

An Application Research on the MIS-Based Workflow Tools Integrated in a Large Hospital System

YANG Guojun¹, ZHENG Ying², WANG Gang³

1. Neijiang Normal University/ School of Computer, Neijiang, China, 641100

2. Neijiang Vocational & Technical College /Department of Information Engineering, Neijiang, China, 641100

3. The NO one of Neijiang People's Hospital /Information Center, Neijiang, China, 641100

e-mail: Ygj_8383@163.com

Abstract: Based on the current hospital information system integration, point-to-point integration, agent-based information integration, component-based integration, the integration of middleware-based integration programs, such as the inadequacy of traditional, this article analysis the characteristics of an integrated hospital system, discussing the hospital system integration design, workflow mechanism based on the MIS integrated platform for development tools to customize and control processes to achieve strong to connect the main line to the node to work independently as a business system interface to enhance the scalability of loosely coupled integrated system framework and integrated programs, and give the integrated system framework and integrated programs included a integration platform based on workflow mechanism of MIS development tools, a strong connection customized and controlled by the main line, and the node to work independently as a business system interface to enhance the scalability of loosely.

Keyword: WF-MIS; hospital information system; integration platform; process control; integrated program

1 Introduction

With the expanding of hospital scale, increasing of the business, developing of the information, in order to facilitate treatment of patients, improve the efficiency and level of the treatment, a hospital's own information systems independently of each other can not satisfy the large-capacity information of the basic needs. because of the lack of the different integrated technology systems, leading to a lot of critical information has been closed in the system which independent of each other, inter-repeated redundant work, which directly led to the reduction of the efficiency of hospitals and operating costs increase. Therefore, how to integrate these different information systems is the most important and urgent for hospital. Because of lacking the different integrated systems, a lot of critical information have been closed in the system which independent of each other, so the inter-repeated redundant work directly led to the reduction of the efficiency of hospitals and operating costs increase.

The current of the integrated hospital information system has heterogeneous, inconsistent data structure, message format inconsistency, and inconsistent communication protocols and so on. Integration of the traditional

program for the integration of a particular area may be a very good solution, but the entire hospital systems to achieve full integration and seamless integration, the use of an integration of a traditional program is not resolved, be considered using a variety of integration methods and integration solutions. In view of the above problems, give full play to the customized process workflow technology and process control advantages, this paper proposes a mechanism based on a new type of workflow MIS application platform development tools to achieve large-scale hospital information system integration solutions can be achieved on the one hand, hospitals the process of custom information systems and process control, on the other hand, can also be through the existing development tools and integration of new information systems to meet process control systems within hospitals, seamless sharing and data exchange needs, thereby better to complete the service activities of hospitals and hospital information system to provide flexibility to adapt to rapid development and changes in hospital.

2 Background Technology

Based on the studying subject in "mechanism based on workflow development tools, a new type of MIS research and development", the NO one of Neijiang People's

Hospital Information System as the research background, and the hospital establish a unified integration platform, with the process of customization and process control for the line will be existing hospitals fully integrated software system, the system goal is integration, digitization, patient-centered, with the openness, scalability and maintainability, the realization of the hospital business process customization and control.

First, large-scale multi-hospital system has many subsystems, such as HIS(Hospital Information System), LIS (Laboratory Information System), RIS (Radiation Information System), PACS (Picture Archiving and Communication System) and so on.

Second, general hospital has a number of legacy applications, general medical equipment has its own unique software systems, but these systems do not have source code available to them only know that some interface.

Third, hospital involved in a variety of data formats, common data, graphics and images and so on.

Fourth, the realization of electronic medical records. Hospitals and other hospitals can achieve a good information exchange (for example, when the patient transfers). We must abide by the international community about the existing medical system of standards and norms, such as the HL7 standard, DICOM standards, IHE norms. Although the various criteria of the interaction between various systems need to pass the message format, but do not include a specific technology, so integrating the various business systems is technically difficult. The information can exchange between hospitals and other hospitals.

Fifth, the hospital complex and changing business processes. Many of the existing systems not adapting to the hospital because of changing in business processes are eliminated.

Existing large-scale hospital software systems, although the hospital to achieve the integration of various subsystems, but most just put together a simple subsystems. The connections between them is only the use of peer-to-peer mode (Message-Oriented Middleware, or direct access database, etc.) to achieve. So the development and maintenance aren't only very difficult, but also

high degree of integration of business processes in support of the hospital are inadequate. Doctors of information sharing and management of hospital management, there are many inconveniences. And often because the hospital needing new business processes and large-scale changes to source code, make the price very high maintenance. In addition, they support only part of the international standard. Although the existing large-scale hospital software systems can achieve the integration of various subsystems.

This paper presents a workflow-based mechanism for the development of new MIS tool integration platform for large hospital system integration program, which is not only to achieve integration in the development and maintenance of simple, easy to support the international standards, and allows hospitals to comply with the Business Process IHE norms. The doctor in to see a doctor when the patient's information will be more comprehensive, the implementation of doctor's advice even more automation and smooth, from the registered patients, and body search, doctors, hospital and other processes carried out by the system according to co-ordinate the use of the allocation of hospital resources. Therefore, both for the convenience of doctors, and conducive to the patient. And the realization of the unity of the process design and management, even if the process changing, as long as the managers simply to re-design workflow, so the application can be completed by a small number of changes. That have a lot of help for managers. Mechanism based on workflow development tool integrated MIS is a feasible option to optimize.

3 Large Hospital System Analysis and Design of Integrated

3.1 Hospital System

Large-scale hospital information system as a whole system of vast, complex structure, the independence of the system, and mainly in the following categories.

Hospital Information System (HIS) is to achieve the hospital's core business system, which includes the registered subsystems, workstations doctors, reproductive center management system, health-check management system, blood transfusion management system, surgery,

anesthesia management systems, sub-clinical experts system, drug management system, economic management system, integrated management and statistical analysis systems and data security management systems.

Laboratory and central laboratory information system (LIS) is mainly responsible for dealing with the inspection report and laboratory information management business

Image archiving and communication system (PACS) is mainly responsible for image acquisition, transmission, storage, processing, display and print management. In addition, Full PACS systems now typically including a radiology information system (Radiation Information System, RIS), is responsible for a variety of radiation processing equipment inspection reports, as well as the associated systems and PACS image access, and in accordance with HL7 standards and the external system (For example, HIS) to interact.

Office Automation System (OAS) is mainly responsible for a number of day-to-day office functions.

Refers to the external system is mainly the banking system, medical insurance system, drug supply systems. Because a large hospital system not be a closed system, it is inevitable that teaching the out world, and the development trend of the future.

3.2 Design Principles

The contents of a large hospital system involved in many demanding system integration. In the design of the system would have to consider the feasibility, flexibility, robustness and scalability, system integration for maintenance of the basic design principles.

Feasibility. Because the system is a large three-tier B of the real system used in hospitals, so the feasibility of the technical feasibility and time becomes a problem that needs to be considered first

Flexibility. Large hospital system is not only the complexity of business processes, and changing, so flexibility also need to focus on the design of the system to consider the question ,Whether hospitals adapting to the complexity of the existing processes and future changes in processes and changes in demand changing as little as possible procedures is the embodiment of system flexibility so flexibility is a question need to consider on

the design of the system.

Robustness. By using of the system of hospitals, outpatient amount of its approximately 2,500 average daily trips throughout the year the average outpatient amount of 65 million, whether the system is able to stand the high load, high-volume, that is, the system robustness is also the problem of the design of the system needing to focus on taking.

Maintainability System maintenance cost of the system as a whole accounted for a large part of the cost of the system maintenance is also crucial.

Scalability. After referring to system integration, with the hospital system and the ever-increasing expansion of the business continues to expand, the external system to expand the provision of standardized interfaces.

3.3 Technical Difficulties

The realization of a large hospital system integration need to consider and resolve the many technical difficulties were described in the following.

Multi-subsystem .Because the hospital system more than the independence of the subsystems and the interaction between subsystems more,if using the traditional methods to achieve point-to-point interconnection, it will form a network structure, but that will make the system almost not scalable because of needing to add a subsystem and other subsystems needing to add interaction and its all connected, so that poor maintenance caused by.

Data format conversion. The realization of this system is not only the realization of the subsystem from its own simply by sharing the database with the Internet, but also bring other hospital system suppliers products (such as: PACS) integrated into the hospital system, but directly accessing other database vendors products is unsafe and not feasible. Because relating to a specific data structure may have a product of a dependent, and the definition of the medical profession between the system runs counter to the standard interaction. In short, in order to reach the Internet, we need to address different suppliers in different systems of the unification of data formats.

Changing business processes. The business processes of hospital are complex and changing. For example, to fill the orders of doctors belonging to the original task, but it

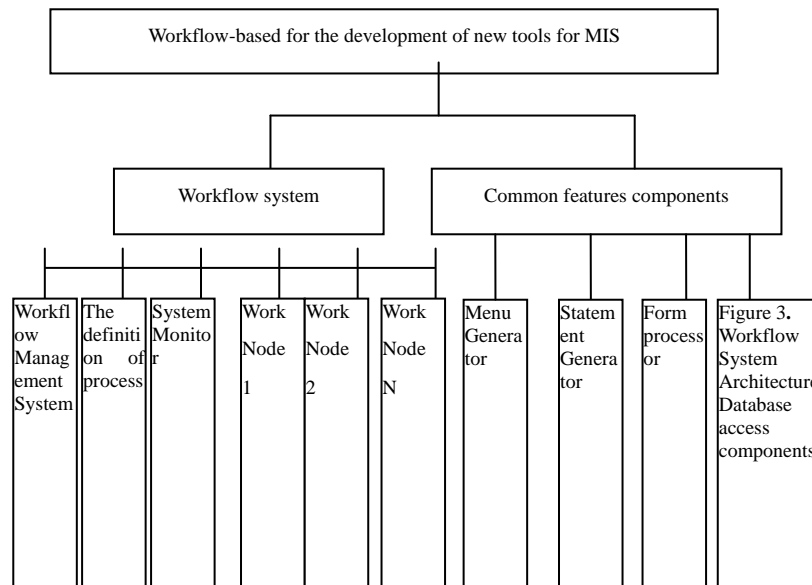


Figure 2. WF-MIS Functional Architecture

may be fill out the task to the nurses because the process of change. For another example, the year-end assessment of the indicators of medical personnel, may be different as time changing may also add new content. To adapt to changes in the process is the most intractable problems in the system been running.

4 Workflow-Based New Development Tool for MIS

4.1 WF-MIS Development Tool' Framework and Summary

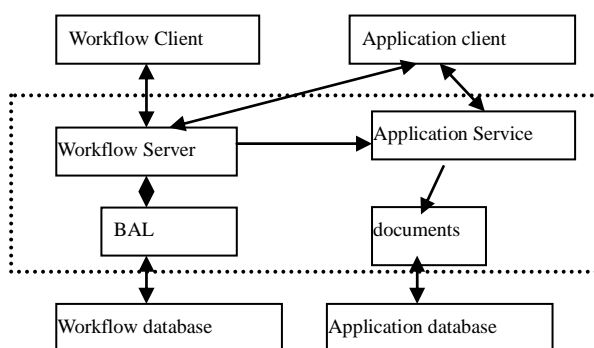


Figure 1. WF-MIS framework structure

According to its features WF-MIS make workflow mechanism embed MIS found process to set up a structure platform for the men who develop the software, thus they

concentrate on developing transactional logical and active MIS of process control. The generated MIS support rebuilding-up of enterprise transactional and support recompiling construction and software's reusing in Distributed heterogeneous environment, and it supports system scale's expanding. In a word, it is a RRS (Reconfigurable Reusable Scalable) system [1], which optimizes enterprise transactional process especially key process and strengthens enterprise works' cooperation and communication. The system adopts bottom framework of CORBA communication mechanism system and is shown as Figure 1. [2]

According to above analysis, we can know that if MIS function components are encapsulated and integrated with workflow management system, the system can not only accomplish enterprise's MIS function but customize and control process flexibly. The workflow system is a kind of MIS which supports process customization and control and supports current function component platform. And it can smooth over the shortage of current MIS.

Therefore, we consider using workflow technology to support the implementation of flow customization and flow control, which contents some parts: workflow which is the core part and used to explain and control process executing; flow customization tool which is used to build the model to maintain process and system monitor tool

which is used to the running of workflow system; work point which integrate workflow system with application

smoothly via supplied interface. And function component can use current development tools. For accelerating the

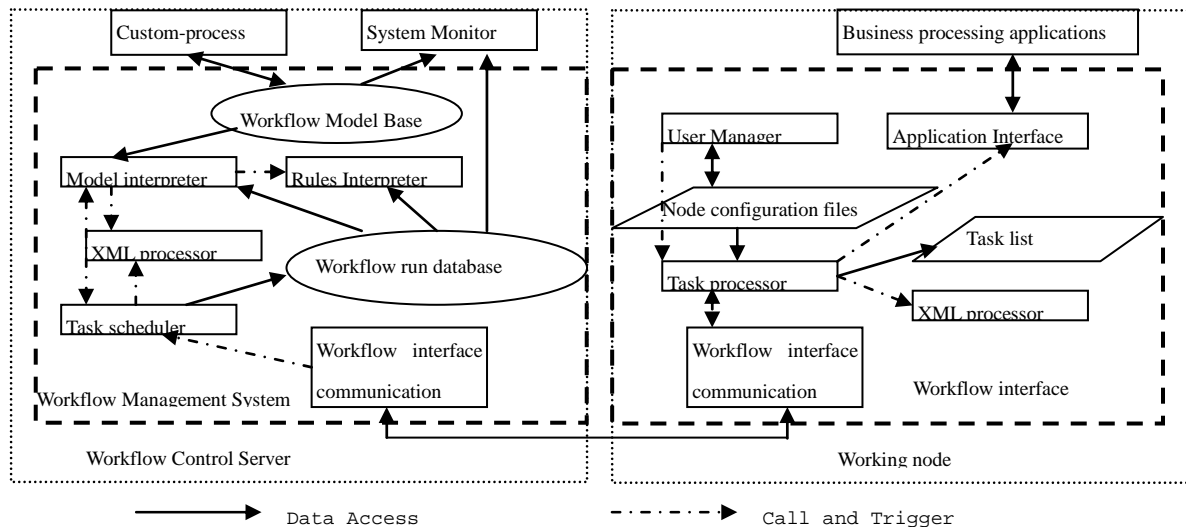


Figure 3. Workflow System Architecture

development of MIS function components, WF-MIS gives some common function components which can be used after simply customized. [3]

4.2 WF-MIS System Structure

WF-MIS which is composed of commonly function components and workflow system is described as Figure 2. The former assist to developing MIS function components ; the latter is used to build process model and control process being correctly carrying out and call transactional process application and accomplish integrating application with workflow system smoothly. [4]

4.2.1 Workflow System

Workflow is composed of customization tool, system monitor, workflow management and several work points. Process customization tool is responsible of customizing

Process model and offer it for workflow management system. System monitor reads workflow system running data and show system running situation. Workflow management system starts process according to process model and controls it running correctly to build the MIS fit to transactional process. Work point is the carrier of transaction process application, which accept task and carry out related transactional process application. The architecture of can be shown as Figure 3. [4,5]

Process customization tool: It runs in workflow server as independent application, which is used to build maintain process and write process data to workflow model base. A group of basic elements such as work point, incident, condition, connection are supplied, in order to give the rout describing process. In addition, it permits several child processes embedded in process to support process reused.

System monitor: It runs in workflow control severer, which analyzes and calculates workflow running data and monitor process running situation in system and shows it with digraph to administer.

Workflow management system: It runs in workflow control severer which is composed of workflow communication interface, task management, XML processor, model explainer and procedure explainer. Workflow communication interface accept the XML document which is result from work point, and hand it to task manager. Task manager call XML processor to process application running result, XML document, and hand the result to model explainer to process. According to the result of application running and process model, model explainer found appropriate procedure and calculate it to decide the next work point.

Work point: It is the carrier of transactional process

application, which carry out correctly according to workflow management system calling, setting up work interface in it to implement integrating application with workflow. Workflow interface is composed of workflow communication interface, task management, XML process, model explanation, rule explanation. Workflow communication accepts task data, XML document, and hand

It to task process to deal with. Task process call XML process to process task data, XML document, to get task data and integrate it with relevant data in point disposition document to make a whole task calling data, and store it to task table. XML process explains the task data that is got by XML document. User interface calls application according to point user's choice and corresponding task data, and sends the executive result to workflow management system through task process and communication interface.

4.2.2 Common Function Components

Common function components are relevant with MIS application closely, assisting to the development of MIS function component. WF-MIS gives four components.

Menu maker: It supplies convenient visual menu make tools. The developer can "draw "needed menu and set relevant attribute to adjust the display style of menu. After drawing menu, the tool generates the corresponding program code (including VB, Delphi, Java, Power Builder), and it can be added to program.

Table maker: It is the ultimate form, which supply with data to manager, and it needs strict data show. The function component give a table maker in the form of JavaBean, which can make sure the data source, assign the table layout, and get initial table which is modified to satisfy needs. The ultimate table is outputted in the form of PDF, HTML, and Excel.

Data table processor: It is the common form of transactional data, which operator use to get data. It has three functions: auto generating data table, controlling authority, and controlling process. First, we can assign the source of table data and it relevant attributes to generate data table. Second, it decides who can see relevant table and generates relevant table according to the authority to relevant field. And it control tables running in relevant

transactional process according to the relation of the transaction in table and other transaction process. [6]

Database access component: Most MIS access functions are based on the operation of accessing database. The component encapsulates common operation of accessing database to form JavaBean component which can be integrated to program. It can pass not only the signal of database model, password but also operate database with the method it give.

4.2.3 WF-MIS Implementation

WF-MIS is developed with Java, so workflow system can integrate transactional process application in different platforms. It describes system data with XML. With the aid of its powerful capacity of describing data, system data is convenient read and used by other systems, and system's extension is raised. Workflow system integrate with transactional process application smoothly to make sure process carried out correctly. The application interface in workflow interface is used to application integration. But owing to the complex situation of transactional process application, the implement of application integration is very complex. 1).If it is common executive program, it can be called. 2).If it is WEB application, it use Request object to pass start parameters to application. 3).If it is component program, it should be integrated as possible. If necessary it can be integrated as WEB serve and implement WEB serve client. Development worker use Jobuilder 9 to develop relevant component and implement relevant integration[7]

5 Application of Large-Scale Study of Integrated Hospital System

5.1 Large Hospital System Integration Program

This large hospital system to achieve the overall program is based on process-oriented customization and process control lines, a new type of workflow-based MIS integrated platform for development tools. Any business other subsystems are based on this platform, to achieve inter-connection and information exchange, as well as the application and data integration. The platform is divided into three, namely, business process layer, business layer and business agent system layer. The main features of this program is based on the business process workflow

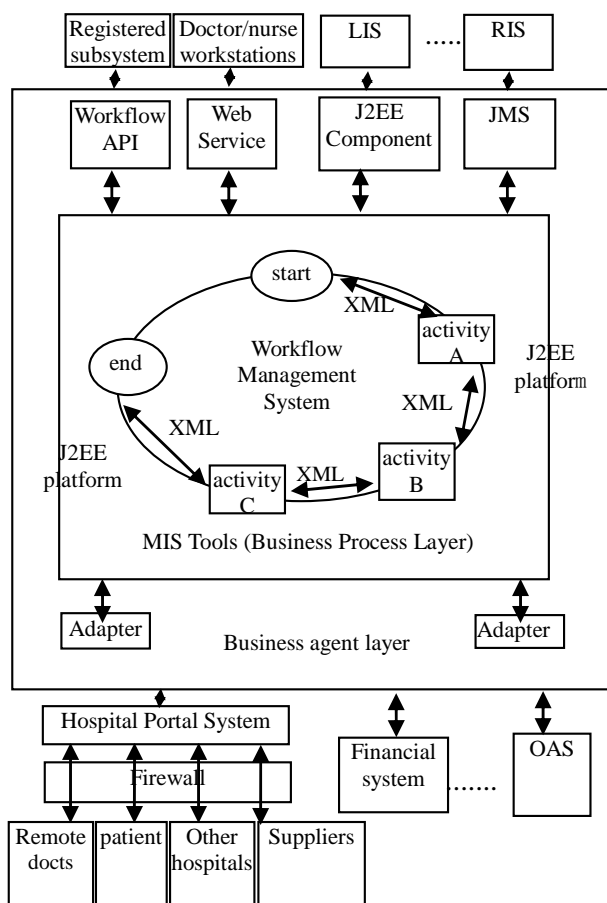


Figure 4. System architecture diagram

management system architecture for the platform through standard adapters, application systems across the communications and XML-based unified data model.

5.1.1 Overall System Architecture

The overall structure of the system shown in Figure 4, business process layer in the center, the realization of process management is the core of the system, business system layer of the business system layer through the business agent to achieve the various agents interact to achieve the hospital's business processes. Layer of its business agents using various agents J2CA based on the Adapter, Web Services, Workflow API J2EE Component, such as technology or JMS. Our platform is based on J2EE, in which the business process layer and business layer proxy running on the J2EE Server, J2EE Server-sharing provided by services such as security and Services.

5.1.2 Business Process Layer

Business process layer is the main function of the design of business processes to explain the implementation of business processes, the use of XML format data to achieve all of the information transmission subsystem in order to achieve the hospital's business. In addition, it has to process monitoring and statistical functions for the hospital management to provide process data to help them find the bottleneck of the system in order to optimize the process.

Business process layer by the workflow management system to achieve, that is used to define, achieve and manage the workflow of a software system to run it with the workflow actors (people, applications) interact to promote the implementation of workflow instances and monitor the work of running stream. A workflow, including a set of activities and the order of their mutual relations and activities also include the process of start-up and termination conditions, as well as a description of each activity. For commonly used business processes, can "template" form of preservation for future use. The introduction of workflow management system, the system can be configured to provide a flexible link, process customization and scheduling algorithm to choose the functions carried out in accordance with the configuration of various business processes customized requests and scheduling. It can be the entire system from the point of view of various business processes of a unified planning and processing, on the one hand, a variety of requests to ensure that all aspects of the system's smooth handling, on the other hand, to ensure that these operations can be the best allocation process. Operational requests may be made from the patient for treatment, but also can come from doctors, nurses and managers.

The system of workflow management system running on the J2EE platform, it is part of the J2EE Server. The development of workflow management is not a hospital system. A large extent, the workflow management system gives the hospital system integration and operation of a software support environment. In the workflow management system, development tools support, by specific integration of business systems and related user interface operation, the system is good able to complete

the operation of the hospital in support of business processes and control.

5.1.3 Business agent layer

Acting through the following business layer technology to achieve a variety of business systems in each layer with the business process layer interaction, and business processes through the various layers to achieve the interaction between business systems achieve specific business processes of hospitals. We use the J2EE platform, and all agents based on J2EE in business agent layer have adopted the technology, which is based on the J2CA the Adapter, JMS, Web Services, Workflow API, or J2EE Component Technology.

The Adapter J2EE Connector Architecture J2CA defines a different type of information system (EIS) to connect to the J2EE standard platform architecture. J2CA also defines a series of scalable, secure, transactional mechanisms to connect the heterogeneous ELS with the application and systems. The J2CA can provide the EIS resource adapter for the suppliers of ELS. The resource adapter can be embedded application server, in order to achieve the EIS application server and enterprise application connectivity.

JMS (Java Message Service) message-oriented middleware (MOM) is increasingly becoming the main component of application integration. It is critical for systems to exchange data and events to trigger the provision of a reliable and flexible service. In order to enhance portability, J2EE platform gives a JMS (Java Message Service), and JMS enables Java code to a common way to create, send and receive messages, which makes use of JMS to prepare the Java code for different news middleware products.

Web Services is a new SOAP-based service delivery model. The basic elements of the model is a SOAP / HTTP, XML, WSDL and UDDI. Web Services is a loose bundle of services form the rapid, low cost to develop, publish, discovery and application of dynamic binding, but also can be achieved between the application-level functions or methods of integration. They are not natural-based services, while providing a basic "request / response" feature. The current version of Web Services there is a performance, complexity and security issues, but for

interactive cross-platform it is still quite useful. There can be achieved between the each other, while Components under different platforms connect a Web Services interface.

For the Workflow API controlling the process flexibly, we make use of the Workflow API of Workflow Management System to achieve direct control of the process. The use of Workflow API to customize their workflow management system provides the functionality to the customer, making the work flow management and Control is easy to melt in our business systems. For example, expanding the Worklist of workflow capabilities and adding features in business systems to make it more in line with our request.

J2EE Component (J2EE components)J2EE Component refers to the deployment of J2EE Server in the EJB component. EJB component J2EE Server to provide access to various services, making the preparation of EJB components simple. Various business systems through the deployment of J2EE Server in the EJB components provide services to other business systems in order to achieve the Internet.

5.1.4 Business System Layer

Business system layer is to achieve specific business operational hospital level, including the registration system, doctors workstations, reproductive center management system, management system for physical examination, blood transfusion management system, surgery, anesthesia management systems, subsystems clinical experts, medicines management system and economic management system, integrated management and statistical analysis systems, data security management system, laboratory and central laboratory information systems, picture archiving and communication system, office automation systems and external systems and so on.

Business system layer that is the layer of the most important task is to provide them with the business agent of the agent layer. Because the operational system of the business system layer is made up of different suppliers, and other providers can not know how to achieve the technology with the Internet, so it can only be made by all suppliers of business systems business systems to provide their own agents. Workflow system is running in the

process, through a proxy to achieve with the various business sub-systems interact to achieve the entire process from.

5.1.5 System Integration Case Study

Hospital out-patient customization process as an example that implements a specific simplified example of the work of the hospital out-patient process flow model shown in Figure 5. Registered patients is the function of the registering system, medical doctors belongs to the functions of the workstation, fees are charged the function

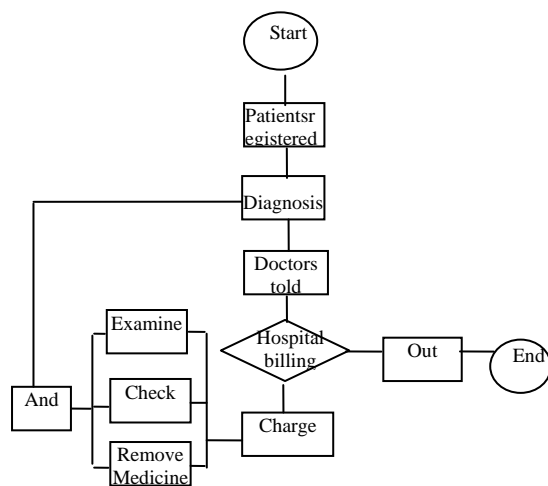


Figure 5. Out-patient flow

of the system, checked under the PACS system, testing is an LIS system, medicine is medicine management system. Programs by integrating the various subsystems of the various techniques described in the realization of agents, and business processes through a proxy access layer. Map each activity through a proxy to interact with various subsystems in order to complete the business process.

The operation of the actual system shows that the system successfully passed all kinds of business layer proxy technology to the business process layer subsystem of articulated, the process shows that the operation of our information in all inter-subsystem transfer has been very good. Messages are XML-format to achieve a good conversion of the data format. When business processes change, the process may also be adjusted to meet demand.

6 Conclusions

For the existence of the traditional shortcomings of integration, the article proposes a mechanism based on

workflow development tools, a new type of MIS as a platform to achieve integration of a large hospital system program, the use of WF-MIS systems to large hospitals, the business process as long as necessary use has been available, developers only use the WF-MIS application integration components provide appropriate programming, the working nodes to achieve the application interface to integrate applications, and then the correct deployment of workflow systems, the final definition of the use of device customization process flow model, workflow management system to enable the creation of processes and control the correct implementation of the process; this form is the workflow system to support the process of customization and control system of the MIS. Through this integration platform to integrate information resources inside and outside of the hospital, the realization of the norms of the hospital moves to streamline and speed up hospital business processes, achieve high efficiency of low-cost actions for patients to provide more convenient medical services, increased efficiency and the level of the hospital clinics. Therefore, It is ensured to sustain development for hospital information system which building such a integrating platform.

Acknowledgment

This work is supported by Youth Fund of Sichuan Education Department (NO.2007B021) and Youth Fund of Neijiang Normal University(NO.07NJZ-09)

Reference

- [1] D.Hollingsworth, The Workflow Reference Mode, Workflow Management Coalition, 1994, pp.11-35.
- [2] F.Casati, S.Ceri, and B.Pernici etc, Workflow evolution Data Knowledge Engineering, 1998, pp.211-238.
- [3] F.Leymann, D.Roller, "Workflow-based applicaion", IBM Systems Journal, 1997, pp.102-123.
- [4] S.Khodakaram, W. Mike, "Petri net-based modeling of workflow systems An overview", European Journal of Operational Research, 2001, pp.664-676.
- [5] C.Prior, Workflow and process management, Workflow Management Coalition Handbook, 2002, pp.34-45.
- [6] G.F.Paul, R.R.Vries, "A Reference architecture for Workflow Management System", Data&KnowledgeEngineering, 1998, 27 pp.32~34,38~42.
- [7] R.Agarwal, G.Bruno, and M.Torchiano, "An Operational Approach to the Design of Workflow System", Information and Software Technology, 2000, 42, pp.549~553.
- [8] Karl R.P.H Leung et al. The Liaison Workflow Engine Architecture. Proceedings of the 32 Hawaii international conference on System Sciences,Hawaii,Jan 1999.
- [9] Yanbo Han, Amit Sheth, Christoph Bussler. A Taxonomy of Adaptive Work(CSCW'98),Towards Adaptive workflow Systems

- Workshop, Seattle, 1998.
- [10] M.Kang, J.Froscher, A.Sheth, et al. A Multilevel Secure Workflow Management System. Proceedings of the 11th Conference on Advanced Information Systems Engineering (CaiSE'99), Heidelberg, Germany, 1999.
- [11] Mathias Weskel, Thomas Goesmann, Roland Holtenl, et al. A Reference Model for Workflow Application Development Processes. Proceedings of the ACM 1999 Conference on Work Activities Coordination and Collaboration, San Francisco, 1999.