



Research Article

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## Service-oriented supply and demand network of enterprises

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### ABSTRACT

To realize dynamic, open and multi supply-demand cooperation of Supply and Demand Network of Enterprises with Multifunction and Opening Characteristics (SDN), both the operational mode and implemented information platform were proposed, according to the restrictions existed in operational mode and service platform. A new operational pattern of SDN based on "full open, win-win cooperation" was propose, by bring service operator and platform provider in SDN. With "Decentralized resources centralize management, centralized resources dynamic service" as guidance, the information system framework of service-oriented SDN was proposed, the key technologies of SDN platform were discussed, the feature of service-oriented SDN were analyzed. Finally, a case of service-oriented SDN of small and medium-sized manufacturing enterprises was discussed.

**Key words:** SDN; system architecture; operational mode; business mode; service platform; Cloud manufacturing

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### INTRODUCTION

Along with economic globalization and demand diversification in 21 century, the enterpriser are required to provide personalized, short period, low cost and high quality product and service . To meet the challenges of knowledge economy and manufacturing globalization, Virtual Organization (VO) [1] and Supply Chain (SC) [2] break through the traditional boundary of enterprise, share resource and cooperate synergistically around product, which achieved abundant results in providing high efficiency, high quality and low cost product and service. Rounding the core enterprise, cooperating on product and logistics, there exists limited function, static stability, limited agility, limited integration and limited openness in VO and SC [3], which makes the resource can not been high efficient, dynamical and optimized shared in SDN.

According to the limitation of SC and VO management, aimed to improve the comprehensive abilities of enterprise with global resource obtain, global manufacture and sell, a new manufacture and management pattern with multi flow interact, Supply and Demand Network of enterprises with multi-function and opening characteristics (SDN) was proposed [4]. He [5] discussed the evolutionary and stability of SDN. He [6] discussed the impact of SDN on the traditional Supply Chain management from the complexity view. Xu [4] redefined the primary ideas and essential features of SDN. He Jin [5], He Jianjia [6] and Luo [7] discussed the formation, evolutionary developer, stability mechanism of SDN. Xiao [8] study the Enterprise's Reputation under the Environment of SDN. ZHENG [9] researched the coordination for supply and demand network based on web services and agent. Liu [11,12] proposed suggestions on how the traditional enterprises transfer to SDN enterprise. Tang [13] discussed the synergetic theory and key technology of MC based on SDN. Cheng [14, 15] researched the knowledge management of SDN enterprise oriented collaborative innovation. Li [16] studied the suppliers select evaluation and synergetic of automobile manufacturing suppliers based on SDN. From above, we can get that series of study have been done and get abundant achievements on SDN.

Lacking of effective operational mode and technology platform oriented primary feature of SDN, which restrict the dynamic, multi-function, full open and containment cooperation of SDN enterprise. Along with the development of

Cloud Computing and Internet of Things, intensely manage the dispersed resource and dynamically allocate the centralized resource can be done, which give us new ideas on realizing the core idea of SDN "full-open and win-win cooperation"

The rest of this paper is organized as follows: the bottleneck in SDN implementation is analyzed in Section 2. Section 3 introduces the basic concept, information system architecture, key technology and main features of service-oriented SDN. In section 4 a case of SDN service to small and medium-sized manufacturing enterprises is discussed.

## Bottleneck in SDN implementation

### 2.1 SDN

The supply and demand network of enterprise with multifunction and open characteristics (SDN) refers to a network in a global scope, formed among relevant enterprises by their interaction of "Supply and Demand Flow", with the aim of accessing to global resource, manufacturing and marketing [4]. The supply and demand flows refer to information, materials, funds, technologies, human resources, management, etc, which richer than the flows in supply chain, flow among individuals, organizations and dynamic alliances. The interaction of supply and demand information between nodes built on a unified platform, the supply and demand stream flows among the networks, to meet the needs of each node in a wider range, thereby creating a more global value.

The follows are the key concept of SDN:

#### 1) Dynamic Network Cooperation

SDN is a network composed of enterprises, alliances, and individuals in terms of the dynamic supply and demand. The equal members called nodes. The supply and demand relationships build among any nodes in the network in terms of dynamical, appropriate, time-varying supply and demand.

#### 2) Diversity Cooperation

Breaking through the traditional product-oriented cooperation in supply chain, SDN emphasize the interaction of multiple resources, such as products, information, capitals, talent, technology (knowledge), facilities, management and corporate culture, to meet different supply and demand requirement among different nodes.

#### 3) Full-open Cooperation

Breaking through the traditional supply chain concept, "cooperation in chain, competition inter-chain", SDN emphasize "full and win-win cooperation". Broken the alliance concept, manufacturing which can really achieve global sourcing, global fabrication and global sale to realize the global resource sharing.

#### 4) Inclusive Cooperation

Nodes of SDN, which can be either a single enterprise, also can be a traditional alliance (such as supply chain, virtual organizations, etc.) and various other end-consumers. This special nodes' structure allows SDN abandon the traditional competition-based mindset and integrate gradually into the collaborative environment of SDN.

#### 5) Competitive Cooperation

Competition is the driving force to promote technological progress and social development. As not entirely common interest groups, there always have the competition among SDN enterprises. The features of co-competition facilitate the robustness of SDN.

Therefore, SDN researches are focused on breaking through alliance ideas between demander and supplier, to form a dynamic relationship according dynamic supply and demand in the network, with "full openness, cooperation and win-win" thinking.

### 2.2 Problems in SDN Implementation

Although SDN yielded rich results on open and multifunction cooperation, lack of effective business model and efficient practical platform, which restrict the further promotion and application of SDN

#### (1) Lack of effective business model

SDN is a dynamic interactive network driven by "supply and demand flow" among nodes. Since no nodes responsible for the centralized management of network resources and information, the timeliness, accuracy and authenticity of supply and demand information can not be guaranteed. Lack of centralized management of resources and information, the efficiency of dynamic, open and inclusive cooperation is difficult to guarantee. Poor information sharing between supplier and demander limits the scope and content of cooperation, which can not provide dynamic, optimized resource to demander.

## (2) Lack of unified collaborative platform

Enterprise information system is relatively independent and the business process is relatively fixation, which provides only limited services within the enterprise or among limited enterprises, unable to achieve inter-enterprise heterogeneous information systems interoperate, dynamic resource sharing, intelligent allocation, synergetic collaboration. Lack of a unified information platform, the resource and information within SDN can not be effectively converge, seek, intelligently match, dynamically combine, which limited the implementation and promotion of SDN.

From the view of decentralized resources centralized management and centralized resource dynamic service, SDN needs an information system to converge and manage the resource and dynamically match the demand and service saved in SDN.

## The Business Model of Service-oriented SDN

### 3.1 Opportunities IT brings

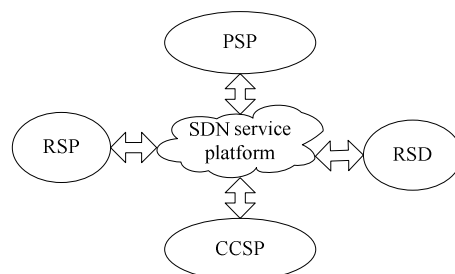
The rapid develop of Internet, Wireless Sensing Technology, Machine to Machine Communication Technology, Radio Frequency Identification, etc, provide a means to solve the information sharing, work organization, intelligent control within person and things, things and things [17]. Embedded Technology provides the enabling technology for the intelligent terminal access physical devices. Semantic Web provides support for intelligent computing based on the knowledge. High Performance Computing provide the possibility for large-scale business cooperation and synergies [18].

Cloud Computing [19] virtual the computing resource saved as cloud, to provide the computing resource in terms of individual and enterprise requirement. Internet of Things [20] realizes the communication, control and management of Things and Things, translating the property of Things to information. Above-mentioned technology proved us not only the ability of comprehensive perceive the natural world and visit the computing resource, but also furnish the opportunity of technical innovation.

Hence, using the core idea of Cloud Computing [21] for reference, bring resource operator to SDN, assembling SDN resource, forming scale effect, improving resource utilization rate, reducing use-cost, advancing division of labor based on specialization, optimizing industrial distribution, to promote enterprise comprehensive abilities. Blending Semantic Web, Embedded Technology, Internet of Things, Cloud Computing and High Performance Computing, service-oriented SDN realize the perception, virtualization, optimal operation and synergetic management of SDN resource. To realize the full open, win-win and high efficient resource sharing and synergy, provide optimized, intelligent management and operation, service-oriented SDN centralize the virtual resource and provide service resource through networks.

### 3.2 Service-oriented Operation Model

Figure 1 shows a service-oriented SDN operation model, the participants include four kinds of roles. Resources Service Provider (RSP) refers to enterprise, enterprises alliance and Individuals, which provide products, information, capitals, talent, knowledge, facilities, management and enterprise culture, etc to SDN. Resources Service Demander (RSD) refers to enterprise, enterprises alliance and personage, which needs the mentioned resource. Platform Service Provider (PSP) refers to enterprises, trade association and local government, which mainly manage resource, demands, RSP and RSD, process management, supply and demand matching, service charges, service quality, etc. Cloud Computing Service Provider (CCSP) refers to Cloud computing enterprises, which provide information technology support and safe operation technology.



**Figure 1** Operation model of service oriented SDN

RSP gains profit through provide the proper resource on SDN platform in terms of the requirement of resource demander. RSD propose the requirement on SDN service platform to get the cooperation and promote the comprehensive competitiveness. PSP gains profit by managing and match the resource and demand, providing the

supply and demand resource collaboration platform to demander and supplier. CCSP gains profit by providing information technology service of hardware, software, platform etc to RSP, RSD and PSP. SDN service platform in charges of the management, operation, maintain, service access of resource and service, which analyzed the demand of RSD and automatically seek optimum matching service resource to provide the service to the user. Service oriented SDN realizes the core SDN ideas of full open and win-win cooperation.

### 3.3 Architecture of Service-oriented SDN Information System Platform

Based on the detailed research on the hierarchical structure and logical relationships, the architecture of service-oriented SDN was established as Figure 2 shows, in terms of the ideals of “centralize the decentralized resource, dynamically provide the service from centralized resource”. Supported on system and security standard of SDN, and Cloud Computing integrative operating environment, the architecture of SDN platform mainly covered 5 levels.

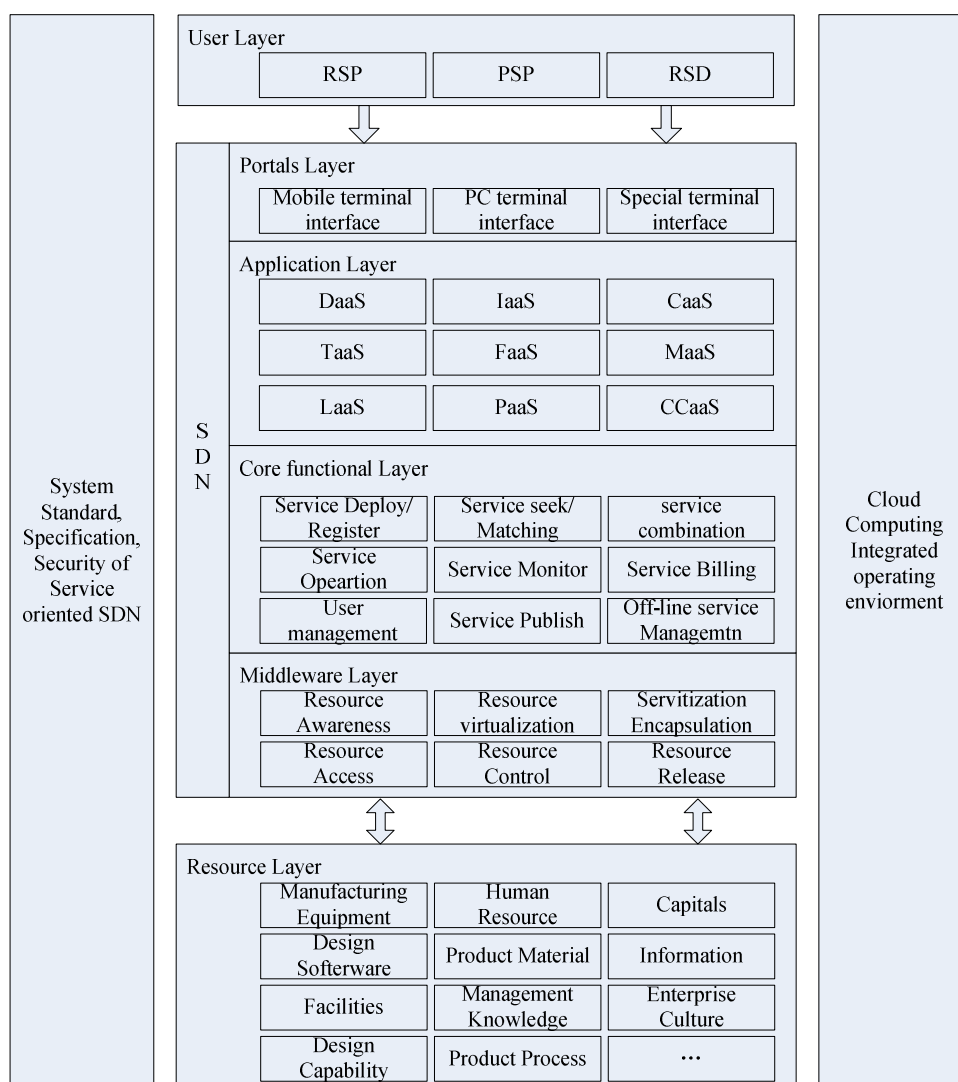


Figure 2 System Architecture of service oriented SDN

#### (1) SDN Resource Layer

The resource of cooperation and transaction in SDN mainly include: 1) equipments, software, products, information, capitals, talents, technologies, facilities, management and enterprise culture, etc, provided by SDN node. 2) Service resources such as professional standards, policy advisory, etc, provided by PSP. 3) Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), provide by CCSP.

#### (2) Middleware Layer

Virtualization is an approach to general accesses and manages all kinds of logic resource, by abstracting the resource, hiding the difference of property and operation. Varied resource in SDN were virtualized to virtual resource, encapsulated to could service, published to cloud service center of SDN, to from a powerful shared virtual

resource pool. So, the middle layer mainly realized the perception, virtualization, service packaging of resource, and the access, control and release of physical resource.

### (3) Core Functional Layer

This layer provide varied comprehensive management to RSP, RSD and PSP, mainly include resource standardization, interface management, service deploy and register service orient to RSP; service seek and optimal matching, service combination and schedule to RSD; user management, system management, service catalog management, service operation and fault tolerance, data management, service monitoring and evaluation, service pricing and charging, provided to PSP.

### (4) Application Layer

Provided varied service, such as Product as a Service (PaaS), Information as a Service (IaaS), Capitals as a Service (CaaS), Talents as a Service (TaaS), Technologies as a Service (TeaaS), Facilities as a service (FaaS), Management as a Service (MaaS), Logistics as a Service (LaaS), Corporate Culture as a Service (CCaaS), Computing as a Service.

### (5) Portals Layer

This layer provide unify user interface based WEB to SDN nodes. User can access varied resource with accordant configuration and authority under any address using any client, such as mobile terminal, personal computer, special purpose terminal, etc.

## 3.4 Key technology

Figure 3 shows the key technology used in SDN information system.

### (1) Overall Technologies

From the view of system to research the structure, organization and operation models, overall technology [22] of SDN information systems mainly include SDN operation, organization pattern; development and application of SDN service platform; standard specification of application; the architecture and service platform of SDN and its autonomy and agility; the pattern of resource sharing, transaction, service-oriented synergy; the standard, protocol and specification of resource connection, describe and access.

### (2)Resource Virtualized Technologies

Virtualization, service packages, register and publication technology according to product, information, capital, talent, knowledge, facility, management and enterprise culture. Main include: resource describe techniques; virtual resource service packaging techniques; virtual resource and physical resource map techniques; virtual resource pool building and manage techniques; virtual resource pool dynamic optimization techniques; virtual resource activation, deploy and monitoring techniques; virtual management and communication techniques [23].

### (3)Integrated Management Technologies

Integrated management technologies (ITM) research the matching, scheduling and combination of SDN resource, provide dynamic, optimized service matching and deploy techniques. IMT mainly include service catalog manage techniques; high efficient, intelligent, dynamic matching techniques; dynamic combinative and optimized techniques; dynamic build and agility deploy in terms of requirement techniques; service price and service quantity techniques; transaction process management techniques; operation monitoring and controlling techniques; high reliability synergy and virtual resource fault tolerant techniques; service quantity comprehensive evaluation techniques; RSD and RSP user authorization, demonstration and log in manage techniques; dynamic task building and deploying, disintegrate, resource service synergy and optimized configuration techniques; automatic dynamic deploy and monitoring techniques; visual operation and monitor management techniques.

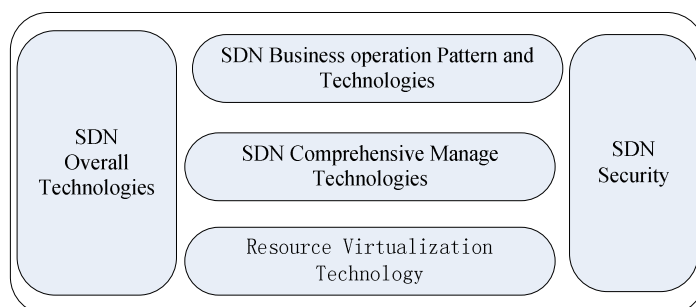
### (4) SDN Service System Safety Technologies

Safety technologies are the safeguard of SDN service stability, safe, effective operation, involving 4 kinds of roles in SDN. The Service system safety techniques mainly include credible access techniques of RSD and RSP; participant credible manage mechanism and realized techniques; service credible trading technology; service safety demonstrate techniques; multi-tenant security isolation techniques; resource rapid deploy and agility evaluation techniques; large-scale multi-tenant techniques; large-scale messages communication techniques; SDN service system reliability, stability analysis and evaluation.

### (5) Business Manage Pattern and Realize Techniques

Business Management Pattern and Realize Techniques mainly research business events and process management techniques in SDN, to provide products, information, capitals, talents, knowledge, facilities, and enterprise culture

service. Such as dynamic enterprises business process building in SDN; business process execution and management techniques; service cost structure, pricing, bargain and operation techniques; license manage and charging, and proper electronic payment.



**Fig 3 Key Technologies of Service-oriented SDN**

### 3.5 The Characteristics of Service-oriented SDN

#### (1) Oriented to service

Different from the traditional model cooperating around product, service-oriented SDN emphasize multi-matter interaction, to share the resource as service in SDN. Different from E-bay and Alibaba, which only provide transaction information, service-oriented SDN provide not only the transaction, but also product design and manufacturing, capitals, talents, logistics service, etc.

#### (2) Dynamic Service and Billing by Flow

The virtual resources of SDN concentrated in the large-scale resource pool, are optimized matched dynamically and intelligently, according to the requirement of demander and supplier. In the service process, the resource type and quantity can be changed elastically, to realize multi-granularity, multi-scale access shared resource. The dynamic cooperative relationships are based on dynamic supply and demand among equal status nodes in SDN. RDS access the resource in terms of demand, billing by used flow.

#### (3) Resource Virtualization

The physical resources distributed on SDN enterprise, but in logically appear as single integral resource to meet the requirement of stretch collect, on-demand service, multi-granularity and multi-scale access. Final, the user access the SDN resource as needed through network, billing by flow, don't need management the resource.

#### (4) Full open based cooperation

SDN break through the traditional Supply Chain ideas, cooperation in chain and compete out chain, to a full open and win-win cooperation model. SDN change the resource allocation model from self-sufficiency to specialized synergy, which reduce and alleviate the cost and investment risk on non-core resource.

The above features distinguish the service-oriented SDN from traditional enterprise and Supply Chain. In virtue of information technology means, service-oriented SDN convert the enterprise resource to service to provide itself and other nodes use. By centralizing manage resource, optimal configuration, dynamically service to improve the resource use efficiency and enterprise comprehensive strength.

### 4. Service-oriented SDN for SMME

Service-oriented SDN for middle and small-sized manufacturing enterprises (SMME) is a comprehensive network serviced for middle and small manufacturing enterprises, to improve the manufacturing resource use efficiency and save use-cost, to support the synergy of exploitation, process and among SMME, to realize the optimized exchange the manufacture resource and ability in SDN based on internet.

Figure 4 is a service-oriented, high efficient and low consumption networked intelligent manufacturing model. The service platform of SMME based on resource cooperate, provide research and development, design, simulation, management, logistics, capitals service to SMME in SDN. RDP published the unoccupied resource and ability on the platform, seek partner, conclude the transaction or form cooperation to gain profits. RSD seek the proper manufacturing resources and abilities, dynamically get the needed low-cost resource, to improve enterprise competitiveness. PSP get the profit by providing service to RSD and RSP, such as cooperative environment, enterprise authentication, credit assessment, cooperation monitor, platform, virtual resource management, private manufacturing cloud management, application integration, etc. Assistant Decision-Making System (DSS) of supply

and demand matching, based on preference and regulation, provide not only online service subscription and system optimal recommendation, but also service in terms of offline agreement, to form long-term alliance cooperation relationships. The private manufacturing cloud formed in platform to improve the cooperation efficiency. Platform provided not only virtual manufacturing resource perception, use, release service, but also joint connect the virtual resource with the core business process, to realize the system integration of private cloud manufacturing resource and enterprise ERP.

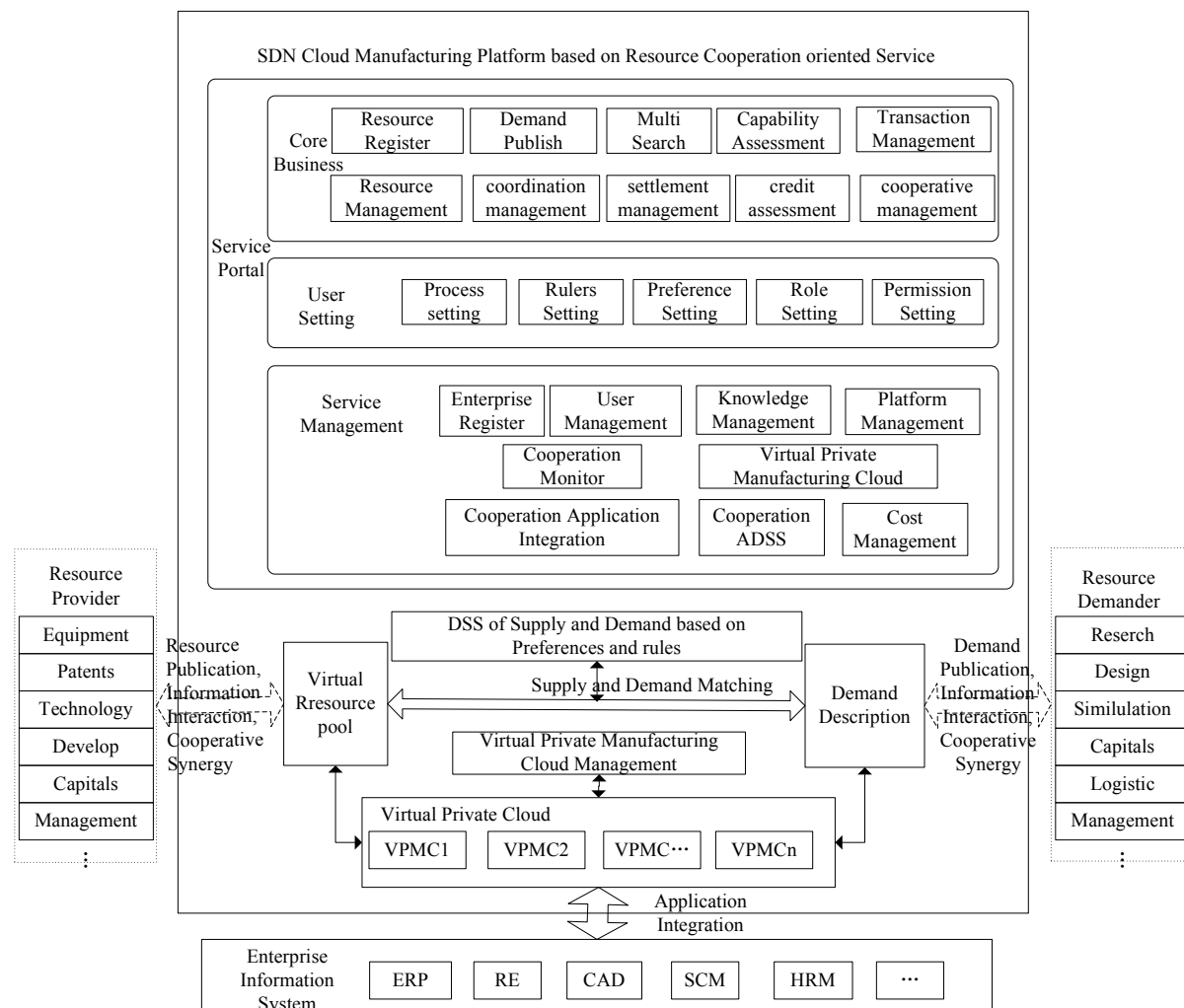


Fig 4 System Architecture of SMME based on service oriented SDN

## CONCLUSION

The finiteness and paid use for resource, make it become possible that by cooperating among enterprise to get the overall benefit maximization. Cooperation lowered the operation cost and promoted the competitiveness of enterprise. The progress of information technology makes the perception, virtualization and formalization of resource become true. A new service-oriented SDN operation pattern was proposed, the architecture of the information system was build based on Cloud Computing and Things Network, the key techniques and the features of the system was analyzed. The popularization and application of service-oriented SDN will accelerate the standard management of enterprise, optimize industrial distribution, boost the special division of labor, improve resource use efficiency, and promote the international competitiveness of SDN enterprise.

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