Abstract—Service-oriented business ecosystem (SOBE) is a relatively new paradigm for the development of service-oriented enterprises (SOEs). It tries to operate and reorganize business services provided by enterprises as business ecosystems in analogy with the way that natural ecosystems are running on. Business ecosystem is composed of diverse business services members and inter-member flows of material, energy, knowledge and money. In this paper, first different analogies of biological ecosystem are reviewed. Second, the component elements and the characteristics of the SOBE are analyzed. Third, based on the analysis of the SOBE, the topology is advanced. Then, an architecture of Service-oriented business ecosystem is proposed.

Keywords-business service; service-oriented business ecosystem; service-oriented enterprises

I. INTRODUCTION

Under service-oriented enterprises environment, business services or units from various enterprises and their surroundings together constitute a business ecosystem [1]. Considering the individuals of this kind of ecosystem are business services, we call the ecosystem service-oriented business ecosystem (SOBE). The SOBE is used to describe the collaborative relationship and operation mode between business services. The SOBE describes a new kind of business network including a variety of business services, which are interdependent, mutual coordination, competing, just as the individuals’ activities in natural ecosystems.

Now, researches closely associated with the SOBE mainly focused on the following aspects: business ecosystem, digital business ecosystem and Web service ecosystem.

Business ecosystem attracted researches’ attention in recent years. Business ecosystem is an analogy of biological ecosystems, which is used to describe the collaborative relationships and the operation mode between enterprises. Moore defines business ecosystem as “an economic community supported by a foundation of interacting organization and individuals – the organisms of the business world” [2]. These communities come together in a partially intentional, highly self-organizing, and even somewhat accidental manner [3]. Peltoniemi consider a business ecosystem to be a dynamic structure which consists of an interconnected population of organizations. These organizations can be small firms, large corporations, universities, research centers, public sector organizations, and other parties which influence the system [4]. Tian presents a framework for the modeling and analysis of business ecosystem. The framework includes an ecosystem-modeling component, a simulation component, and a service-analysis component, and integrates methods from value network modeling, game theory analysis, and multi-agent systems [5].

DBE (digital business ecosystem) resembles business ecosystem in another way. DBE emphasized the interaction between business units at certain extent, which is different from the business ecosystem focusing on the interaction between enterprises. Digital business ecosystem is a European Union funded environment, which provides a structure, where software coded by European SMEs can act like organisms in an ecosystem. The main goal is to enhance possibilities of SMEs to compete with larger software houses. Nachira proclaims that a digital business ecosystem is constructed when the “adoption of Internet-based technologies for business” is on such a level that “business services and the software components are supported by a pervasive software environment, which shows an evolutionary and self-organizing behavior” [6]. Ecological standpoint is present in DBEs in such a way that it is considered to be a “digital environment” populated by “digital species”. These digital species can be software components, applications, services, knowledge, business models, training modules, conceptual frameworks, laws, etc.. The environment enables species to behave like species in natural world, to interact, express an independent behavior, evolve or become extinct if the amount of individuals of a species is not sufficient. Simpler species may form compositions, which allows more complex species to appear [6].

As the Web service infrastructure matures and first-generation SOAs move to the mainstream, web service providers are interconnecting their offerings in unforeseen ways, giving rise to Web service ecosystems. Barros thought that a web service ecosystem is a logical collection of web services whose exposure and acts are subject to constraints characteristic of business service delivery [7]. Considering the dynamic nature in services provision, LI studied the characteristic of service migration and proposed a grid services migration algorithm [8]. Sawatani discussed value chains for services compared with product-based value chain, which were quite different [9]. So, a shift to services-focused business model requires changes of value flows. Quitadamo studied the dynamic services composition in service

The SOBE is different from the current business ecosystem focusing on the interaction between enterprises. Individuals in an SOBE are business services. Although the two ecosystems have different individuals, many problems are similar, such as the system operation mode, framework, complexity and risk related problem. Research results of the business ecosystem are important for understanding SOBEs.

The SOBE is different from the web service ecosystem which is a logical collection of web services. Web service technologies provide supporting for studying SOBEs in some aspects, e.g. business services selection and composition, while this does not mean that web services are equivalent to business services. Business services are different from web service for they have some performances like economic, sociality, and subjectivity. In fact, at a technical level, web service technologies can be considered as business services' external interface, which are used to achieve the data exchange between business services and business coordination.

In the following of this paper, the component elements and the characteristics of the SOBE are analyzed in section 2, and the topology of the SOBE is advanced in section 3. Then, an architecture of Service-oriented business ecosystem was proposed in section 4.

II. ANALYSES OF THE SOBE

A. Component elements analysis and basic definitions

The SOBE is a logical collection of business services and relationships between them. The component elements of the SOBE are mainly business individuals, business populations and business communities.

Business individual: Every business individual has certain business functions, but also has non-functional attribute description. It is the smallest business unit according to business function in the SOBE.

Business population: A business population is a collection of business individuals with same business functions. Individuals in the same population have the same business functions, but they may have different non-functional attributions, such as cost, time, reliability and availability. Therefore, there is competition between individuals. The value of business individuals’ non-functional attributions may change with users’ feedbacks or competition from other individuals.

Business community: A Business community is a collection of business populations with complementary relation according to business function. The so-called functional complementation is that a business individual generates business value by using another business individual in different business populations. Individuals in two or more business populations form a business service chain in accordance with complementary relationships between them. The business service chain inherits all the individuals’ properties in the chain, and generates new properties, thus providing new business functions which are not available for any single individual in the chain.

Fig. 1 shows that enterprises provide business services to outside enterprises. According to descriptions of business services’ business functions, business services with the same business functions join the same business population, as well as business services with different business functions join different business populations. The related populations and the social, technological and economic environment form a business community ecosystem, called SOBE in this paper. Then, these business services are business individuals in the SOBE.

B. Characteristics of the SOBE

The SOBE has many characteristics [1]. First, the SOBE is a concept that describes the business service population which links the interconnected and interdependent services together to form a system. At the individual level, an SOBE shows rational choice, so that each member’s objective is to continuously innovate in order to achieve commercial success. In this way, on the one hand, each individual can have their own goals and strive to achieve, but on the other hand, other individuals may hinder or facilitate its operation. This is the competition and cooperation relationship in an SOBE. At the population level, the connected individuals share the same fate, namely, the rise and fall of an individual can influence the survival of other individuals and even the whole system. Second, SOBEs are composed of a large number of different business services which are together to each other. Both competition and cooperation lie in the system. Thus, a wide range of interaction is an important component of the business ecosystem behavior. Third, credence and risk related problems in the process of cooperation need to be considered. Credence plays a vital role in Business services selection. Besides, an SOBE is self-organization system. Self-organization is related to decentralized decision-making. In an SOBE, each individual can make their own decisions, even though these decisions may be constrained by other individuals. Meanwhile, the behaviors of an SOBE are very complex. The performances of emergence, interrelatedness and adaptive make the SOBE shown non-linear, uncertainty and unpredictability.

Thus, not only the behaviors of an SOBE are complex, but all actors have a strong independence. The traditional control and management methods cannot be directly applied to the behavior control of an SOBE.
Dynamic alliance and service-oriented management style may be used to improve the performance of an SOBE. Therefore, to carry out studies on the behaviors, interaction styles and performances of the SOBE will have great significance for organizing and operating an SOE.

III. THE TOPOLOGY OF THE SOBE

To describe the SOBE proposed in this paper, we give the SOBE topology in this section, shown in Fig. 2, the components of which involve business service, business individual, business community, business individual registry point, business population registry point and business relation registry point.

In Fig. 2, the business service is the business which has not joined in any population, and we call the business service belong any population business individual in this paper. Concepts about business individual and business community have been depicted in section 2.1. According to Fig. 2, business services join in business population by registering at business individual registry point, and business populations join in a business community by registering at business population registry point. Business relations can be depicted by two kinds of relationships: relations between individuals and relations between populations. The former one expresses definite relations of two or more business individuals, but the latter one describes the abstract relations of two or more populations without pointing out the specific individuals. The two kind of business relation can be registered by business relation registry point. All individuals in the same population have same business function, but may have different non-function attributions. Individuals in every two population have different business function descriptions.

IV. THE SOBE MODELING ARCHITECTURE

In this section, we study the architecture of the SOBE by focusing on organization and operation of the system, and advance an SOBE modeling architecture, which is presented in Fig. 3. From Fig. 3, it can be seen that the SOBE modeling architecture is composed by business services providers, business services consumers, and business services ecosystem.

From the business service life cycle perspective, relationships between different elements are: ① Business service providers submit business services registration information including function and non-function description to the SOBE through the business service registry point, as well as providers can give business relation depicts between business services provided by them if they submit more than one business service. ② Registration information is analyzed. According to the business information, each business service, as a business individual, join into the corresponding business population. Business relationships submitted by providers are used to depict relations between business individuals and business populations. ③ The newly added individuals and relations are managed by the SOBE including modification and cancellation. ④ Business service consumers submit business needs to the SOBE through the business services provision and evaluation point, and give business services evaluation information after using business services. ⑤ According to consumers business demands, single business service or business services group meeting the conditions will be selected, and the corresponding relations for business services group will also be submitted to consumers. In the business service selection process, some scheduling work will be done to achieve a balanced use of resources. After determine specific business services, business service providers and consumers need to negotiate a service level agreement (SLA), which is used to coordinate services providing and consuming.
⑥ Provide the selected business services and its related information to consumers. ⑦ Get and analyze consumers' evaluation of business services. Then, these evaluation information will be used to manage individuals and relations in the SOBE, e.g. individuals with many times poor rating will be Eliminate from the SOBE.

V. CONCLUSIONS

Service-oriented enterprise will be a new kind of enterprise form in the future. So, more and more business services will replace the whole enterprises to participate in market competition. Under this environment, the SOBE was proposed to manage the considerable business services in a good way and promote operational efficiency of business services. It tries to operate and reorganize business services provided by enterprises as business ecosystems in analogy with the way that natural ecosystems are running on. The SOBE is involved in management models, business collaboration, business services selection, business services scheduling, business ecosystem behavior, business ecosystem evolution and many other problems, and these problems are very complex and very challenging. In this paper, we discussed the component elements and the characteristics of the SOBE, as well as the topology. Then, an architecture of Service-oriented business ecosystem was proposed. Our work presented in this paper only is a basic research for the SOBE and more work need to do in this area to promote the development of SOBE-related theory, technology and systems.

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