

## Process Planning Service Mechanism Based on SaaS Mode

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**Abstract** *Software-as-a-Service (SaaS) is a new mode that the software is deployed as a series of services on the Internet. The customers could choose the necessary function services or the better services to meet their normal and individual requirements. For process planning is a highly individual work, Process planning service mechanism based on SaaS mode was proposed and researched. The service-oriented architecture of CAPP was established. Process planning services were designed to service components, which could communicate each other with messages. The thought of Process Service Bus (PSB) was put forward and applied to manage the process planning services needed in real time. On this basis, a case was analyzed to show how to apply the service mechanism to gears process planning, the feasibility and validity of the process planning service mechanism were demonstrated by the case.*

**Keywords** *Process planning Software-as-a-Service Service-Oriented Architecture Process Service Bus*

### 1. Introduction

With the development of China's manufacturing informatization technology in the last decade, the technology informatization (CAD/CAM) and management informatization (PDM/ERP) have made significant achievements and brought certain economic and social benefits to the country and enterprises. However, in actual production circumstance, process planning is considering as the connecting bridge between product design and manufacture, whose informatization degree lags far behind the actual application requirements<sup>[1]</sup>. The development and commercialization of CAPP are difficult, even become a bottleneck of the application of CIMS, which can be ascribed to the complicated and changeable characters of process planning project. Not only does process planning exist in almost all production activities including product design, production schema, shop fabrication, stock management, quality management, sales management, cost management and other business activities, but also be related to parts' types, product structures, technology and equipments and so on. Furthermore, it is influenced by personnel practical experiences and the constraints of production management system, any change of these factors may lead to revise the process planning project. For the actual state and conditions of different enterprises are different, there are various different process planning requirements. Further speaking, the individual process planning service of the CAPP system can become a decisive factor for the development of CAPP systems.

A flexible multi-user service mechanism is needed to meet the enterprises' individual requirements. In detail, the system architecture, the service management and the serving model of CAPP must be unified, complete and agile. Ref.<sup>[2-5]</sup> gave some researches on CAPP system architecture using components technology. the related CAPP system architectures are classified as traditional system architecture, which is need to be revise wholly when system updating or modifying are happened because the connections among components are tight coupling and complex and the communication standards are different. Ref.<sup>[6-9]</sup> constructed CAPP systems with web services. Although these studies were still based on traditional system architecture, they provided us one new thinking way: forming system with services, just like Web services. With the emergence and application of Service-Oriented Architecture (SOA), it became a hot point doing research on CAPP based on SOA. Because the interface between the modules in this

architecture is unified and standard, different manufacturers provide integrated solutions for better compatibility between each other, and the architecture is easy to be extended while the business expanding. The attendant problem is about service management, namely, how do the service "components" run in the service-oriented architecture? Ref.<sup>[10,11]</sup> adopted the thought of Enterprise Service Bus(ESB) when building system architectures and which can be used for reference. ESB shows that the services are distributed and are connected via bus-like method, which supports message communication and data dynamical interaction based on a widely accepted and open standard. Process Service Bus (PSB) is proposed to express process planning service management clearly. So far, it is still not enough to meet the multi-user individual service requirements, given that the service thought claims to choose and configure services according to the users' practical requirements. Traditional CAPP systems are set up in the users' computers as a whole software, and most functions of the software are not be needed or are not suitable for the different applying environments. So a better serving model is needed. Ref.<sup>[12-16]</sup> described one serving model named as Application service Provider(ASP) and Ref.<sup>[17,18]</sup> discussed the applications of ASP. However, ASP is just a primary serving model. Ref.<sup>[19-22]</sup> used an advanced serving model, Software-as-a-Service(SaaS), which is more comprehensive and sophisticated.

It is summarized that SOA,PSB and SaaS are coincident, trying to provide customers with flexible, diverse and personalized services, rather than a fixed, simple software. In the paper, process planning service mechanism based on SaaS mode is proposed and be researched detailedly.

## 2. SaaS Mode

SaaS is a mode of software service by renting software or on-line services<sup>[23]</sup>. The core of SaaS is deploying software into services and accessing services via network. Software vendors provide services such as maintenance, daily operation and technical support service, which conveniences users to focus on their own business, regardless of the purchasing related hardware and software, and the cumbersome system maintenance and upgrade. This service mode has much difference from the traditional software services mode, especially on the ways of paying, deploying, serving, using and upgrading<sup>[24]</sup>.

SaaS maturity model is assorted into four grades according to the data structure and deployment for customers<sup>[25]</sup> (see Fig.1).

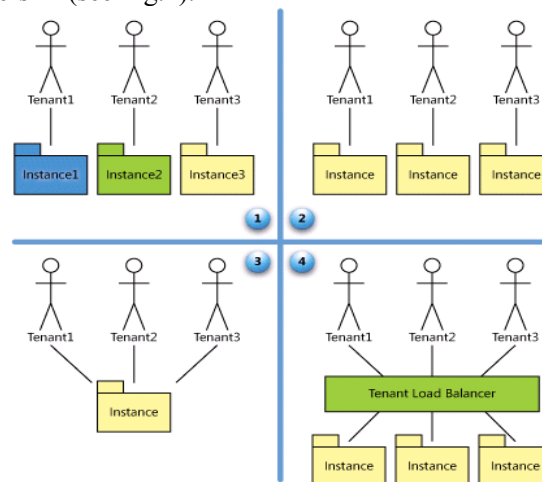


Fig.1. SaaS maturity model

On the first grade, Application Service Vendors offer individuals a customization sample, which includes independent database, virtual content, website, etc. what the software provides is not a service but an application to each customer. Software vendors haven't consider the various

needs of customers as a whole, thus the personal demands wouldn't be better satisfied. The ideal SaaS model should be the fourth grade: the clients connect into the server cluster, and a layer used to balance the loads of clients is added between clients and servers, which also can deal with the customization, expansibility and the efficiency of multi-tenant. So it is regarded to meet the demands of customers excellently and solve the load problem by coordinating the multi-tenants.

On the one hand, the processes of domestic commercial CAPP have fixed in the procedure, which results that the system can not respond to the part's process changes to meet individual customer requirements opportunely. On the other hand, Most of systems, designed by one common process planning management model, couldn't meet individual customer requirements, So the workload of software development increases while the software life cycle shortens. CAPP lags behind the use of modern information-based manufacturing requirements due to the particularity and complexity of process planning. SaaS model provides a good solution for the development of the CAPP system. In this model, customers will consider that each service is provided as their needs.

### 3. Process Planning Service Mechanism

In the SaaS model, to provide customers with individual services, the CAPP system must be studied in the aspect of process planning service mechanism, including system architecture, design & realization of process planning services and service management mechanism and other relative problems.

#### 3.1 System Architecture

CAPP should not only be general but also adaptable to different requirements of individual users, which determines the system itself should be flexible. According to the SaaS model, software vendors provide process planning services to users, and users access to services after registering and searching. It should be emphasized that the provided software must be in the form of services. When service-oriented architecture (SOA) is introduced to CAPP system, independent, standard and loosely coupled services could be provided because these services in SOA architecture can be configurable, reconfigurable, scalability. In accordance with the thinking of SOA<sup>[26]</sup>, CAPP system is divided into multi-level services, business could be completed by calling services. Users can invoke services dynamically and configure on-demand system and choose the right interface style, business processes and management through customizing services.

The architecture is divided into four layers: the user layer, business layer, services layer and data layer (see Fig.2).

(1) User layer. System users are classified into enterprise users and individual users. Users login in system with Web browser or other network equipments directly after identity authentication.

(2) Business layer. In accordance with process planning task, process management modules invoke appropriate services through PSB. For process planning is multi-threaded task, a number of process management modules may be needed., but there is only one process management center that harmonizes and controls their work process.

(3) Services layer. This layer contains four categories of basic services: process planning service, process service, process rules service and basic system service (such as data service, logical service, agency service). Each type of services contains many fine granularity services. These services can be searched and used after services registration by UDDI<sup>[27]</sup>, short for Universal Description Discovery and Integration. The whole system is based on the SOA architecture and the services are independent, standards, loosely coupled and call or visit each other by process controlling, information mapping.

(4) Database layer. It supports the system data provision and contains process knowledge

database, process files database, process resources database and process cases database. Users can customize the type and structure of the database and add, modify or delete them without having any impact on other users’.

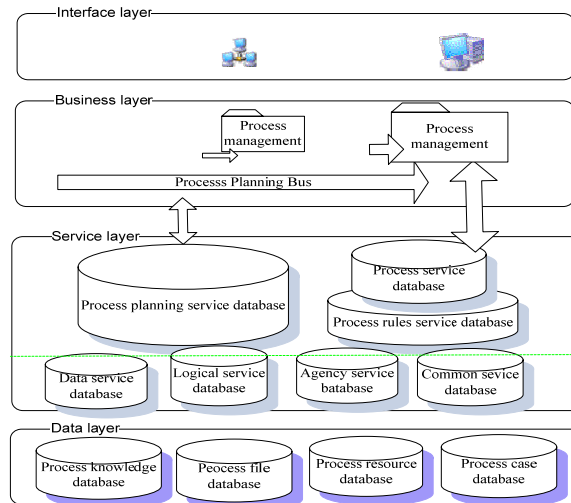


Fig.2. the framework of CAPP system

### 3.2 Design & Realization of Process Planning Services

Generally, a service describes the input and output parameters, right, accessing control lists, security and the quality of service (priority levels, delivery, transaction characteristics, recovery semantics, etc.) and services levels, including response time, availability rate. Under an ideal circumstance, process planning services could be designed in accordance with the existing definition of the domain. If the existing CAPP systems are expected to be reused, process planning services could be got by packaging components interface, traditional message format or APIs. The common service design method is that classifying functional services wholly with top-down manner, these coarse granularity services could be further classified fine granularity services or atomic services. According to the analysis of the process planning field, seven categories services are abstracted: CAD parts information service, process decision service, process edited service, manufacturing resources service, process data service, process knowledge service and output of process service. Messages transfer among the seven services (see Fig.3).

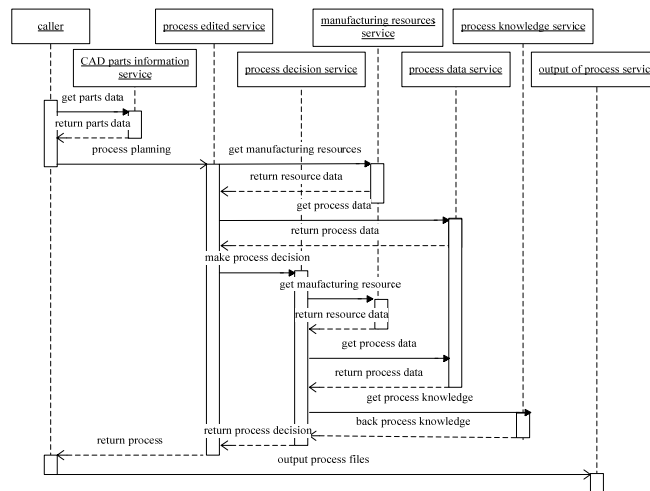


Fig.3. Message Passing among services

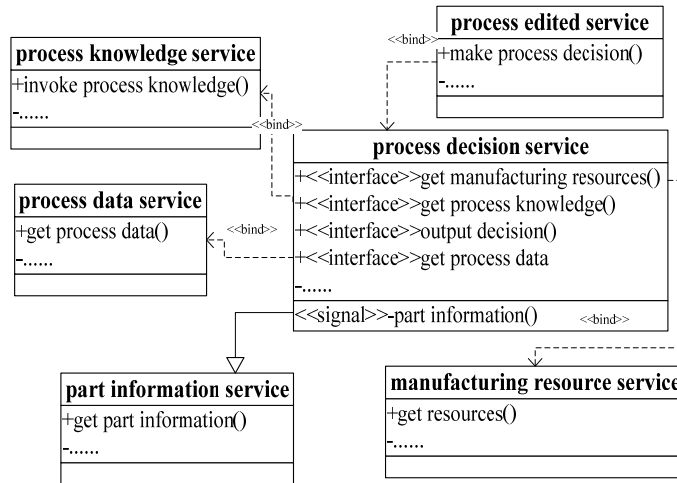


Fig.4. the interfaces of process decision service

In the service-oriented architecture, it is necessary to ensure that services are loosely coupled and can be dynamically discovered and bound to other services in order to deal with changes in business processes or interactive partners flexibly. So process planning services are packaged into Service-Oriented Component models, which could afford one kind uniform invoking way for different interfaces<sup>[7]</sup>. The Component declaration should be took to regard service as component like as following:

```

<component name=" ProcessOrderComponent ">
<implementation.java class="ProcessDecision.ProcessOrder "/>
<reference name="addService">ProcessDivivdeComponent
</reference>
</component>
    
```

**3.3 Process Service Management**

All functions provided as services, only is there a reasonable mechanism for service management, users’ requirements would be met. PSB is proposed to manage the services in the process planning system. It is an architecture mode, supporting virtual communication, interaction among services and services management. It affords the connection between the service vendors and requesters, even the services are not perfectly matched. The services participants don’t interact directly, but through PSB, which supplies management functions and virtualizations, including the location and identity, interactive protocol, Quality of Service (QoS), and many other virtualizations, to achieve and expand the core services definition.

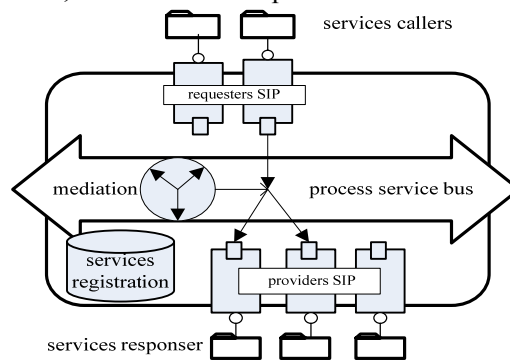


Fig.5. the basic PSB mode

In the basic PSB mode, the message flows link the various communication participants into the bus (see Fig.5). Some participants invoke the provided services while others just are interested in the published services information. The endpoint that services and PSB interact is named Service interactive point (SIP), which could be web services endpoint, WebSpere Message Queue, or Remote Method Invocation (RMI) agents. The service registering table captures the following metadata: the requirements and functions of SIP, the hoped interaction ways (synchronous or asynchronous, HTTP or JMS, etc.), the requirements of QoS (the first safe choice, etc.) and other information about supporting other SIP. Process planning services put messages on the bus or take away from the bus. SIP will deal with these dynamic messages and ensure the QoS of the hosting interactions.

#### 4. Application

The case is about the application in a gear enterprise, which has an annual output of 1.5 million middle-module gears and 50 thousand spline shafts and other gear boxes. In accordance with the requirements of the function of the system, the coarse- granularity process planning services were: gear aided design service, gear intensity checking service, process edit service, typical process management service, users management service, gear routing service, etc. Fine-granularity services were defined based on detail function requirements. Interfaces and function of each service were designed.

Take gears routing service as an example, the correlation between gears routing service and other services was described and the interfaces could be defined (see Fig.6)

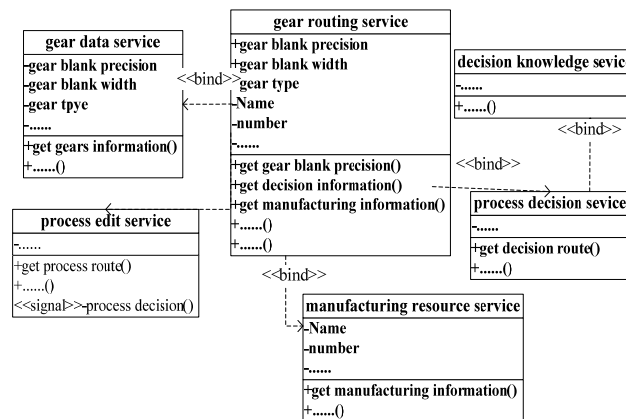


Fig.6 the interfaces of gears routing service

It was designed with Java language and packaged into service component, the following Java code described the interface definition and function realization of gear routing service:

```
package services.GearRouting;
public interface GearRoutingService
{
    String getGearInfo(String info);
    String GetGearRouting( String info );
    String SendGearProcess( String routing );
}
Package services. GearRouting;
import org.osoa.sca.annotations.*;@Service(GearProecess; class)
public class GearRouting
implements GearRoutingService
{
    public String getGearInfo(String info){...}
```

```

public String GetGearRouting( String info ){...}
public String SendGearProcess( String routing ){...}
}
    
```

PSB was realized by Model Driven Architecture (MDA). In practical application, the core services were retrieved and matched from the local service or network database. The so-called process planning system was in essence composed dynamically with scalability, agility and availability. Fig.7 shows the dynamical correlation of services on the PSB.

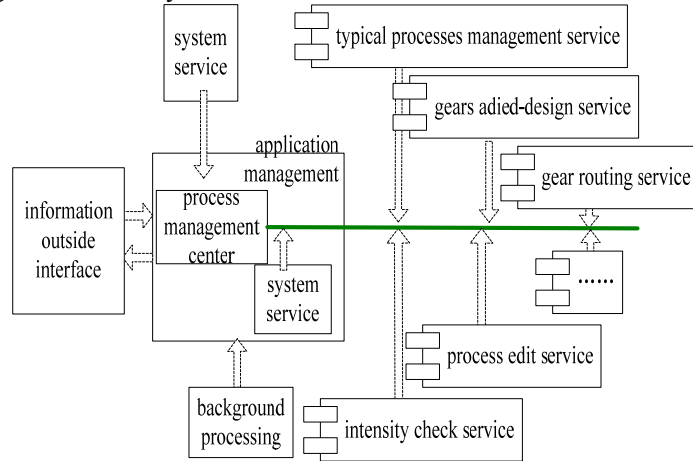


Fig.7 The dynamical correlation of services on the PSB

More efficient and robust process planning services were needed to be searched to meet the process planning requirements in a high extent. The user interface was different with different practical requirements. The interface of gear process planning system was designed as web pages(see Fig.8).

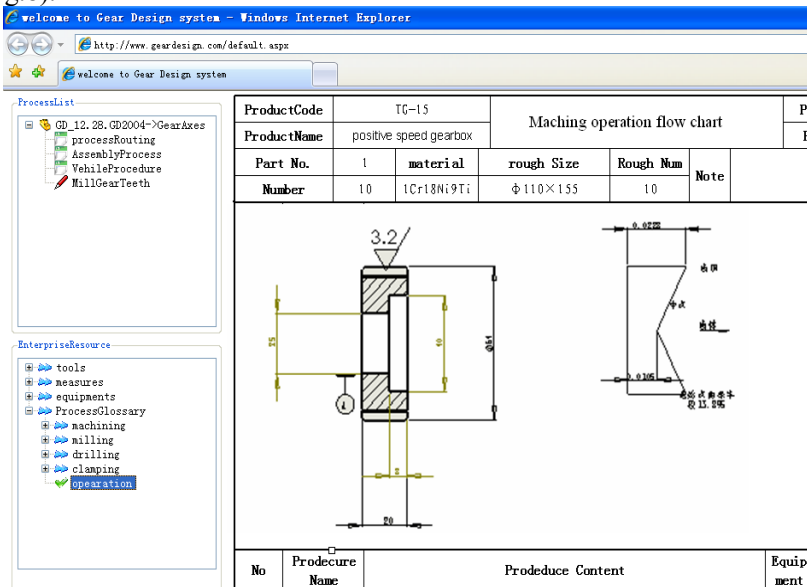


Fig.8. interface of Gear process planning system

### 5. Conclusion

This paper researches on process planning service mechanism, including how to compose

process planning service-oriented architecture based SaaS model, design & realization of process planning services packaged as service-oriented component and process service management with PSB. CAPP system based SaaS model represented the developing direction on the network, personalized, flexible, modular, and integrated. It does not only show its advantage in information technology costs, efficiency to small and medium enterprises, but also meets the needs of different business' personalization process planning requirements.

It is still the primary stage that SaaS mode is applied in process planning, although some achievements and progress have been made, the feasibility and practicality of process planning service mechanism based on SaaS mode remains to be proven in actual production.

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