A DYNAMIC CUSTOMIZABLE ARCHITECTURE FOR SAAS BASED PLATFORM

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ABSTRACT

The characteristics of multi associations business coordination among the enterprises in industry chain is firstly analyzed, and the demand of customizable business of SaaS(Software as a service) based platform supporting the industry chain coordination (in brief, PLATFORM) is intensively analyzed. Based on these, customizable business-oriented PLATFORM architecture based on SOA is designed in the paper, which takes support layer as the foundation, takes bus layer and service layer as the core and takes customizable application layer as the target. Based on the architecture, application layer can provide simple, convenient, rapid support for SaaS based business customization and system applications, based on the rules of dynamic union building, business functions configuration and personalized functions configuration. Application results show that the customizable business-oriented architecture of PLATFORM proposed in the paper can well satisfied a variety of requirements for customizable business due to the business characteristic includes variability, dynamic and multiplicity from different alliance enterprise in the PLATFORM.

Keywords: *Industry Chain, Business Coordination, SaaS Based Platform, Customizable Business, Architecture.*

1. INTRODUCTION

SaaS platform is a kind of third-part service platform which allocates leases and managers application service through internet based on SaaS (Software as a Service, SaaS) mode. As a product of integrating informatization and servitization[1] , SaaS platform can provide third-part informatization support for enterprises in an industry chain with advantages in resource, efficiency and cost. Currently, the development of SaaS platform has become an important trend in manufacturing industry chain [1]-[4]. The development of SaaS Platform, which is aiming to support industrial collaboration, has achieved significant breakthroughs[5].

However, it will lose the meaning and advantages of the saas platform, if we conducted one-on-one systems development and maintenance in order to meet the needs of different collaborative business among the different alliances, different types of enterprises and different roles of users in the collaborative environment of the industrial chain which have the different, multiple and dynamic characteristics. Therefore, the question of how to support the business collaboration among more than one alliance and many types of enterprises by setting only one systems and its maintenance plan becomes one of the key issues to be addressed. At present, to adapt to the changing needs of users, the design concept of the "customization on demand" software has been gradually on the rise, and is considered to be the future development direction of software industry[6]-[8]. However, most of the present literatures even more concerned about programming models, customized software model, organization, etc[9]-[11]. but pay no attention to the customizable architecture, business customizable rules, design and implementation of the system based on the PLATFORM.

Hereby, based on the experience in development and application of a product of Chinese national high-tech program, i.e. the SaaS based coordination platform for automobile industry chain (in brief, PLATFORM), Focusing on the research on how to build customizable PLATFORM to support the business collaboration among enterprises in multi-alliances or cross-alliances, the characteristics of multi associations business coordination among enterprises in industry chain is firstly analyzed, and the demand of customizable business of SaaS(Software as a service) based platform supporting the industry chain coordination (in brief, PLATFORM) is intensively analyzed. Based on these, customizable business-oriented PLATFORM architecture based on SOA is designed in the paper, which takes support layer as the foundation, takes bus layer and service layer as the core and takes

customizable application layer as the target. Based on the architecture, application layer can provide simple, convenient, rapid support for SaaS based business customization and system applications, based on the rules of dynamic union building, business functions configuration and personalized functions configuration. Application results show that the customizable business-oriented architecture of PLATFORM proposed in the paper can well satisfied a variety of requirements for customizable business due to the business characteristic includes variability, dynamic and multiplicity from different alliance enterprise in the PLATFORM.

2. CUSTOMIZABLE BUSINESS DEMANDS OF THE PLATFORM

2.1 Characteristics of PLATFORM Support for Collaborative Business

The incentive of market competition promoted socialized cooperation and specialized division of labor of the automobile industry chain, in the environment of the whole industry chain, it gradually formed a single chain and cross-chain collaboration, which takes the entire vehicle factory as the core. Under the cooperation environment of the single-chain, groups of suppliers, dealers and service stations take the vehicle manufacturer as the core to carry on the collaborative business of purchase, sales and service separately; Under the cooperation environment of the cross-chain, one collaborative enterprise may carry on collaborative business with more than one vehicle enterprise, then, multiple collaborative enterprise and multiple vehicle enterprises have formed a many-to-many and crisscrossing collaborative system. Around the collaborative system of the single-chain and cross-chain industrial chain, the PLATFORM can provide the all-in-one solution to support the automotive industry chain collaboration, and the solution is suitable for the characteristics and needs of the socialized collaboration in the automotive industry chain, also fully demonstrate the concept of modern marketing and services, the program can provide the comprehensive ability including large mass customization, social inventory management, parts management, integrated management of old parts, service-oriented product support technologies, etc, which take the purchasing business, service business and sales business, etc as the core. Features of the PLATFORM are as follows:

(1) **Ability of Supporting for the Collaborative Business of the Single–alliances**

1) Providing the support for the collaborative business taking the manufacturing enterprises as the core: supporting for "one to many" collaborative business around the manufacturing companies –that is to provide support for one vehicle manufacturing companies to collaborate with various types of collaborative enterprise, it consists of coordinating purchase system, coordinating sales system and coordinating service system for the manufacturing companies.

2) Providing the support for the collaborative business taking collaborative enterprises as the core: supporting for "one to many" collaborative business around the collaborative enterprises –that is to provide support for the collaborative business of multi–association taking the collaborative enterprises as the core, according to the different types of collaborative enterprises, the PLATFORM can provide suppliers-oriented collaborative supply system, dealers-oriented sales system and service station-oriented service systems. Each kind of collaborative enterprise can carry out work by entering the corresponding collaborative system according to the collaborative category in a different alliance, the PLATFORM will individually configure respective collaborative service system for different alliance, the service station can access any one of the service collaborative system, at any time and in accordance with need to convert to the other two systems.

(2) **Ability of Supporting for the Collaborative Business of the Multi-alliances or Cross-alliances**

The PLATFORM can provide the support of crisscrossing collaborative business which spreads across to "many alliances", this is the important characteristic which is distinguishes between only supports the collaborative business of the single-alliance or only supports the interior collaborative business of the single enterprise through the information system.

2.2 The Demands of the Customizable Business PLATFORM

As the platform has to simultaneously support all the business collaboration among the enterprises in single -alliance, multi-alliance or cross-alliance, the demand of the customizable business PLATFORM by different types of enterprises in different alliance are as follows:

(1) The alliance of the PLATFORM can be customized: The PLATFORM provides web-based operation of business collaboration; the collaborative content, collaborative requirements and collaborative protocol among enterprises in different alliance are not exactly the same, so the

PLATFORM should have the ability of supporting the alliance being customized.

(2) The business of the PLATFORM can be customized according the type of the enterprise: In a single-alliance, the types of collaborative enterprises around the vehicle enterprise include suppliers, dealers and service stations; the collaborative content is different between different types of enterprises and vehicle enterprise, so, the PLATFORM should have the ability of supporting the business being customized according the type of the enterprise.

(3) The business of the PLATFORM can be customized according the type of the users: Since the type of the users in one enterprise exist the features of diversity and levels, the PLATFORM should have the ability of supporting the business being customized according the type of the users.

(4)The demand of the rapid customization business functions due to dynamics of the collaborative relationships: Collaborative work process taking the vehicle enterprises as the core in the industrial chain is a continuous optimization process, In the collaborative process, the vehicle enterprises can eliminate poor performance collaborative enterprises and add new cooperative enterprises at any time, so that the industrial chain can be optimized continuously and its overall competitiveness can be improved[1]. Therefore, the PLATFORM should have the ability of configuring the corresponding business functions fast for related enterprises according to the change of the collaborative relationship.

(5)The demand of the rapid customization business functions due to dynamics of the collaborative content: Alliance of industry chain collaboration is the result of competition and profit-driven, its cooperation contents would change along with the profit relations, the competition environment and business development. The new collaborative business point may be continually

growing; the old business point may be eliminated at any time. Therefore, the PLATFORM should have the ability of configuring the corresponding business functions fast for related enterprises according to the change of the collaborative contents.

3. DESIGN OF THE SOA-BASED SAAS PLATFORM ARCHITECTURE ORIENTING THE DYNAMIC CUSTOMIZATION BUSINESS

The SOA-based SaaS platform architecture has been designed to meet the needs that the platform business can be customized in the paper, which can be described by the support layer, the service layer, the bus layer and application layer, as shown in Figure 1.

(1) Support layer

Support layer is the foundation of SOA architecture, it gives the statute and application context, such as the description of web services, dynamic registration, dynamic discovery and invocation, services quality and so on, which makes each service cooperate mutually in SOA. The statute of the Web service provided by support layer include: XML, WSDL, SOAP, UDDI, QoS and so on. WSDL defines a set of XML-based syntax, is to describe the format of the Web service, including the service name, service name of the machine, listen port number, the transmission parameter type, the integer and the order, the type of the returns result and so on. SOAP is a simple cross-platform communication protocol for exchanging information in a distributed environment based on an XML. SOAP defines a messaging framework including the envelope, the encoding rules, binding and the PRC, envelope describes the message content, the sender, the receiver and the processing request; encoding rules represent the instance of the data type which service consumer need to use; binding defines the underlying communication protocol for message exchange; RPC is a agreement for remote procedure call and answer. UDDI is the
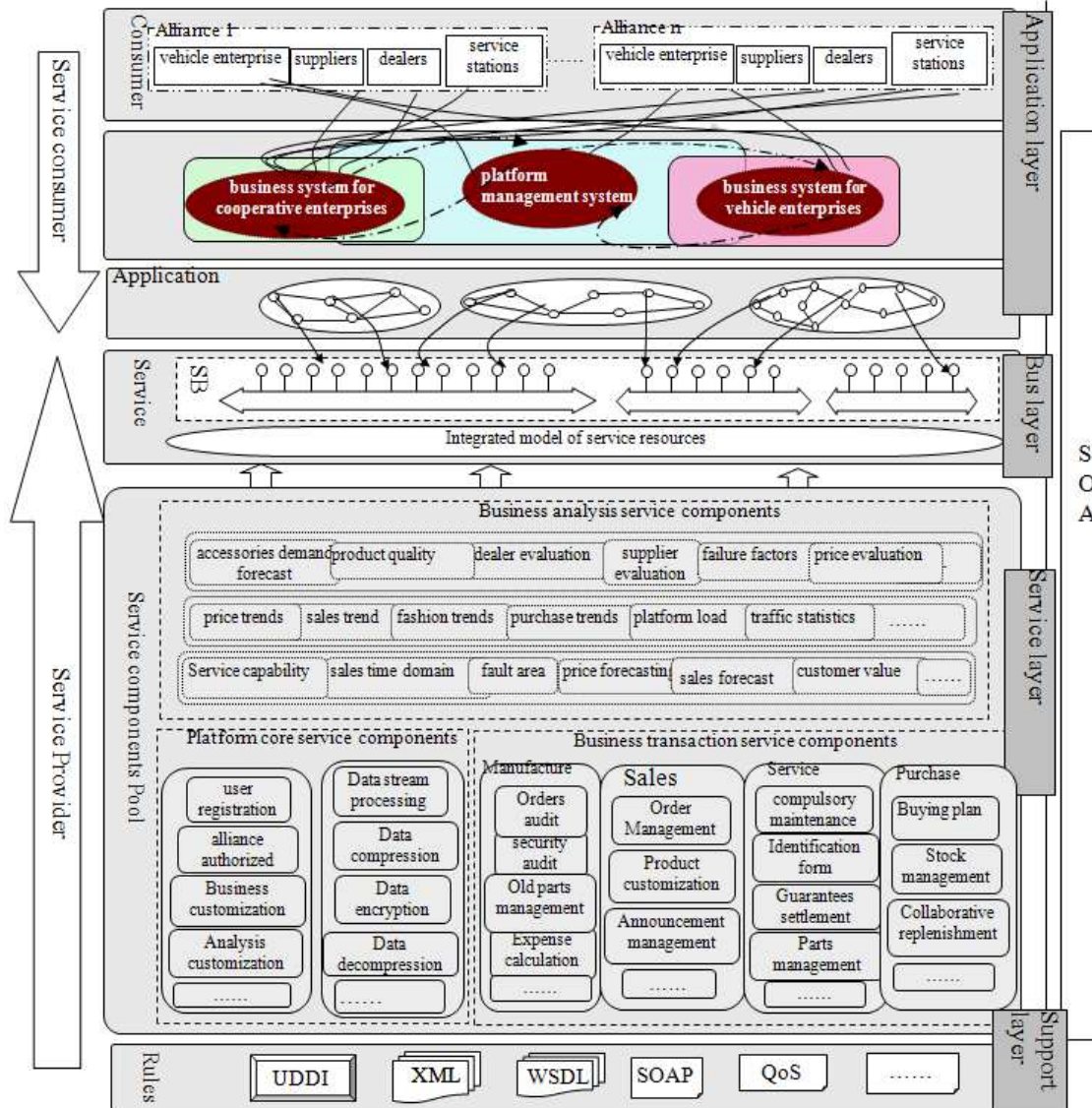
Figure1. The SOA Based SAAS Platform Architecture

realization standard of information registration center, which used for used for centralized storage and finding the WSDL description file, plays the role of the directory server. QoS is a set of criteria, rules and properties set of service quality.

(2) Service layer

Service layer is basis layer supporting for system configuration, reusable, loosely coupled and interoperable, it is like a large pool of service components, consisting of two broad classes of services components, i.e. public service components and business services components. Public services component is standardized norms, protocols, or service components which "stripping" out of the system and independent of the specific application,

it includes user management, alliance relationship management, security management, communication services, etc. Business service components include business processing components and business analysis components, Business processing component provides a variety of daily business processing functions such as order submission, identification documents audit, and three bags of settlements, stock inventorying, old parts management and other functions. Business analysis components provide various types of daily statistics, analysis, forecasting and assessment functions such as product quality assessment, sales trends, service capabilities, partner evaluation etc.

Characteristics such as independence and openness of the SOA based architecture not only

enables self-developed components, third-party components and commercialized components be absorbed and used by the PLTATFORM, but also but also supports the service components for dynamic maintenance and updates.

(3) Bus layer

The service bus layer is the "integrator "of public service component and business service components, it enables various service components with the "pluggable" way to insert or allocate so that to meet the different business applications. The bus layer structure shown in Figure2 and its working mechanism is as follows:
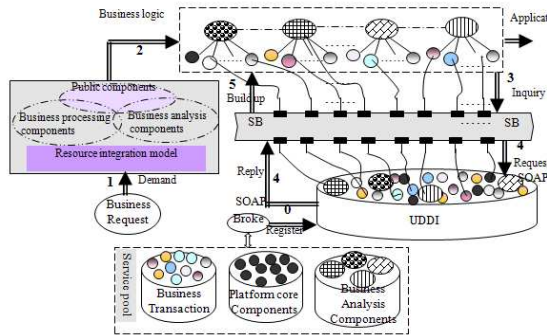

Figure2. Structure Of The Bus Layer

Step1: register serviced components; post the packaged Web Service interface and the description information (WSDL) to UDDI Center to register. The description information includes the component identifier, name, function and dress and so on. Service layer components need to be registered before they can be applied to the platform, maintenance, and management.

Step 2: submit business request, set a business analysis demand for DRi, and clarify its relationship with the platform public business and related business processes.

Step 3: take the DRi as the input of the decision-making support integration model of the PLATFORM, and form the business logic according to the platform resources integration model.

Step 4: soap query message is sent to the service bus (SB) based on business logic, and the related web service component is queried.

Step 5: after SB receives the SOAP inquiry news, gains the WSDL of services in UDDI, and creates the SOAP service request of the required services, then performs the service and replies SB

the processing result by the SOAP news form, and eventually feeds back to the business logic.

Step 6: loop step 3, 4 and 5 to realize the service assembly, and forms a complete service unit process.

Thus, when the service demand change causes the service logic change, just change the requested service, and "pull out " unneeded services or "insert" new services by the SB so as to realize that the business can be customized.

(4) Application layer

The application layer take platform-based collaborative business applications as the goal, depending on the needs that the business of the platform can be customized, provide the functions of customized business, rapid adjustment and personalized application management and so on for the users of different Union, different types of enterprises and different levels.

4. PLATFORM BUSINESS CUSTOMIZATION BASED ON BCA-SOA

On the basis of the development and application of analysis system of the platform, in this section, the business customization rules have been defined and the realization process of the business custom has been discussed.

4.1 Business Customization Rules Based On the BCA-SOA

Platform business custom can be implemented at the application layer in the basis of the design of the support layer, service layer and bus layer, which includes the construction of dynamic alliances, corporate business configuration, user customization business configuration, the customization mechanism of these functions are:

(1) Build rules of the dynamic alliances

Because the SaaS based platform supporting the automobile industry chain coordination only takes the alliance as the union to provide business collaboration between enterprises, building union is the first condition that platform business can be used by the enterprise. Leader, members and their departments, and departmental users of a single union on the PLATFORM have composed alliance tree with the shape of tree structure, because the platform supports the coordination business of the multi-alliances and the cross-alliances, many alliances composed the mutually staggered alliance woods with the branches and leaves to be luxuriant, as shown in Figure 3. The trunk represents the leader of the alliance, boughs represent different

types of collaborative partners, in the figure, ① represents supply collaborative enterprises, ② represents sale collaborative enterprises, ③ represents service collaborative enterprises, ④ represents other types of enterprises, limbs represent some alliance member's different departments, and the leaves represent the department users. The construction mechanism of the alliance tree in the PLATFORM is:

Rule 1: the common rules. The bough of the alliance woods has four kinds of types, initially, the bough is stateless, it takes state at the time of being implanted into an alliance trunk and will be given the corresponding union flag. The similar bough can be implanted into different alliance trunks and be given different union flag, that is, a type of bough can have more than one union flag.

Rule 2: multi-property rules. Initially, the enterprise is stateless, it will be given a certain type of enterprise signs at the time of being added to the corresponding alliance woods, the same enterprise can be given different types of signs in an alliance, and an enterprise may have more than one type of bough flag. For example, the dotted line A indicates that the collaborative type of the enterprises in the alliance tree 2 is both types ② and type ③.

Rule 3: dynamic portability rules. The boughs and limbs of the alliance tree have the dynamic probability. Any tree, any bough and any limb in the alliance woods being removed or implanted should not affect the structures and relationships of the other alliance tree, that is, the limbs and the branches can always be dynamically transplant.
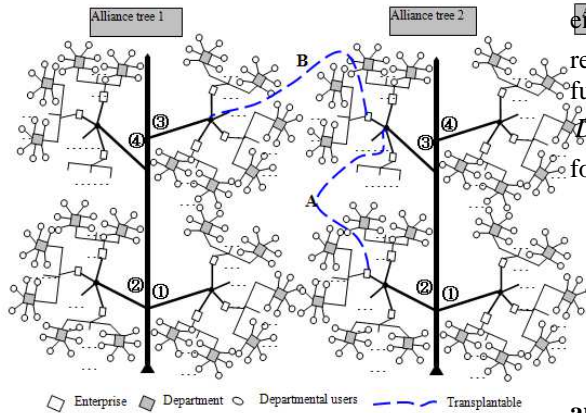

Figure3. The Shape Of The Alliance Tree Structure

Rule 4: Level rules. The terminal operator of the PLATFORM is the department users that are leaves. Initially, the leaves are stateless, when being added to the alliance tree; they are firstly given

departmental signs and then are given the signs of enterprise type and alliance, the construction process of any alliance tree should maintain the level.

(2) Configuration rules of the business function

Rule 5: register business function. All the business functions of the PLATFORM must be registered on the bus to be identified and customized. Initially, all the business functions are stateless, until the business functions are registered on the PLATFORM, they could be given to the types of business functions, and the types include supply, sales, service, supply analysis, sales analysis and service analysis.

Rule 6: the relationship between the business processing functions and the alliance. If we use $B^k = \{b_{k1}, b_{k2}, \cdots b_{k\theta} \mid \theta \geq 1\}$ representing the set of the business processing functions which the enterprise of type K can operate, and use B_i represents the set of the business processing functions which the alliance i can operate, then B^k and B_i met such a relationship shown in formula (1).

$$\begin{cases} \forall k, B^k \subset B_i \\ B_i = \bigcup_{k=1}^{4} B^k \end{cases} \quad (1)$$

Rule 7: the relationship between the business analysis functions and the alliance. If we use $D^k = \{d_{k1}, d_{k2}, \cdots d_{k\theta} \mid \theta \geq 1\}$ representing the set of the business analysis functions which the enterprise of type K can operate, and use D_i representing the set of the business analysis functions which the alliance i can operate, then D^k and D_i met such a relationship shown in formula (2).

$$\begin{cases} \forall k, D^k \subset D_i \\ D_i = \bigcup_{k=1}^{4} D^k \end{cases} \quad (2)$$

Rule 8: the relationship between the business analysis functions and the business processing functions. All of the business analysis functions on the platform are carried out based on one or more of the business processing functions. Being registered, the business analysis function will be given to the binding properties associated with the business

processing functions. That is, each of the business analysis functions can be bound and associated with more than one business processing functions, as shown in figure 4.
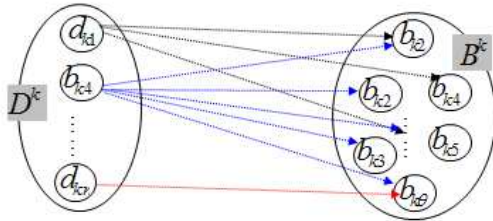

Figure4. The Business Analysis Functions Being Bound And Associated With Business Processing Functions

Rule 9: empower users to use business functions. Empower enterprise users to use business functions are essentially the process of enabling the business on the PLATFORM being bound to the users. Initially, business functions are stateless, and they have the state until they are bound to an enterprise user. Initially, business functions are stateless, and they have the state until they are bound to an enterprise user. First of all, business functions are given the corresponding alliance sign by the administrator of the PLATFORM; secondly, they are given the corresponding signs of enterprise type by the alliance chief; finally, they are given the corresponding user flags by the administrator of the enterprise. Thus, business functions and the alliance users have completed the binding.

(2) Configuration rules of the personalized business

Once the businesses are configured, the different type of users will have the difference and personalized characteristic in the platform application function, the platform should be generated for each user personalization business application interface. As shown in figure 5 for the configuration rules of the personalized business.
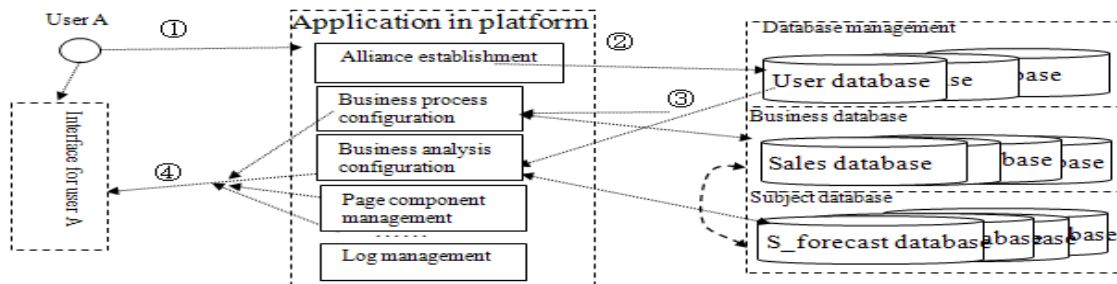
Step 1: user A submits the login information;

Step 2: After receiving the login request message, the platform will query the user A's union formation including the position and relations in the alliance tree in the management database of the PLATFORM

Step 3: the configuration of the he user A's business functions will be queried according to the position and the relations of the user A in the alliance tree.

Step 4: comprehensive the query results of the steps 2 and 3, after joining the corresponding interface components such as page component, the PLATFORM will generate dynamically user A's application interface of the business function.

4.2 The Applications of the Business Dynamic Customization

This research result of this paper has been applied in SaaS based platform supporting the industry chain coordination. (http://auto.easp.cn). Currently, the dynamic customization business has been supported by the PLATFORM for eight alliances, three types of leader enterprises and four types of collaborative enterprises. So far, the PLATFORM has supports more than 5,000 enterprises carrying out the coordination business between cross-alliances. So far, one public components library including user management components, collaboration relationship management components, user role management components, platform monitoring components, message management components, operation log management components etc and five types of business component library including sales business-oriented components, service business-oriented components, supply business-oriented components and analysis oriented components have been established in the PLATFORM; based on BCA-SOA, the PLATFORM can realize various kind of the dynamic customization business for all kinds of the users as easy as a la carte.

Figure5.Configuration Process Of User Personalization Service

5. CONCLUSION

The customizable business-oriented PLATFORM architecture based on SOA is designed in the paper, which takes support layer as the foundation, takes bus layer and service layer as the core and takes customizable application layer as the target. Based on the architecture, application layer can provide simple, convenient, rapid support for SaaS based business customization and system applications, based on the rules of dynamic union building, business functions configuration and personalized functions configuration. And based on the development and application practice on SaaS based platform supporting the industry chain coordination, the instance of the dynamic union building, business functions configuration and personalized functions configuration for users have been expounded in the paper. Application results show that the customizable business-oriented architecture of PLATFORM proposed in the paper can well satisfied a variety of requirements for customizable business due to the business characteristic includes variability, dynamic and multiplicity from different alliance enterprise in the PLATFORM.

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