all	all

Table 2 DWS Role and Rights Table

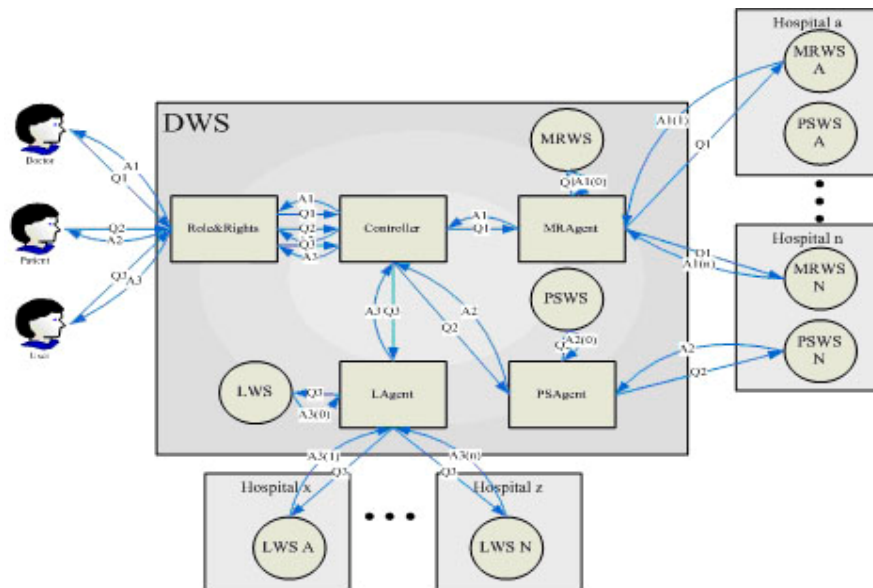


Fig.3: The Process of Data Exchange between DWS and Other HIS

## 4. Conclusion

In this paper, we have described how to design and implement a universal HIS platform named DWS. DWS

uses web services to achieve data exchange. In addition, we illustrate the process for communication between our system and other HISs. We also provide a schema to operate the web services.

```

<xs:schema
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:doctoradvice="http://dwsxml/doctoradvice"
  targetNamespace="http://dwsxml/doctoradvice">
  <xs:element name="MRlist">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="MR" type="doctoradvice:MRType"
maxOccurs="unbounded"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:complexType name="MRType">
    <xs:sequence>
      <xs:element name="Illness" type="xs:string" />
      <xs:element name="Symptom" type="xs:string" />
      <xs:element name="Record" type="doctoradvice:Order" />
      <xs:element name="Test" type="doctoradvice:Test" />
    </xs:sequence>
  </xs:complexType>
  <xs:complexType name=" Order ">
    <xs:sequence>
      <xs:element name="medicinename" type="xs:string" />
      <xs:element name="medicineid" type="xs:string" />
      <xs:element name="spec" type="xs:string" />
      <xs:element name="Quantity" type="xs:string" />
      <xs:element name="Interval" type="xs:string" />
      <xs:element name="exequantity" type="xs:string" />
      <xs:element name="exequantityunit" type="xs:string" />
      <xs:element name="usetype" type="xs:string" />
      <xs:element name="condition" type="xs:string" />
      <xs:element name="conjunction" type="xs:string" />
      <xs:element name="unitprice" type="xs:string" />
      <xs:element name="exefrequency" type="xs:string" />
      <xs:element name="exefrequencyid" type="xs:string" />
      <xs:element name="ownmedicine" type="xs:string" />
      <xs:element name="allprice" type="xs:string" />
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      <xs:element name="advicetime" type="xs:string" />
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      <xs:element name="End date/time" type="xs:string" />
      <xs:element name="zhutuo" type="xs:string" />
      <xs:element name="advicetype" type="xs:string" />
      <xs:element name=" Order status " type="xs:string" />
      <xs:element name="Priority" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
  <xs:complexType name="Test">
    <xs:sequence>
      <xs:element name="Type" type="xs:string" />
      <xs:element name="Motive" type="xs:string" />
      <xs:element name="Picture" type="xs:string" />
      <xs:element name="Result" type="xs:string" />
      <xs:element name="Attitude" type="xs:string" />
      <xs:element name="Date" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:schema>

```

Table 3 An example schema of MRWS communication content

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