Modern Service Industry and Crossover Services: Development and Trends in China

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Abstract—Modern service industry (MSI) is an information and knowledge intensive service industry, relying on information technology and modern management philosophy. The development of MSI is of high significance for promoting rapid global economy, accelerating social progress, and realizing the general strategy of building an innovation-oriented society and harmonious realm. This paper gives an overview of the worldwide MSI development status, especially introduces the development of MSI in China. Our survey of 62 MSI-related listed firms in China shows that Crossover Service emerges everywhere including their business models, product, and services. Thus, we propose the concept of Crossover Service and introduce its 3C-features (*Crossover*, *Convergence*, and *Complex*), the scientific issues, the technique framework and the challenges. And also, we give a brief introduction of our middleware platform named JTang++, which supports the lifecycle of Crossover Service well.

Index Terms—Modern Service Industry, Crossover Service, Crossover, Convergence, China

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MODERN service industry (MSI) is an information and knowledge intensive service industry. Based on IT and modern management philosophy, MSI emerges when industrialization reaches an advanced level. It consists of two types of service industry: 1) Upgraded traditional service industry; 2) Emerging service industry. MSI has increased its share in Gross Domestic Product (GDP), and become a critical criterion for both domestic and global economic development.

MSI development has three basic characteristics: *Triple-High*, *Triple-New*, and *Triple-Little*. Specifically, *Triple-High* means high human capital, hi-tech, and high added values; *Triple-New* means new technologies, new business models, and new approaches; *Triple-Little* means little area, little cost, and little pollution.

Alternatively, MSI can also be categorized into four classes based on the sectors of the services: 1) *Basic services*, which includes communications and information services; 2) *Manufacturing and market services*, which includes finance, logistics, e-commerce, agriculture support services, intermediary and consulting services; 3) *Personal consumption services*, which includes education, healthcare, hospitality, entertainment, tourism, real estate and retail; 4) *Public services*, which includes governments public administration services, compulsory education, public health, medical treatment, and public information services.

Generally MSI involves in four Stages: 1930s-1950s: Business, transportation & communications rapidly developed; 1950s-1990s: Finance, insurance and business services enhanced the service function of the secondary industry; 1990s: E-commerce and modern logistics grew quickly; Late 1990s-21st Century: ICT (Information and Communications Technology) facilitated the explosive development of MSI. It should be noted that, in 1960s-1970s, the developed world shifted the focus from capital-intensive industries to knowledge & technology-intensive industries. And in 1980s, the developed world vigorously developed high-tech industries and transformed conventional industries. Since 1990s, the developed world has gained a strong foothold in the top of the industry value chain.

With the shift from industry-based economy to service-based economy, globalization and professional work division have further promoted MSI development. The statistics from the World Bank [12] indicates that the service industry in developed countries accounts for about 70% of their GDP; MSI has accomplished a production value of over 50% of the service industries total, and facilitated the more integrated development of the primary, secondary and tertiary industries [1]. MSI and traditional industries have been increasingly integrated, which helps upgrade the latter. The emerging service industries, including the internet-based e-commerce and content service, have become a leading engine for global economy; MSI is becoming a link and core of the modern industry system.

ICT and the integrated technologies in the service industry support MSI. ICT, represented by mobile broadband network, tri-networks integration and platform-based software, provides more space for MSI development. Innovations in service models increasingly become the core of MSI competition. The ever-changing monopolistic competition market is MSI-dominated market structure. The network-based third party service model will be the mainstream MSI model. Information resources, IT and information network operating platform increasingly become the main driving forces for MSI development.

According to the statistics from the World Bank [12], as shown in Fig. 1, in 2009-2013, North America, Western

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Europe, Japan and Australia led the world in terms of the percentage of the value-added of the global service industry against GDP, while China, Africa and South America had much potential for further growth. Further, as Fig.2 shows [12], the proportion of employed population absorbed by the service industry in total employment is about 45% worldwide: 60%-75% in developed countries, 45%-60% in middle income countries, and 30%-45% in low-income countries. The rapid development of MSI attracts the global attention. Taking US as an example, the value-added of the service industry in US in three decades increased by four times. Three MSI clusters have emerged in the west coast, the south and the northeast of US. Currently, the proportion of the tertiary industry in Japans GDP is over 70%, and MSI is concentrated in Tokyo. The GDP of Tokyo takes 30% of Japanese GDP, while about half of Japanese companies with total assets of more than 1 billion and over 45% listed companies are located in Tokyo. The population employed by the service industry in Australia has accounted for 75% of the total employed population over recent years, higher than Japan and European countries. The ratio of service value-added in GDP stays at 70%, higher than the world average level.

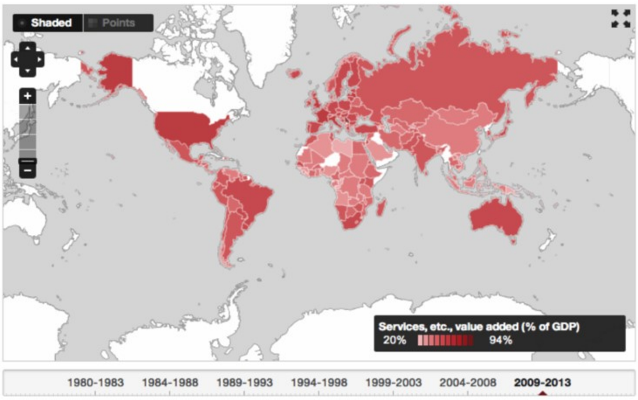

Fig. 1. Global services, value added (percent of GDP)

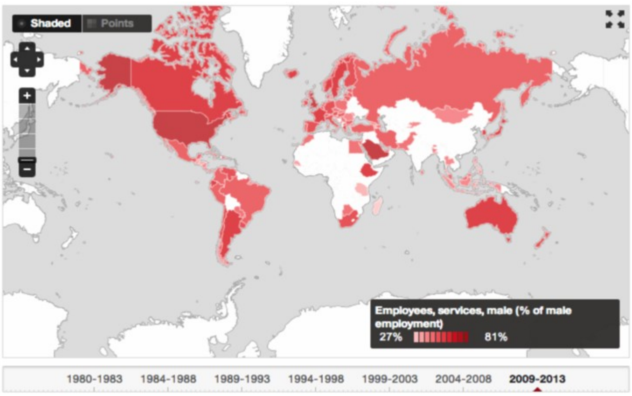

Fig. 2. Global employed population of the service industry

With the development of MSI, the characteristics of crossover and convergence have become an important trend, requirement and feature of MSI innovative development. Our recent research on the business models, product services and markets of 62 listed firms related to MSI in China shows that the phenomenon of crossover and convergence exists everywhere. However, to the best of our knowledge, crossover service in MSI has not been clearly defined and studied well in the literature. In this paper, we first elaborate on what crossover service is by clarifying its concept, features, scientific issues, and challenges. We then propose a technical framework and support platform for crossover service.

The rest of paper is organized as follows. Section 2 briefs the current development and trends of MSI in China. Section 3 presents the concept, features, scientific issues, challenges, and a technical framework of crossover service. Section 4 proposes a platform for supporting the development, deployment, and management of crossover services. Section 5 concludes this paper.

2 MSI IN CHINA

2.1 Overview

Currently, China has become the second largest economy in the world [12], and MSI has been one of the most important industries as it is for other developed countries. In 2013, China GDP totaled about RMB 57 trillion, to which the service industry contributed about RMB 26 trillion [13]. The market sizes of some MSI segments have witnessed significant growth, with Intelligent Transportation System, Cloud Computing and Internet of Things reached RMB 20 billion, 117 billion and 490 billion respectively. The FDI (Foreign Direct Investment) in the service industry exceeded the investment in manufacturing for the first time in 2011.

China's MSI regional distribution features *one axis, two belts, and three clusters.* One axis refers to the central axis on the eastern coast. Two belts are northern and southern belts. Three clusters are in the northeast, center and west of China.

There are some MSI related companies growing rapidly in China. Out of Alexa 2014 top 10 websites [14], three of them are accessed mainly from within China: Baidu, Taobao, and Tencent (featuring search, e-commerce and social networking services, respectively).

MSI has witnessed significant growth in China, but imperative issues still exist. For instance, in the area of manufacturing and market services, e-commerce and modern logistics develop rapidly, but the information island and industry barriers hinder the generation of industry chain.

2.2 New Focus of MSI in China

With the adjustment of industrial structure and the availability of new technologies, the focus of MSI continues to evolve. In this section, we describe a number of new focuses of MIS in China.

2.2.1 Transformation and upgrading: purchasing public services

Service-oriented government focuses on transforming government's role in acquiring public services with the goal of benefiting people with useful and quality public services. The purchase of public services and the resolution of the long-standing dispute on whether public services should be provided by government or market clarify the reform route that society can undertake some government duties. This defines the keynote for government mechanism reform and industry reform.

2.2.2 Boosting domestic demand: stimulating information consumption

The strategy for stimulating China information consumption is threefold: 1) implementing the Broadband China strategy to speed up the network, lower the service fees, and reach more corners of the country; 2) accelerating the project Information Benefiting People to make information technology more available and convenient for people's daily life; 3) providing more information products and contents for information consumption, and developing emerging service industries; 4) constructing a safe and credible information consumption environment.

2.2.3 Improving people's livelihood: elder care services industry

China has the largest elderly population in the world, which totals nearly 200 million. China needs to take the following steps: 1) strengthen the elder care services capacity building; 2) provide elder care services at various levels; 3) innovate the models of elder care services; 4) effectively strengthen elder care services in rural areas; and 5) promote the integration of medical treatment and healthcare.

2.2.4 Guaranteeing basic services: health service industry

The Chinese government vigorously develops the health service industry. Promoting health service industry, guiding nongovernmental investors to run elder care services, developing healthy elder care services, and providing more commercial health insurance products are the common view of China government. Specifically, first, taking measures to develop the health service industry, and enabling nongovernmental investors to provide health services. Second, accelerating the development of elder care services. Third, providing more commercial health insurance products.

2.2.5 Developing new industries: cultural and creative industry

Accelerating the integrated development of the cultural & creative industry, design service and other relevant industries is one important policy in the China MSI development plan. The annual executive meeting of the China's State Council in 2014 identified the policy measures for the integrated development of the cultural and creative industry, design service, and other relevant industries. The MSI focus comprises of five execution strategies: 1) strengthen the creation and design IPR protection, and create an enabling environment; 2) implement the support plan for cultural creation and design service talents; 3) guide private capital to invest in cultural and creative industry; 4) be oriented toward green, energy conservation and environmental protection; and 5) improve the relevant support policies and financial services.

2.2.6 Promoting stable economic growth: manufacturing and market services

The annual executive meeting of the China's State Council in 2014 for accelerating the development of manufacturing and market services effectively stimulate domestic demand and guide the industry to the high end of the value chain. The meeting pointed out that priorities should be given to manufacturing and market services, such as R&D design, business services, marketing and after-sale services. The detailed strategies consist of five parts: 1) intensify the efforts for R&D and application of new materials, new products and new processes; 2) construct logistic public information platforms and cargo distribution centers; 3) improve the information technology service level; 4) promote financial leasing services; and 5) encourage service outsourcing.

2.2.7 Constructing a strong innovative country: S&T service industry

It should be emphasized that innovation is the key to the success of keeping the economy growing at an intermediate and high speed and of improving the quality and efficiency of econom. Premier of China required to reasonably develop the strategic layout for science and technology innovations, aim at cutting edge technologies, work on basic research and applied research, strive vigorously for original breakthroughs, and master critical and core technologies.

2.3 China's MSI Development Plan

Before introducing China's MSI development plan, it is essential to identify the strategic demands of China's MSI development: 1) transforming and upgrading conventional industries and optimizing industrial structure; 2) improving peoples livelihood and building a harmonious society; and 3) improving public service capacity and promoting the construction of service-oriented government.

China's MSI development can be divided into four stages: embryonic stage in 2006-2010, rearing stage in 2010-2015, growth stage in 2015-2020, and maturity stage after 2020. In the past China's 12th 5-Year Plan, the short- and medium-term development goals for China's MSI include: increasing the ratio and level of service industry, constructing MSI system and giving priority to development an environment and highlighting focuses. The goals for China's 12th 5-Year Plan are developing environment and highlighting focuses. Development environment means creating development environment and policies oriented towards market and guided by government, and highlighting focuses include e-commerce, modern logistics, e-culture, e-health, e-life, e-contents, R&D and design.

Figure 3 shows the MSI development framework for China's 12th 5-Year Plan Period. The overall framework could be summarized via "3311": 1) 3 areas: manufacturing service industry, emerging service industry, science and technology service industry; 2) 3 systems: MSI common critical technology support system, MSI development support system, MSI science and technology inno-

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vation system; 3) 1 layout: a number of demonstration cities, parks and enterprises; and 4) 1 safeguard mechanism: safeguard mechanism for plan implementation. During the MSI development in China's 12th 5-Year Plan, there are three main directions: 1) Manufacturing service industry, which includes e-commerce and modern logistics; 2) Emerging service industry, which includes e-life, e-health, e-culture, e-learning, social security public service; and 3) S&T (Science and Technology) service industry, which includes R&D design and technology transfer, S&T finance and innovative entrepreneurship. It should be noted that the MSI plan in 12th 5-Year Plan period includes 82 projects, involving a total fund of 4 billion RMB.

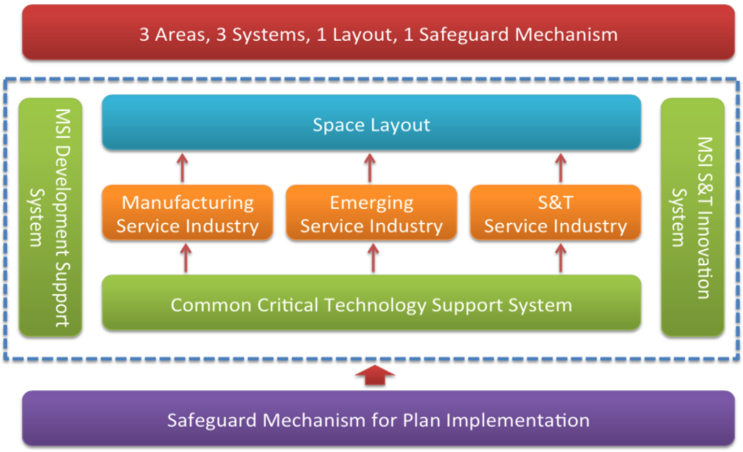

Fig. 3. MSI development framework for China's 12th 5-Year Plan

3 CROSSOVER SERVICE

Crossover and convergence have become not only a trend but also an important requirement and feature of innovative MSI development. Our recent research on the business models, product services and markets of 62 listed firms related to MSI in China's shows that the phenomenon of crossover and convergence exists everywhere [15]. Thus, we put forward the concept of Crossover Services and study the features, scientific issues and technical challenges of crossover services, aiming at stimulating more systematic research and development on the Crossover Service phenomenon from various perspectives.

3.1 The Concept of Crossover Service

Nowadays, crossover and convergence have been regarded as important innovative strategies or methods for modern firms in China to expand their products, services and markets. Crossover and convergence promote the cross-enterprise, -field and -industry cooperation, and the creation of innovative products, services, markets and business models. Crossover has become a trend and fashion, crossing tradition and modern, the East and the West, and culture and technology. The crossover trend becomes increasingly prevalent.

It has become difficult to judge a company which traditional industry it belongs to. More and more enterprises today have evolved to be a combination of different industries. For instance, the giant Chinese company Alibaba Group, whose IPO ranks as world's biggest after additional shares, was traditionally regarded as an e-commerce company, which serves an astonishing more than 45% of China's ecommerce market. However, it is not advisable to classify Alibaba as a pure ecommerce company, because it also provides products and services related to information technology, finance and logistics as well besides its main B2B and B2C businesses. In this case, it's very hard to clarify which industry Alibaba belongs to. Alibaba is a typical crossover company providing crossover services.

At present, we generally define Crossover Service as an innovation creation process for enterprises to provide users creative, novel, and cross-domain products/services, which break through the traditional boundaries of enterprises. Crossover Service can be understood from both the broad and narrow perspectives. From the broad perspective, crossover service means all the necessary processes and activities that support an enterprise to design, implement, produce and manage new products or services aiming at a complete new market or industry. For Alibaba as an instance, all the activities and processes supporting its new product YuEBao-a prevalent financial tool in China can be regarded as a set of crossover services as this new product/service has expanded the traditional industry-ecommerce of Alibaba into another industry-finance. From the narrow perspective, for a company, crossover service only means a specific creative product or a service that expands the companies traditional markets. Also, for the above instance, the product YuEBao itself can be regarded a concrete crossover service from the narrow perspective.

3.2 The 3C Feature of Crossover Service

Crossover service is a multi-subjects concept, which can be understood as a new economic phenomena and economic activity in the modern service industry. It also can be regarded as the new content and new form of modern enterprise management. Furthermore, it also represents a new application scenario of the information technology age for the modern service industry. Crossover services have the 3C characteristics, namely *Crossover*, *Convergence* and *Complex*.

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1) **Crossover**. Crossover is the basic characteristic of crossover services. Crossover services are services provided across different business areas, different industries and different industrial domains. Intangible products formed or derived from crossover services are always cross-domain. For example, banks begin to cross the traditional banking business to provide ticket selling services; traditional network carriers start to provide broadcasting services; Internet enterprises begin to set foot in the field of mobile communication and so on. All the above reflects the natural attribute of crossover services.

2) **Convergence**. Modern enterprises provide crossover services on the premise of realizing convergence. Convergence occurs among different industries and gradually forms a new crossover industry through interaction and mutual infiltration. Convergence is a dynamic development process, in which there will be technology convergence, product convergence, service convergence, enterprise convergence, and market convergence. Intangible products formed or derived from crossover services are the result of convergence. For example, Apple Corp, the IT industry upstart during recent years, has made great achievements in business by converting its culture and creativity into its products. The convergence innovation of technology and culture makes Apple stand out amongst the crowd.

3) **Complex**. Compared with traditional services, crossover services are more complicated in the innovation process, development process, and operation process. It is difficult for the providers of crossover services, not only to cross the boundaries of different industries and integrate all kinds of resources into industries or areas where they are not familiar, but also to conduct a series of innovative activities such as service innovation and business pattern design by combining their advantages of resources, market and technology. Furthermore, those enterprises already existing in the market have advantages in marketing, technology and services, which brings more risks and challenges to the crossover service providers.

3.3 Scientific issues of Crossover Service

As crossover service is an interdisciplinary concept spanning economics, management, and information technology, it would be better to come to know its scientific issues through those three different perspectives.

From the economic perspective, crossover service must address the issues regarding: 1) how to forecast and evaluate the impact of crossover service on business and service economy; 2) the approach to modeling and forecasting the relationship of crossover service and service economic growth; 3) the approach to model and measure the productivity of crossover service; 4) the approach to model and evaluate the promotion of crossover service to business convergence.

From the management perspective, crossover service faces the following issues: 1) how to explore the business model of crossover service and evaluate its risks and value; 2) capacity model and evaluation mechanism of enterprise crossover service; 3) the method to explore and design the business model for personalized crossover service; and 4) the method of value analysis and risk forecasting of the business model for crossover service.

From the information technology perspective, crossover service faces the following issues: 1) how to achieve the integration of crossover resources and provide information technology support to crossover service; 2) the method for modeling and integrating massive, heterogeneous and multi-dimensional information; 3) the method for enterprise to analyze, explore and manage cross-domain knowledge; and 4) the method for enterprises to design and realize service supporting platform for crossover service.

3.4 Technical Framework and Big Challenges

Our research on crossover service aims to establish an integrated set of models, tools, systems and methodologies to help modern MSI enterprises in China with creating innovative products, services and business models and with seeking for new profit sources by expanding their respective enterprise boundaries. Fig. 4 shows our technical framework for realizing crossover service.

The technical framework includes all the major theories and models, techniques and methods, and tools and platforms supporting crossover services in the design phase, the implementation phase and the running phase.

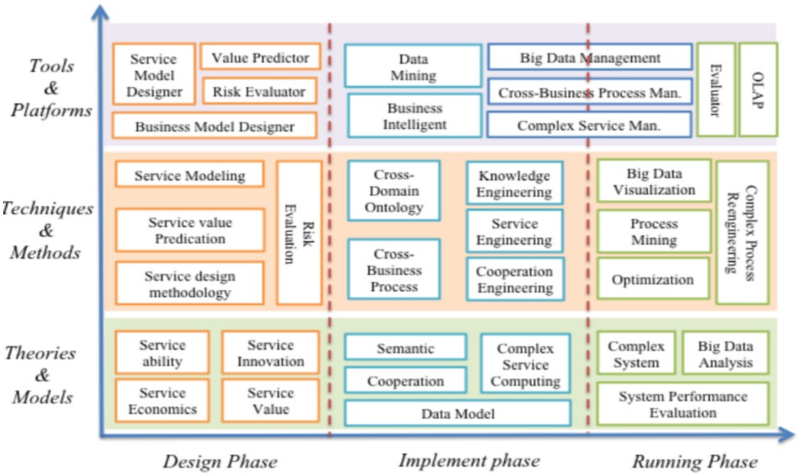

Fig. 4. Technique Framework of Crossover Service

From the information technology perspective, supporting crossover services must attack several big data and cloud computing related technical challenges.

1) **Big Data Management**. Realizing a crossover service would inevitably face big data management challenges, e.g., how to deal with the cross-semantics, cross space-time and cross scale data? Specifically, for cross semantics, the main challenge is how to achieve the sematic interconnection among interdisciplinary, cross-industry, and cross-organization big data, and build complex super data correlation. For cross space-time, the challenge is how to conduct the space-time management for cross-time and cross-space big data, and establish systematic analysis methods of big data in time and space dimensions. And for cross scale, it is how to implement the elastic data processing across multiple scales according to different requirements of big data processing. Glanluca et al. [2] introduced a series of techniques to utilize the data from different domains, and proposed Policy-Making 2.0 for public governance in which crossover big data are utilized for decision-making. Vinayak et al. [3] proposed ASTERIX project to tackle the challenges of big data management by focusing on the architecture issues.

2) **Complex Service Management**. Service evolves to be complex due to its large-scale, multi-functions/instances/models. It should be managed in the context of crossover scenarios. In the application and operation of large-scale complex crossover service, how to realize the sharing, invocation, combination and collaboration to support the efficient collaboration of capital flow, data flow, material flow, affair flow and workflow in crossover business. Lee et al. [4] proposed a technique framework and a prototype system for building an integrated crossover service management platform for ubiquitous ecological cites. Luis et al. [5] proposed a crossover service management system, named Claudia, to support the automatic deployment and escalation in clouds. Since QoS-based service selection and composition become more complex due to various QoS correlations among complex services, we propose the Correlation-Aware Service Pruning (CASP) method to compose services [6]. In order to address the challenges arising from service composition in the dynamic and complex mobile environment, we propose a mobility model, a mobility-aware service selection method [7] and an efficient offloading strategy for mobile service compositions [8].

3) **Cloud Platform Management**. Cloud platform (Infrastructure as a Service/Platform as a Service/Software as a Service) should have the characteristics such as open, dynamic, elastic and multi-tenants to support crossover application design, development, and operation. Considering the application features of heterogeneous large-scale service systems, how to realize the intelligent scheduling of complex service resources to support the application requirements for being open, highly dynamic, elastic and multi-tenant need be addressed. Dejan et al. [9] proposed a cloud management tool, named OpenNebula, to address relevant challenges in terms of real-world use cases. Juraj et al. proposed a series of security analyses of cloud management interfaces, which should be carefully considered in the crossover service scenarios [10]. We propose a depnedable Enterprise Service Bus (ESB) Framework, named JTangSynergy, to support the large-scale service integration. It enables automated recovery from component failures and robust execution of composite services by checking service compatibility [11].

4. JTANG++ PLATFORM

In terms of the common computing mode for new network applications and the existing JTang middleware [11][16], we have designed and developed JTang++, a new cloud-based crossover service platform.

Figure 5 shows the architecture of JTang++, which consists of four parts: Complex Service Development, Integrated Service Management, Crossover Service Collaboration, and Intelligent Data Service.

JTang++ CSD (Complex Service Development) supports the rapid and effective construction of MSI, which is typically a complex service system. JTang++ CSD consists of four modules: 1) Complex Service Modeling supports the complex service oriented online developing mechanism, according to process model visualization, Business Process Modeling Notation (BPMN) based model description language, QoS-based service retrieval, automatic model verification, etc; 2) Component Development supports the cross-domain & multi-type service component oriented rapid developing mechanism, according to cross-domain & multi-type oriented development toolkit, EJB toolkit, WebEditor, etc; 3) Development Toolkit supports the rapid development of complex services, based on the model-driven development mechanism; and 4) Deployment & Configuration supports the heterogeneous platform oriented complex service application deployment and configuration automatically.

JTang++ ISM (Integrated Service Management) provides the function of monitoring, management, and performance analysis of large-scale service systems. It mainly consists of four modules: 1) Runtime Monitoring decomposes the global performance objective into local performance objectives, and adjusts the local sources to satisfy the global Service Level Agreement (SLA) requirement according to the runtime monitoring; 2) Cloud Service Management models multiple software/hardware sources into a unified service model, and provides simple and efficient management; 3) Performance Analysis provides the performance analysis for the computation intensive services and storage intensive services in MSI; 4) Network Service Management provides a unified interface management mechanism based on OpenFlow intelligent network visualization technology.

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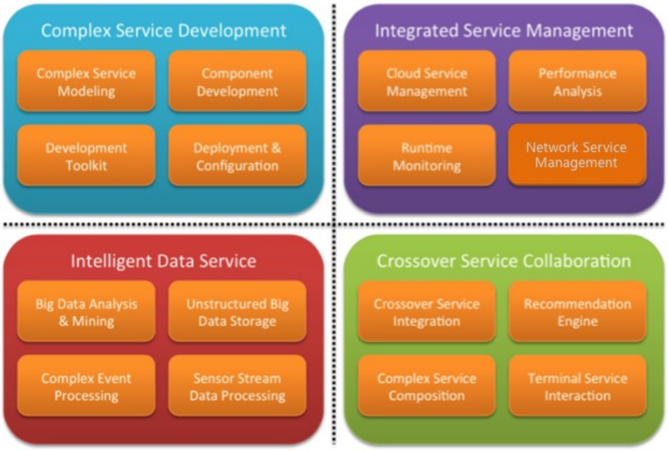

Fig. 5. JTang++ Architecture for Crossover Service

JTang++ CSC (Crossover Service Collaboration) considers mainly the large-scale crossover service environment, consists of four modules: 1) Crossover Service Integration considers the multi-domain and heterogeneous environment, building the crossover service integration platform based on the Cloud Service Bus; 2) Complex Service Composition. Big data and complex service pose lots of challenges to the traditional service composition. We propose some novel approaches for the intelligent composition optimization, intelligent composition process mining, and composition recommendation of crossover complex services; 3) Service Recommendation Engine collets the service data from multiple domains, unifies the data structure, integrates service data, generates unified multi-domain service execution log, and finally recommends services based on machine learning and data mining technologies; 4) Terminal Service Interaction provides the quick interaction between MSI services and users based on multiple mobile devices.

JTang++ IDS (Intelligent Data Services) aims to provide high-value services for MSI by utilizing big data. It mainly consists of four parts: 1) Big Data Analysis and Mining. The rapid development of MSI leads to the explosive growth of Big Data. To solve these challenges, we parallelize the classic data mining approaches to realize the big data mining algorithms and analysis system; 2) Unstructured Big Data Storage. It provides the cache service for massive unstructured files, containing unstructured storage module and rapid cache module; 3) Complex Event Processing. It collets data from complex event processing platform, analyze and mine these data based on predefined rules, and further discover some ignored complex events; 4) Sensor Stream-Data Processing. It preprocesses and analyzes the stream data collected from the massive sensors based on distributed resources scheduling mechanism and real time stream computation framework.

5 CONCLUSION

The development of MSI is highly realistic and of historically significant for promoting rapid domestic and global economy, accelerating social progress in an all-round manner, and realizing the general strategy of building an innovation-oriented and harmonious society. With the rapidly worldwide development of MSI in recent years, government, industrial and academic circles in China are paying more and more attention to the development of MSI in China. In this paper, we present our initial study results on modern service industry in China, including an overview of the worldwide MSI development status, the development of MSI in China, specifically, the new focus and policy, as well as the development plan of MSI in China. We present the crossover services as a new trend of MSI, and a hot topic for research on MSI evolution and development. Crossover services are introduced and discussed from different perspectives, ranging from scientific issues, to challenges of crossover services, and to technical framework for supporting crossover services in the context of both complex business strategies and new trends in service computing.

ACKNOWLEDGMENTS

This research was partially supported by the National Technology Support Program under grant of 2013AA01A604, 2013AA01A213, and 2013BAD19B10, the National Natural Science Foundation of China under grant of 61170033, 61173176, and 61272129, Key Science and Technology Research Program of Zhejiang Province under grant of 2013C01073 and 2012C01037-1, and Zhejiang Provincial Natural Science Foundation of China (LR13F020002).

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