Research on Integration Technology of ERP and PDM Based on Business Remote Function Call

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Abstract: - To better support ERP system and PDM system integration for independent enterprise network manufacturing system, the characteristics of ERP and PDM integration were analyzed and the technology of business remote function call was presented. The standard or custom functions which supporting remote transfer through BRFC interface could be called by the ERP or PDM systems to gain data which would be used to achieve the integration. Not only was a kind of integration model of ERP and PDM composed, but also the RFC interface was described semantically. And the structure, realization and interview of remote function call technology which was used by ERP and PDM integration was researched. Also, data exchange of system integration based on data stream direction was discussed to ensure self-containment, collaboration, recombination and unsustainably of the ERP and PDM systems integration for network manufacturing. The conception of heterogeneous data translator was put forward, and its data structure was given. Interface development tools provided by ERP or PDM were given full considerations. And the system composing mode was construed clearly. The heterogeneous data translator was applied to realize classic code system, system information searches of PDM, system information searches of ERP and integration information searches. Then the advantages of BRFC were expounded. Finally, an application example of typical integration of WLPDM and SAP R/3 ERP in WLNM networked manufacturing platform was presented to verify the feasibility and efficiency of RFC technology. As a result, seamless integration, plain integration, non-repeated data memory, integration flexibility and low cost were realized.

Key-Words: - enterprise resource planning product data management business remote function call integration network manufacturing

1 Introduction

In order to achieve the purpose that responding rapidly to market requirements in networked manufacturing environment, realizing seamless heterogeneous data integration between enterprise ERP and PDM system and interactive operation among application systems, spanning the restrictions in the boundaries between enterprise departments and heterogeneous data systems, eliminating the difficulties brought by "isolation island of automation" and "isolation island of information" in the enterprise benefit improvement, it is urgently for enterprises to find a kind of open, reliable, standard and reusable integrated tool and technology. Thus, the integration and efficient use of ERP and PDM heterogeneous data system in network manufacturing can be totally achieved.

In recent years, Chinese and foreign experts and scholars had researched and discussed the integration method and technology of heterogeneous data system from different perspectives, and presented many methods of data integration with different ideas. NATANYA P[1] used the Extensible Markup Language and achieved data exchange and integration among web applications of heterogeneous data system by designing the meaningful marks on his own; FENG S[2] achieved the data integration and sharing between heterogeneous data systems CAM and CNC by using the product data exchange standard technology; SWATMAN P M[3] applied electronic data interface technology and expressed data through the unified format in electronic form to realized sharing and integration for form data of independent-developed heterogeneous data electronic commerce system. QI GuoNing[4]

applied SML technology to achieve integration of CAD and PDM systems facing to MC design. WILLIAM C[5] put forward a standard of product data exchange and integration on the basis of XML and STEP, which realized data integration among heterogeneous data CAD systems. And ZHANG ShuSheng[6] researched semantic model construction technology for heterogeneous database system integration, and achieved the prototype system by using above technology as core. Now, these methods still have some significance effects on the heterogeneous data systems integration.

In this paper, requirements of ERP and PDM heterogeneous data system integration in network manufacturing is analyzed, system remote function call technology in the circumstance of network manufacturing is discussed and unified system model is established. Then the system structure, realization and interview method of Business Remote Function Call (BRFC) technology which are adapt to ERP and PDM heterogeneous data system integration in networked manufacturing environment are put forward. In the end, typical integration of WLPDM and SAP R/3 ERP in WLNM network manufacturing platform is exemplified to elaborate specific realization of ERP and PDM heterogeneous data system integration technology based on the component BRFC.

2 Requirements Analysis for ERP and PDM Heterogeneous Data Systems Integration

In the process of implementing networked manufacturing, enterprises have accumulated a mass of data in design, manufacturing and management process. Not only do the ERP and PDM system in network manufacturing differ in data format and storage mode, but also in data management and application systems. As shown in figure 1, the integration view of ERP and PDM heterogeneous data system in independent enterprise network manufacturing is depicted. Although the ERP and PDM heterogeneous data systems can work well in their fields, information in these heterogeneous data system is independent, and can not be exchanged and transferred, which becomes a bottle-neck for enterprises' further development. So ERP and PDM heterogeneous data system integration has become one of the preconditions to implement networked manufacturing. The characteristics of the manufacturing mode and technology of networked manufacturing determine that ERP and PDM heterogeneous data system should satisfy the requirements as reliability, open-characteristic, standardization and reusability.

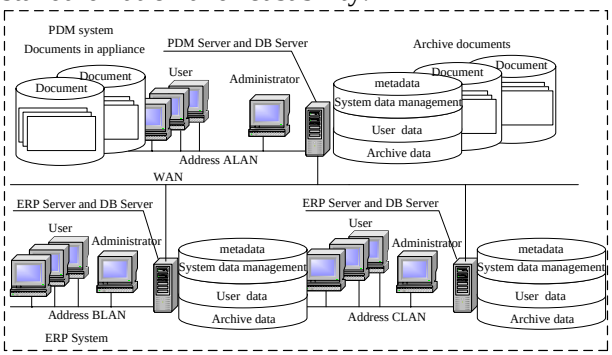

Fig 1 Integrated view of ERP and PDM heterogeneous data

2.1 The Expression of ERP and PDM Heterogeneous Data System

The isomerism of ERP and PDM heterogeneous data system is mainly shown in following aspects:

(1) Computer architecture isomerism of the ERP and PDM systems: the computer architecture requires for the ERP and PDM systems are different, ERP system's requirement relatively high, while PDM system's is low.

(2) Computer operating system isomerism of ERP and PDM systems: the fundamental operating system of each system is different, operating system such as Unix、Windows NT、Linux are likely to exist at the same time in the circumstance.

(3) DBMS isomerism of ERP and PDM systems: the DBMS of each system is different. In the circumstance, there may be different relation database systems such as Oracle、SQL Server、etc, or there may be databases in different data modes such as mode、hierarchy、network, object-oriented, function database, etc.

2.2 Constraints of ERP and PDM Heterogeneous Data System Integration

There are all kinds of expressions for the ERP and PDM heterogeneous data system, so in order to better realizing the integration of ERP and PDM heterogeneous data system, the system integration technology should satisfy the following constraints:

(1) Containment: Integrated interface of ERP and PDM heterogeneous data system should be configured independently and constructed in the form of unitization, in order to satisfy the requirement for reliability of integration.

(2) Cooperation: Integrated interface of ERP and PDM heterogeneous data system should be characterized by being independent with the environment, and could satisfy the requirement for openness of integration by offering good method for communication and cooperation.

(3) Composition: Integrated interface of ERP and PDM heterogeneous data system should define clear interface standards to satisfy the standardization requirement for integration.

(4) Reusability: Integrated interface of ERP and PDM heterogeneous data system shouldn't own individual and specific properties, and shouldn't be distinguished from its own copy, in order to satisfy the reusability requirement for integration..

3 Component Interface Technology of ERP and PDM Heterogeneous Data Systems

Component interface is the composition which could be identified and matches requirements for certain standards, and it is similar to the "key" in mechanical industry. The integration of ERP and PDM heterogeneous data system in networked manufacturing can be realized efficiently by using component interface technology.

3.1 Semantic Description of the Component Interface for ERP and PDM Heterogeneous Data System

The description of component interface contains three parts which are node, analysis and execution. "Zero-order description" is adopted to emphasize the components' semantic characteristic. Component interface's execution of ERP and PDM heterogeneous data system is usually invisible to technicians. The abstract description of the external view of component interface is provided by the node and analysis which are the bases to implement the integration of heterogeneous data system. The detailed semantic descriptions are as follows:

(1) Node: An operation which is called between the ERP and PDM heterogeneous data systems is described.

The name and type of integrated operation can be acquired through the node. The "refined" relations should be established between the interfaces of heterogeneous data system in networked manufacturing. Semantic description of the abstract class of the node NAME is:

TYPE
NAME,
Interface*::
R1: First_name-set
R2: Last_name-set,
Interface={|n: Interface*⊙R1(n)∩R2(n)=Φ|}
VALUE
Con: Interface Interface→(0 or 1)
Con(n1,n2)≡R1(n1) R1(n2)∧R2(n1) R2(n2)

(2) Analysis: The confirmation of the integrated operation's characteristics between ERP and PDM heterogeneous data systems is described.

The characteristics of the integrated operation could be acquired through the analysis. The characteristics of the integrated operation are as follows: real value, atom name atom(n)m、reverse property rev(p)、combined property con(p1,p2)、allusive property all(p1,p2), etc. An analysis contains an initial characteristic and a group of characteristic pairs corresponding to each written operation, and all characteristics of the analysis are established on the basis of the read operation of the component interface. Semantic description of the abstract class of the analysis JOB is:

TYPE
JOB::
Define: Person-set
Exp: Name→ID OLD,
VALUE
Characters: JOB→Person-set
Interface: JOB→Interface
Interface(s) as n of W(n)=Exp(p) ∧ R(n)={i|i:Name⊙ c:ID⊙c∈OLDs(p)∧i∈Name(c)}

(3) Execution: The process of an operation called between ERP and PDM heterogeneous data systems to realize the system integration is described.

The result of ERP and PDM heterogeneous data system integration could be acquired through execution. An execution contains the definition to integrated read and written operations, feedback to the result of the operation, node and analysis corresponding to the component interface. The intersection of names of component interfaces, read and written operations is null, realization of the read operation is established on the basis of names of component interface and its read operation, while realization of the read operation is established on the basis of names of component interface and its written operation. Semantic description of the abstract class of the execution CHANGE is:

TYPE

CHANGE*::
R: ID→Old
W: ID→Program
S: ID→New,
CHANGE={|n: CHANGE*⊙Old(n)|}
VALUE
Isc: CHANGE*→(0 or 1)

Isc(n)≡S(n)∩R(n)∩W(n)=Φ and s,s1,s2: Old ⊙(s∈R(n)∧(s1,s2)∈New(R(n)(s) →s1∈S(n)∧s2 ∈R(Interface(S(n)(s1))) and (n∈W(n)∧(s1,s2)∈ Name(W(n)(s) → s1 ∈ S(n) ∧ s2 ∈ R(Interface(S(n)(s1))) and s2∈Exp(S(n)(s1))))

3.2 System Model of the Component Interface of ERP and PDM Heterogeneous Data System

To realize the advanced manufacturing mode of networked manufacturing, it is necessary to implement the integration and interaction between ERP and PDM heterogeneous systems. ERP and PDM heterogeneous data systems could be integrated through component interface technology. Requests of system integrated operations are received by nodes of the component interface of the relative software, and wake up the corresponding executive programs respectively by component interface analysis to satisfy requests of integrated operations of ERP and PDM heterogeneous system in networking manufacturing environment.

Because the node and analysis of the component interface are the only bases for ERP and PDM heterogeneous data system integration, the component interface should satisfy the constraint for containment. The component interface could contain several nodes to receive integrated requests of different kinds of data, which avoids the difficulties of integration brought by the complex data type in ERP and PDM heterogeneous system and realizes the integrated cooperation. The definition of the node is under certain standard with clear norm of definition, and could be for compound use; Integration effects in different hierarchies can be achieved through the analysis of the component interface, which makes the integration more flexible and achieves the integrated requirement for reusability. Therefore, the component technology can completely satisfy the integrated requirements of ERP and PDM heterogeneous data system in networked manufacturing.

4 Design of Component BRFC of ERP and PDM Heterogeneous Data System

The component BRFC is the typical realization of the component interface technology, and it could realize the interaction and communicated integration between commercial objects such as companies, suppliers, employees, clients and material of ERP and PDM heterogeneous system in networked manufacturing.

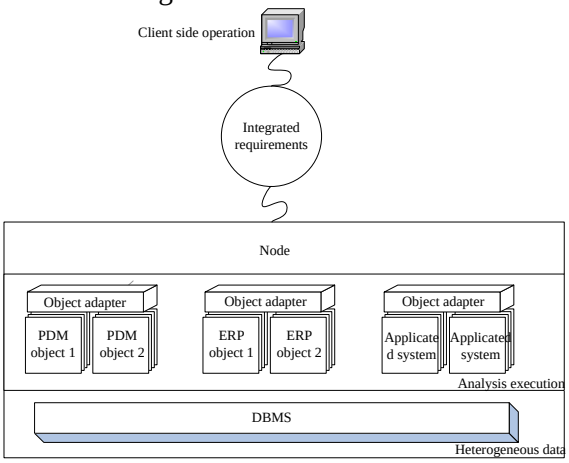

Fig.2 Component interface model of ERP and PDM heterogeneous data system Integration

4.1 Structure of Component BRFC of ERP and PDM Heterogeneous Data System

The component BRFC technology is based on the conception of commercial object, for example, main material data in PDM and sale order in ERP represent a commercial object in networked manufacturing. It packs the bottom data and process of realization between commercial objects. In order to realize the containment, cooperation, composition, reusability of the integrated interface of ERP and PDM heterogeneous data system, the structure of the component BRFC of ERP and PDM heterogeneous data system should be designed as the figure in figure 3:

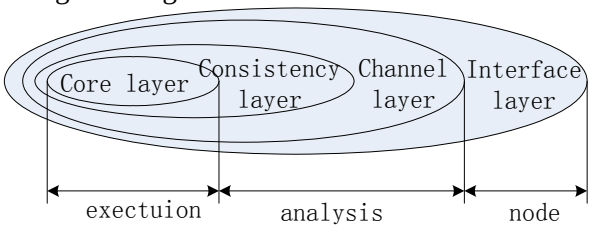

Fig 3 Structure of component BRFC

(1) Interface layer: It contains one or several nodes of component BRFC, and matches the standard norm for naming. Also it defines the technology that allowing external visiting to the commercial object data.

(2) Channel layer: It implements the analysis to the data Interface layer receives, and acquires the characteristic or characteristic set of the integrated operation.

(3) Consistency layer: It implements correct verification to the characteristic or characteristic set of integrated operation which is got by analysis. Enforced constraints of commercial objects in ERP and PDM about the values and its range are maintained;

(4) Core layer: With the integrated operation characteristics acquired by analysis, it awakens the corresponding executive programs to visit the bottom data which will be then deal with to realize the integration of ERP and PDM systems.

4.2 The Realization of Component BRFC of ERP and PDM Heterogeneous Data System

Tools needed to be used for design realization of the component BRFC of ERP and PDM heterogeneous data system contain: data dictionary, function modules library and commercial objects library. The interface layer of component BRFC is realized by commercial objects library, channel layer and consistency layer are supported by function modules library, and core layer directly face the system bottom data type, namely data dictionary. Component BRFC is usually realized by the remote function call module of ERP and PDM heterogeneous data system.

To realize component BRFC of ERP and PDM heterogeneous data system, the follows must be satisfied:

(1) Business: containment, cooperation, composition, reusability.

(2) Call form: Component BRFC needs to be called synchronously when reading data or interactive interface from other heterogeneous data systems; Component BRFC needs to be called asynchronously when exchanging data between ERP and PDM heterogeneous data systems;

(3) Screen output: Component BRFC its own function and all functions called by component BRFC mustn't produce screen output.

(4) Error treatment: Component BRFC need perfect error treatment mechanism and information feedback, and the phenomenon exiting programmers automatically is not allowed to occur when errors come.

(5) Performance optimization: Using entire IF condition to minimize transmitted data, interview the bottom database as seldom as possible, and granularity of the lock should be consistent with commercial objects.

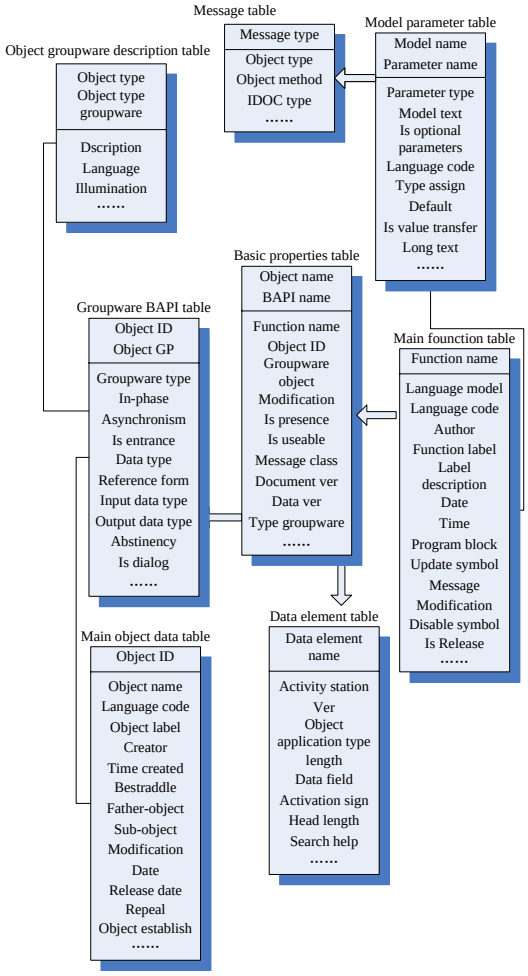

Fig 4 Realization of component BRFC

Component BRFC of ERP and PDM heterogeneous data system realized by adopting main data table of the commercial object, component BRFC table, fundamental property table, data element, etc is shown in figure 4.

4.3 Visiting of component BRFC of ERP and PDM heterogeneous data system in network manufacturing

The approach to visit component BRFC includes three methods: IDOC document, SOAP protocol and plug-ins of JAVA、C#、PowerBuilder and so on. The methods of interview are shown in figure 5:

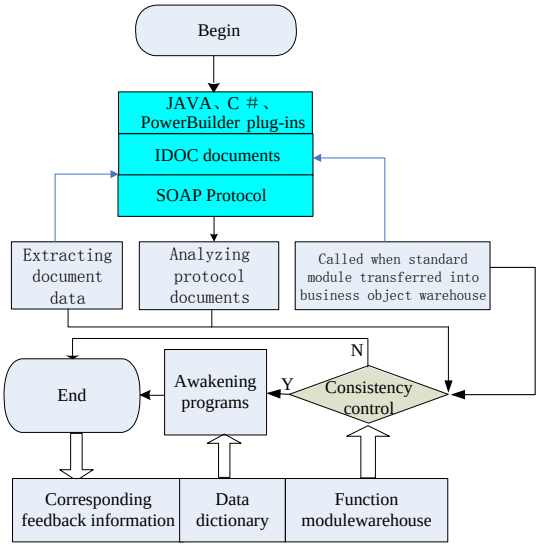

Fig.5 Interview of component BRFC

4.4 Advantages of Component BRFC of ERP and PDM Heterogeneous Data System

Using component BRFC technology in ERP and PDM heterogeneous data system integration has following advantages:

(1) It's convenient for the interface layer to set integration standard, and easy to realize the standardization of ERP and PDM heterogeneous data system integration.

(2) Owing to the existence of the consistency layer, stability and reliability of component BRFC are improved.

(3) The design of commercial objects library makes interface component BRFC separate with the detailed interview technology, and doesn't limit to use specific programmed technology and data type, makes component BRFC with stronger reusability.

(4) By using all the platforms supporting remote function call agreement, it could be interviewed to realize the integration of ERP and PDM heterogeneous data system, which shows well openness.

(5) Inner nuclear layer is completely packed to guarantee the safety of the system bottom data and realize the strict privacy of the bottom data type.

(6) Through channel layer, component BRFC technology could be compatible with EDI、XML、STEP and PDML and so on.

5 Integration Instance

ERP and PDM heterogeneous data system integration technology in independent enterprise network manufacturing based on component BRFC had been realized in the project "Research on network manufacturing integrated platform and its application on motor industry", which is the scientific and technological key task project of Zhejiang province. The WLNM networked manufacturing platform of WO LONG electric crop. realized the data exchange and function interconnection between each heterogeneous data system in the platform. The appliance of component BRFC improved the integration degree of WOLONG crop dramatically, realized the information share in networked manufacturing, improved product quality, reduced the cost and shortened the delivery time. The example of typical integration of WLPDM and SAP R/3 ERP in WLNM networked manufacturing platform was provided, concrete realization of ERP and PDM heterogeneous data system integration technology in independent enterprise networked manufacturing based on component BRFC was demonstrated in detail.

Integration requirements of WLPD and SAP R/3 ERP system are shown in figure 6. By implementing secondary development to remote function call module of SAP R/3 ERP system, component BRFC is created according to different integration requirements and integration of these two systems is realized in the form of applying PowerBuilder plug-ins in WLPDM system.

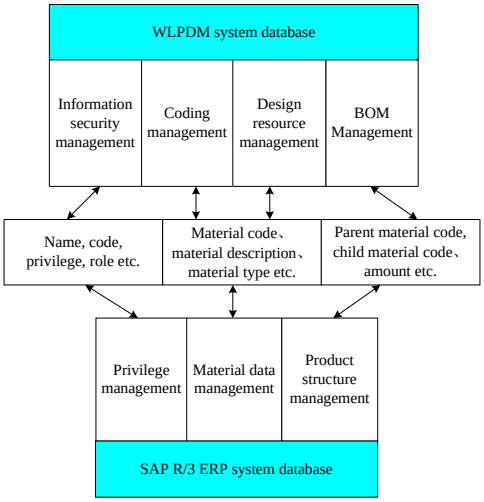

Fig.6 Integrated requirements of WLPD and SAP R/3 ERP system

The process of creating component BRFC by implementing secondary development to remote function call module of SAP R/3 ERP system is shown as follows:

(1) Creation of interface layer: The name BRFC_MATERIAL_GET_ALL conformed to the standard is created for component BRFC, and definition of relative properties is shown in figure 7;

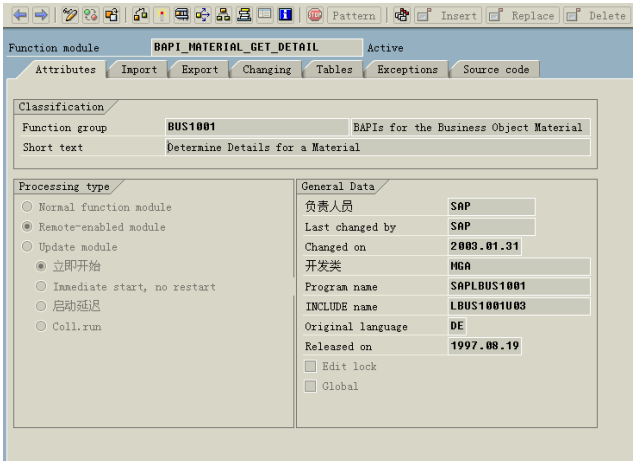

Fig.7 Interface to create interface layer of component

(2) Creation of channel layer: After analyzing the relative data of the material received from interface layer, it acquired the characteristic sets of integrated operations between systems such as CHECK_OUTPUT_DETAIL、CHECK_NAME、FILL_MESSAGE_NO_MARC and so on, which are shown in figure 8.

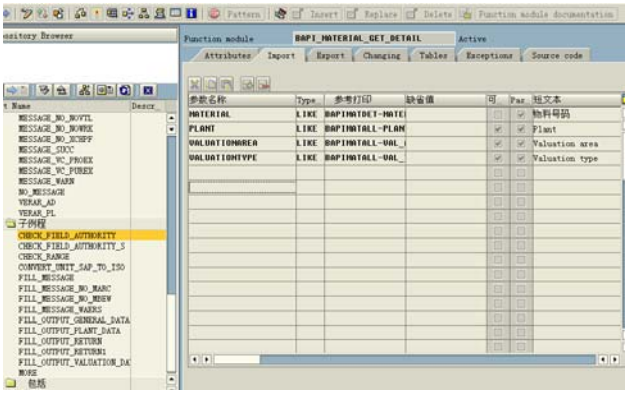

Fig.8 Interface to create channel layer of component

(3) Creation of consistency layer: The correction examination to acquired operation characteristic sets and enforced constraints about the value and its range which is already defined are implemented, and is shown in figure 9.

(4) Creation of core layer: Analyze the characteristic sets of integrated operations; create the corresponding executive programs which are awakened in the circumstance shown in figure 8 to visit the bottom data. In the meanwhile, the program should be compiled according to the semantic description. This part will be strictly exclusive to the exteriors.

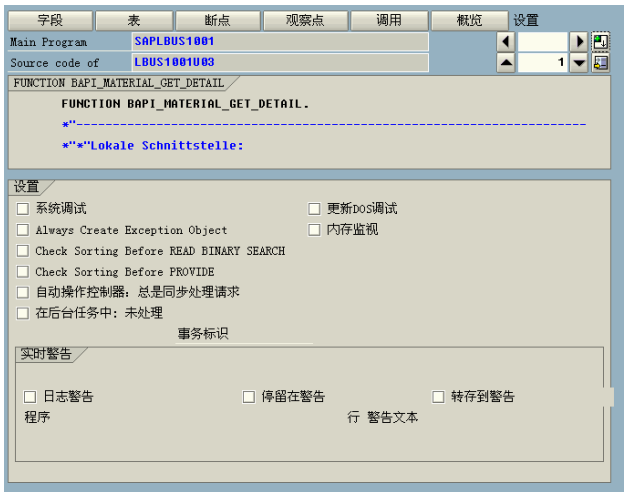

Fig.9 Interface to create consistency layer of component BRFC

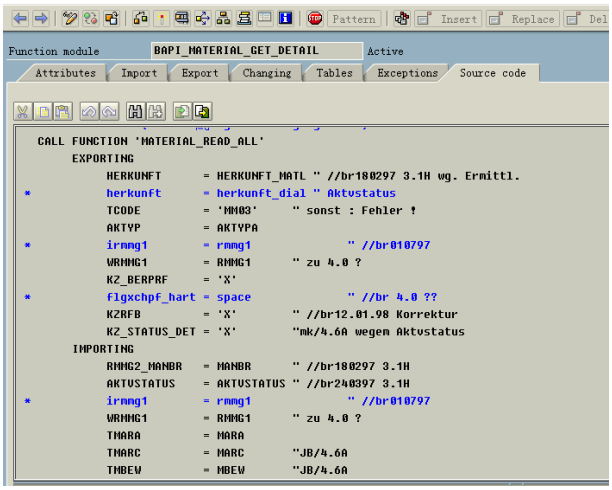

Fig.10 Interface to create core layer ofcomponent

The method of realization of component BRFC corresponding to other integrated requirements is similar to the one motioned above, so unnecessary details needn't to be given here. The method to apply PowerBuilder control to call BRFC is described as follows:

R_object = create oleobject//define connection object

R_object.ConnectToNewObject("SAP.LogonControl.1") //control

R_con = R_object.NewCon

R_con.Language = "EN" //language

R_con.User = "User" //user name

R_con.Password = "Key" //password

R_con.Client = "001" //group code

R_con.ApplicationServer = "10.0.0.1" //IP

R_con.SystemNumber = "11" //system number

R_fun = create OLEobject //define function object

R_fun.ConNewObject("SAP.Functions")

R_fun.Con = go_con

R_fun0001 = create oleobject //define table

……

go_funn.Add("BRFC_* ") //call component BRFC

go_fun00001.Exports("MARC").value = //input data

……

lb_return = go_fun00001.Call() //connect and return the result

o_table.value(n) = //output data

……

Integration of relative data and operation in material main data and BOM management between WLDPM and SAP R/3 ERP systems is realized based on component BRFC technology, software interfaces are shown in figure 11、figure 12. The interface to create material main data is shown in figure 11, and the material will be both created in WLDPM and SAP R/3 ERP systems when it's created. The process of creation is restricted by constraints of these two systems, and feedback to the result of creation will be acquired. Figure 12 shows the failure to create BOM, and acquirement of interface with fail information feedback shows component BRFC technology could achieve higher reliability and safety in integration.

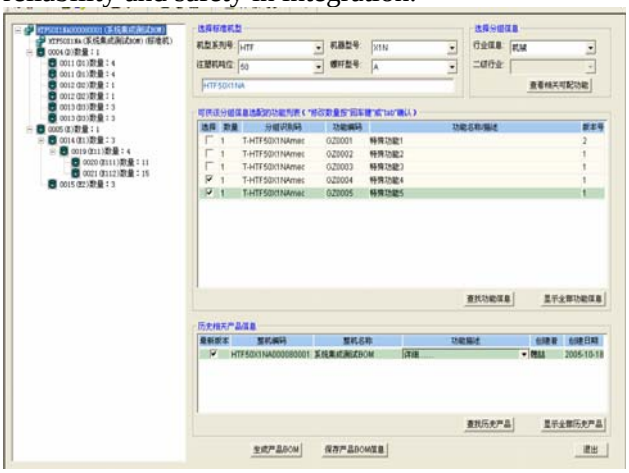

Fig.11 Interface to create material main data

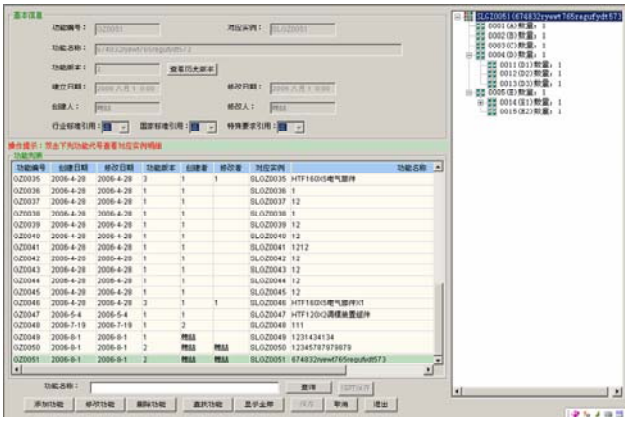

Fig.12 Integrated interface to create BOM

6 Conclusion

ERP and PDM heterogeneous data system integration is one of the key factors to affect the successful implementation of advanced technology of independent enterprise networked manufacturing. On the bases of the analyzing requirements of ERP and PDM heterogeneous data system integration, this paper put forward a component interface technology for the ERP and PDM heterogeneous data system in the environment of networked manufacturing, then descript the component interface semantically and constructed the model of component interface. Through researching on the structure、realization、interview of component BRFC and demonstrating on its technologic advantages, it also illustrated the concrete realization process of component technology and satisfaction to integrated constraints for containment, cooperation, composition and reusability. Finally, an application example of typical integration of WLPDM and SAP R/3 ERP in WLNM network manufacturing platform of WOLONG electronic crop was provided, and the heterogeneous data system integration technology in independent enterprise network manufacturing based on component BRFC was realized with good applying effect. The instance shows that the method is not only practical and efficient but also it has an important realistic meaning.

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