Crossover Service: Deep Convergence for Pattern, Ecosystem, Environmnet, Quality and Value

Jianwei Yin, Bangpeng Zheng, Shuiguang Deng, Yingying Wen, Meng Xi, Zhiling Luo, Ying Li
College of Computer Science
Zhejiang University, Hangzhou, China
Email: {zjuyjw, zhengbangpeng, dengsg, 21621249, 11721019, luozhiling, cnliying}@zju.edu.cn

Abstract—Crossover service is a kind of services, which can provide multi-dimension service, great user experience and high values, through deeply converging services from different industries, different organizations and different value chains. Convergence is the key challenges for crossover service application. Using Alibaba’s crossover service case, this paper illustrates five challenges of the service convergence process: pattern convergence, ecosystem convergence, environment convergence, quality convergence and value convergence. In addition, we propose a technical framework addressing these technical challenges, which includes all the major theories and models, techniques and methods, and tools and platforms supporting enterprises’ crossover service convergence in the modeling phase, the design phase, the running phase and the management phase.

Keywords—crossover service; crossover; convergence

I. INTRODUCTION

Crossover is the process that breaks through the boundaries to achieve collaboration. Crossover marketing, crossover cars, crossover design and crossover music--crossover has become a trend and fashion, crossing tradition and modern, and culture and technology. The crossover trend becomes increasingly prevalent. Crossover promotes the convergence of enterprises from different areas, different industries and different organizations, which leads to the crossover services.

Crossover service is a kind of services, which can provide multi-dimension service, great user experience and high values, through deeply converging services from different industries, different organizations and different value chains. As a new business model of the modern service industry, crossover services have the 3C characteristics, namely Crossover, Convergence and Complex [1].

Crossover convergence is the prerequisite and ultimate goal for crossover services to create tremendous value. The occurs in different enterprises or different fields and among mutual infiltration and cross-cutting, and ultimately pushed the industry to gradually form a new service pattern and a new service ecosystem. Traditional literature on service computing mainly focuses on service lifecycle management. There is no relative systematic research on crossover service convergence, as well as engineering approach and carrier. However, it shows great blindness in the enterprises’ crossover service convergence process for the lack of theories. For example, Evergrande Group launched the crossover product called EVERGRANDE SPRING in 2013, and its total loss was 4 billion up to May, 2015.

Using Alibaba’s crossover service case, we illustrate five challenges of the service convergence process: pattern convergence, ecosystem convergence, environment convergence, quality convergence and value convergence. In addition, we propose a technical framework addressing these technical challenges, which includes all the major theories and models, techniques and methods, and tools and platforms supporting enterprises’ crossover service convergence in the modeling phase, the design phase, the running phase and the management phase.

The rest of the paper is organized as follows. Section 2 mainly shows the five challenges in the process of crossover service convergence illustrated by the Alibaba’s case. In Section 3, we describe the proposed technical framework in detail. In Section 4, we introduce our current works. Section 5 and Section 6 summarize related works and provide a brief outline of future works.

II. CASE AND CHALLENGES

Convergence is the key challenges for crossover service application. Crossover service convergence not only brings tremendous opportunities to enterprises, but brings many new challenges to service integration. This Section uses the Alibaba’s case to explain the five challenges.

A. Alibaba crossover service

Alibaba is a representative e-commerce service business in China, and the largest retail business platform in the world. The affiliates of Alibaba group include Taobao, Tmall, Alibaba Cloud Computing and Cainiao Network, covering e-commerce, entertainment, education and so on. It integrates more than ten thousands of services from 225 countries and regions, including transaction, payment, logistics, offline stores, advertisement, computing and so on. Based on the e-commerce platform, Alibaba integrates other services from different domains, such as cloud computing, entertainment and finance. It combines different enterprises and different industries. Then it brings upstream and downstream businesses of different industries, attracting hundreds of
millions of active users and creating several crossover services, such as double 11, online-offline, new retail.

As the chairman of Alibaba, Jack Ma coined the term “New Retail” in a letter to Alibaba’s shareholders. He said that pure e-commerce will be reduced to a traditional business and replaced by concept of new retail – the integration of online, offline, logistics and data across the value chain. Alibaba has been developing its own futuristic offline grocery store, named Hema. This is one aspect of new retail: using technology to digitize and automate offline stores. And another important aspect is about selling beautifully designed, quickly manufactured, and frequently iterated products at the lowest prices possible, making customers pleasantly surprised. However, it is a big challenge to provide such a crossover service through the existing approach.

B. Big Challenges

Pattern Convergence: Besides integration in technology level, crossover service convergence needs to realize integration of different service patterns by resolving the potential conflicts. As the left picture shown in Fig. 1, we think of the traditional retail as “separation of online and offline”, which separates online services from offline services. However, the right picture shows that new retail is the integration of online, offline, logistics and so on, which is quite different from the traditional retail. To realize its commercial value, new retail must use the method of combining online services and offline services.

Ecosystem Convergence: Besides services, the design of crossover service convergence should consider the whole ecosystem of the enterprises and industries. As Jack Ma said: Alibaba will not become a business empire, but an open and prosperous business ecosystem. We can see the ecosystem of Alibaba’s new retail with the consumer at its core after convergence from Fig. 2. The ecosystem contains not just suppliers, such as retailers and manufacturers, but also Internet companies, which are supported by several new technologies. So it’s a challenge for Alibaba to construct the service ecosystem based on e-commerce platform integrated with many services such as cloud computing, Internet of things, data mining and so on.

Environment Convergence: The running environment of crossover services is open, dynamic and heterogeneous. And it will form a complex network. Crossover service convergence needs to provide a unified environment for users. As shown in Fig. 3, Cainiao Network, Taobao and Hema are three different affiliates of Alibaba group. As part of Alibaba’s new retail, their business process, data model and service interface are quite different respectively. To provide a reliable running environment, we need to set up service standards such as data standard and exchange standard.

Quality Convergence: The quality indices of one crossover service are quite different from the others’. And the quality is influenced by many factors, such as the properties of crossover. We should consider the balance among these factors while calculating the quality. For example, Alipay emphasizes on service safety, while the Cainiao Network focus on service time and service charge. So it is a challenge to integrate the quality standards from different services in Alibaba’s new retail.

Value Convergence: One goal of the crossover service convergence is to maximize the value of the service. The value expectations of one service are quite different from others’. Thus, there are many implicit or explicit conflicts between different services. For example, the offline service Hema and the online service Tmall both expect users to spend more money on the corresponding platform. Obviously there is a conflict between two services. So it is a challenge to resolve the conflicts and make a trade-off between various value expectations of all these services.

III. TECHNICAL FRAMEWORK

Traditional literature on service computing mainly focuses on service lifecycle management, there is no related theoretical models, technical frameworks or quantitative methods in terms of service pattern, carrier, quality and value. And it is very difficult to meet the needs of crossover development in modern service industry. To address above challenges, we propose a technical framework of crossover service convergence.
We divide the whole framework into the following four phases: modeling, design, running and management. As shown in Fig. 4, the modeling phase mainly studies the novel crossover theoretical model and the typical crossover service pattern. On the basis of modeling phase, we study the key technologies of crossover service convergence, provide engineering methods in the design phase and support carriers in the running phase. In the management phase, we study the methods of quality and value assessment with the supports and feedbacks from previous two phases.

Based on the four phases of crossover service convergence, we propose the technical framework shown in Fig. 5 from the perspectives of abstraction, computing, management and operations, including related theoretical models, technical methods, tools and platforms.

A. **modeling phase**

To address the challenge of pattern convergence, the purpose of the modeling phase is to reveal the development of crossover convergence in modern service industry and to propose a novel service model that supports crossover services. This phase mainly studies the three matters as below: ① How to find out the general rules and the trends of crossover convergence development from the typical service cases in modern service industry so as to form a collection of crossover service patterns; ② How to extract essential characteristics and core elements from crossover service patterns to form a new service model and its description language; ③ How to conduct qualitative or quantitative evaluation of the crossover service patterns. The main technical difficulties include:

**Modeling and Description of Crossover Service:** Crossover services create new service patterns by mining and integration of business, information and processes in different fields and industries. Crossover service has the 3C characteristics, Crossover, Convergence and Complex. It contains the service providers, consumers, carriers, processes, goals, values and other important elements. The traditional triangular service model only includes service providers, service consumers and service targets, and it is difficult to reveal the connotation of crossover services. Therefore, how to extend the traditional triangular service model and model the crossover services is a challenge.

**Quantitative Assessment of Crossover Service Pattern:** Crossover service pattern assessment can be used to judge whether a business model of crossover services is effective, which can provide an important reference for the selection of the service patterns. However, most of the studies are qualitatively evaluations, there is a lack of more quantitative in-depth analysis. Therefore, how to select the indicators of crossover service patterns and set up an evaluation function combined with the important elements of service model is a major technical challenge in this phase.
B. design phase

To address the challenge of ecosystem convergence, the purpose of the design phase is to reveal the evolution mechanism of crossover service ecosystem and to establish the ecological-oriented engineering design theory of crossover service. This phase mainly studies the three matters as below: ① How to extract the ecological characteristics of crossovers services and build the ecological-oriented design model of crossover service; ② How to obtain the requirement of crossover services quickly and accurately; ③ How to optimize the design process of crossover service convergence. The main technical difficulties include:

Extraction and Expression of Users’ Requirements: The crossover service convergence often crosses various organizational boundaries, business boundaries, value chain boundaries and knowledge boundaries. And the users’ requirements for services present diversification trend. So it is difficult to obtain the potential demands of users. Therefore, it brings more challenges in the design phase of crossover service convergence.

Synergistic Evolution Mechanism of Service Community: In crossover service ecosystem, synergistic evolution mechanism of service community includes three components: the causal mechanism ensures the stability and continuity of the ecosystem; the random mechanism is the result of the mutation behavior and it will promote the evolvement of service ecosystem; the purposeful mechanism is the manifestation of human free will. How to analyze and utilize the co-evolution mechanism of service community to promote the continuous evolution is one of the technical challenges in the design phase of crossover service convergence.

C. running phase

To address the challenge of environment convergence, the purpose of the running phase is to provide a transparent environment that supports services running efficiently and reliably. This phase mainly studies the three matters as below: ① How to integrate services from different domains and establish a unified model that supports crossover services; ② How to build the service network that supports services routing efficiently; ③ How to optimize the complex service network. The main technical difficulties include:

Crossover Service Integration and Management: Massive crossover services are distributed in the whole network under the open environment. They cross different industries, organizations and areas. Different services are independent to each other, while aggregation and interoperability between them form a service network. To provide a unified service running environment, we should shield the heterogeneity of the complex crossover services. Traditional literature on service integration mainly focuses on internal services in enterprises. And the characteristics of crossover services bring new challenges to service indexing, service routing, service query and so on. Therefore, how to build and manage complex service network is a technical challenge in this phase.

Crossover Service Routing Optimization: Compared with traditional service operation, there are several characteristics of crossover service network: the complex operating environment, service dynamical change and the long service request routes, which badly affect the efficiency of crossover services. Therefore, it is a challenge to combine with the distributed framework, dynamic adaptive method and intelligent prediction technology to optimize the service operation efficiency. These techniques aim at realizing the intelligent and efficient operation of service access and combination. This is another key technical challenge in this phase.

D. management phase

To address the challenges of quality convergence and value convergence, the purpose of the management phase is to realize multi-dimensional convergence of service quality and to maximize the service value after convergence. This phase mainly studies the three matters as below: ① How to modeling the quality and value of crossover service; ② How to optimize the overall value and quality after crossover service convergence; ③ How to perceive the defects and improve timely. The main technical difficulties include:

Quality and Value Evaluation of Crossover service: Each member of crossover service presents diversity due to its’ differences in the three dimensions time-space-domain. The corresponding quality indices are quite different from others, as well as the value expectation. We should utilize the differences between members to extend the crossover service and integrate the quality standards and value systems in different fields. In addition, we should resolve the conflicts and make a trade-off between value-quality-ability according to the value expectations of all the members, ultimately form an optimized quality and value indices of crossover service.

Distributed Awareness of Quality and Value: The quality and value of each member of crossover services is not static. And it continues to evolve dynamically over time. Similarly, with the space deployed (physical space, technical space, virtual cyberspace), different distribution results in significant differences. How to capture the time-varying characteristics and analyze the spatial distribution and domain distribution characteristics and monitor the quality and value indicators of crossover services at the condition of continuous runtime and find out its potential rules is a technical challenge in this phase.

IV. CURRENT WORK

A. Service Pattern

Integrated Business Process Model

New retail is a crossover service which converges online services, offline services, logistics services and data across the value chain. Considering the characteristics of crossover service, such as complex, dynamic and crossover, we introduce service pattern, which is the abstraction of the business process from three perspectives in service pattern: workflow, data and resource. We propose a pattern-centered formalization language, called SPDL (Service Pattern Description Language). To better support the data and service exchange analyzing in new retail, we define the problem as following.
Problem. Given a group of processes $t_1, t_2, \ldots, t_n$, finding out a service element set $\varepsilon = \text{Activity}\mid \text{Gateway}\mid \text{Event}\mid \text{Actor}\mid \text{Data}\mid \text{Resource}$, a connector set $L$, and a group of map $F$, where $t=F_i(\varepsilon, L)$, such that any new process $t_i$ can be easily constructed as $F_j(\varepsilon, L)$.

As illustrated in Fig. 6, the solution framework consists of four layers. The first layer is the theory foundation. We employ $\lambda$-calculus and type theory as our formalization basic framework. In second layer, we provide the definition of service element $\varepsilon$ and connector $L$. And we provide the formalization of service pattern, a group of basic service patterns and the composition rules to generate new service pattern in the third layer. In the top layer, the data and resource exchange in the process $t$ can be studied.

![Diagram of Service Pattern](image)

**Fig. 6. The framework of modeling service pattern**

**Automatic Service Pattern Identification**

New retail redefines the relationship amongst customers, providers and goods. And it always contains a large number of activities, resources and data, with complex control flows, resource flows and data flows. It is quite difficult for process managers to identify service patterns from such a complex crossover service. Therefore, we consider a method of identifying service patterns automatically. And we define the problem as following.

**Problem.** Considering a service process $t$, and a service pattern $p$, service pattern matching is to find out whether $t\in p$. It is satisfied if two conditions hold on the same map $M$: $V(t)\rightarrow V(p)$ in which $V(t)$ means the activity node set of process $t$.

We propose an automatic service patterns identification method based on $\lambda$-calculus, named TypedSPM, which uses SPDL as the input format of services and service patterns. Based on the constructing as identifying style, we turn the identification problem into the task of theorem proving. Moreover, we have built an eclipse based visual process modeling software name SPDL-Editor which implements SPDL. As illustrated in Fig. 7, it can be used to create, edit and save the service process and match a service process automatically.

![Diagram of SPDL-Editor](image)

**Fig. 7. Snapshot of SPDL-Editor**

**B. Service Design**

**Alibaba Crossover Service Language**

In the case of Alibaba’s new retail, a customer can buy goods either online or offline and he can get them in store by himself or choose a delivery service. Thus, the integration of service patterns should be considered. We need to resolve the potential conflicts in different service patterns. So we propose crossover service language serving as basis for modeling and describing services in different domains, which can be used to react quickly to the change of requirements and build domain knowledge. As illustrated in Fig. 8, we implement the service language model based on the service concept model and service design model. Service concept model is a requirement structured method for business staff, which consists of entity concept model and routing concept model. The former is used to describe the constraints of business data by building a business glossary. And the latter is for the change of status. Service design model includes three components: entity feature model is used to build data entities; ability feature model is used to construct the tree of abilities; refined process model is used to refine the requirements and business processes.

![Diagram of Crossover Service Design Platform](image)

**Fig. 8. Alibaba crossover service language framework**

**Crossover Service Design Platform**

Relying on the cooperation between Zhejiang University and Alibaba group, we analysis the business processes of Alibaba group. Based on this, we propose the framework of crossover service language. Moreover, we develop the prototype of crossover service design platform, which has started a test run. As illustrated in Fig. 9, the platform contains...
three functional modules: process refinement, data entity and ability map. There are four data entities: member, goods, field and order. The platform can automatically abstract the data entity and build a tree of abilities, which represents the operations and configurations to the data nodes. Further, users can build business processes based on the templates.

![Fig. 9. UI of crossover service design platform](image)

**C. Service Network**

**Service Network Architecture**

Based on the running characteristics of new retail, such as distributed, dynamic and complex environment, we propose service network serving as the new carrier, which has the functions such as service access, service routing and network optimization and management. As illustrated in Fig. 10, a combinational way of software and hardware is designed. We are working on two novel service infrastructures: service switch and service router. Service switch should realize the functions of service access, access control and message mapping. The framework of service switch consists of the following four layers: Infrastructure Layer (includes cabinet, mains, panel and so on), Device Layer (includes computing server and storage server), Network Layer (includes virtual services router and virtual firewall) and Application Layer (includes functions such as service access, message mapping and authentication). Service router should realize the functions of service aggregation, service discovery and service routing. The framework of service router consists of the following four layers: Infrastructure Layer (includes cabinet, mains, panel and so on), Device Layer (includes computing server and storage server), Network Layer (includes functions such as state sensing, dynamic matching and prediction) and Application Layer (includes functions such as service proxy, service query and service routing).

![Fig. 10. Service Network Architecture](image)

**Service Router System**

We develop the prototype of Service Router System (SRS) based on the architecture of service network. SRS consists of three components: service switches, service routers and a network management platform. Service switch is a service infrastructure for business. As show in Fig. 11, users can register and query service through web pages. In addition, service switch integrates firewall from h3c. So it can provide some security functions for internal services. Service router is a service infrastructure for service operators and it can aggregate all services in a specific area and provide high-speed routing. Network administrator can manage the whole network by the platform.

![Fig. 11. UI of service switch](image)

**V. Related Work**

Compared with the traditional research of service integration, crossover service convergence is required to integrate deeply in service pattern, service ecosystem, service quality and so on. Less related research work has been found at home and abroad. In terms of service pattern, Li [2]
provided a unified enterprise modelling approach named Enterprise Pattern which bridges the gap between the business process model and the enterprise economic model of modern service company. Authors of [3] presented an Ontology Pattern Language, called S-OPL, which is very useful for establishing a common understanding of the main concepts and relations involved, and serving as basis for modeling services in different domains. As for the topic of service design, in order to reuse available service components to develop new service systems to fulfill massive individualized requirements, Xu [4] proposed a new paradigm of software service engineering called RE2SEP, which divides the software service development lifecycle into two different phases: service oriented requirement engineering and domain oriented software engineering. Similarity, Tu [5] proposed an approach that can detect the accurate requirements rapidly from massive customers. In [6], Teixeira integrated two service design perspectives, management and interaction design, into an interdisciplinary method. For the subject of service integration, Delgado [7] proposed a process-aware inter-organizational service integration platform to allow the interaction between collaborating organizations. In [8], Thambidurai proposed a framework which inspects the Business logics independently and recommends proper structure to integrate the web services. For service quality and value, Mohamed [9] presented the rSLA framework, and described how it enables the monitoring and enforcement of service level agreements for heterogeneous Cloud services. In [10], Jagli presented a novel quality model intended for evaluating software as a service.

In general, the research of crossover service convergence is still in the initial exploring stage. Based on the research of crossover service pattern cognition, service design, service management and quality and value assessment, the technical framework we proposed provides a set of theories and models, techniques and methods, and tools and platforms to support enterprises’ crossover service convergence and promote the development of modern service industry.

VI. CONCLUSION

In this paper, we analyze the five challenges of the service convergence process starting from the Alibaba’s case. And we propose a technical framework addressing these technical challenges, which includes all the major theories and models, techniques and methods, and tools and platforms in the modeling phase, the design phase, the running phase and the management phase. In addition, we discuss the critical technical difficulties in detail. Moreover, we introduce our ongoing or finished works in this area. We hope it can give some advices and suggestions to support enterprises’ crossover service convergence and provide new thought for the future research.

We believe that crossover service convergence will play a more important role in business activities in the future. Our proposed technical framework will be more promising with the development of modern service industry and information technology. Although we have done some research in service pattern, service language and service network, extensive challenges and future work which exist in this area remain to be explored. For example, how to model the quality and value of crossover service is so far the key issue in the management phase. The corresponding quality indices are quite different from others’, as well as the value expectation. Balancing and resolving above conflicts can be significant complementary achievement for the crossover service convergence.

REFERENCES