

Nurturing Business Ecosystem with Modular Architecture

Yong Lin¹, Jing Luo¹, Petros Ieromonachou¹, Li Zhou¹, Lin Huang¹
University of Greenwich¹ London, United Kingdom

Abstract

This paper aims to identify the structural elements of a business ecosystem from a view of modularity. The paper proposed that the architecture of the business ecosystem is consisted of three structural layers, including organization, product/service, and technology. Moreover, the structural elements in the business ecosystem can be divided into three categories, which are evolutionary module, developmental module, and fundamental module. This paper extends the modularity research into the context of business ecosystem, and links the modularity in biology with the business studies. The three-layer modular architecture of the business ecosystem provides guidance to practitioners to nurture and evolve their business ecosystem. The identified modules clarify the roles of each actor and position themselves better in the business ecosystem. This paper proposes a modular logic to analyse the business ecosystem, which integrates the modularity theory both from ecology and technology into business/management studies.

Keywords: business ecosystem; modularity; architecture

Introduction

During the last two decades, more and more firms realized that their businesses are operating in a network context rather than an individual firm context (Newman, *et al.*, 2006; Jackson, 2008). Such network can be defined as a *business ecosystem* consisting of interlinked organizations and individuals (Moore, 1993; 1996). Within the business ecosystem, they are not just interconnected with each other, but depended on each other and had a shared fate (Iansisti and Levien, 2004a; b). That means they actually co-evolve with each other to develop mutual benefits, and *co-evolution* is one of the essential characteristics of a business ecosystem (Moore, 1996).

The actors in a business ecosystem include suppliers, lead producers, competitors, and other stakeholders (Moore, 1993). The main research theme on business ecosystem is mainly focus on focal company in the ecosystem (Iansisti and Levien, 2004b). To any complex system the essence is inter-relationship among those actors in the system. Same to the business ecosystem, a coordination mechanism is needed to make sure all actors positioning themselves and working together to reach the expected shared vision. Clarifying the roles and functions of different actors becomes substantial important to the success of the business ecosystem from beginning to a sustainable development.

The more important is, nurturing a business ecosystem becomes essential to the success of companies in particular those in the emerging industries. Rong and Shi (2014) identified the nurturing process from a lifecycle view of the business ecosystem. Different from that, this paper aims to explore the structure elements of a business ecosystem to understand different actors' role and function. In order to understand the business ecosystem as complex network, we adopt modularity to observe the business ecosystems, where modularity has been applied in analysing complex product, process, and organization (Schilling, 2000). From

this point of view, this paper extends the modularity research from product/technology to ecosystem context, and broadens the perspectives in current research on business ecosystem.

Theory background

Business ecosystem

The concept of Business Ecosystem was introduced by [Moore \(1993\)](#), and it was defined as an ‘economic community supported by a foundation of interacting organizations and individuals - the organisms of the business world. This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organizations also include suppliers, lead producers, competitors, and other stakeholders. Over time, they co-evolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments and to find mutually supportive roles’ ([Moore, 2006: pp. 33](#)).

From this original definition, it has listed many actors (including suppliers, lead producers, competitors, and other stakeholders) existed in a business ecosystem, however, it didn’t shown too much on the inter-relationship among those actors ([Rong and Shi, 2014](#)). In order to better nurture a business ecosystem, it is important to have a good understanding on actors’ different role and function in the business ecosystem.

Modularity

Modularity is a general systems concept for managing complexity, and it is typically defined as a continuum describing the degree to which a system’s components may be separated and recombined ([Schilling, 2000](#)). [Baldwin and Clark \(1997, p.84\)](#) describe

modularity as “building a complex product or process from smaller subsystems that can be designed independently yet functions together as a whole”. It refers to both the tightness of coupling between components, and the degree to which the “rules” of the system architecture enable (or prohibit) the mixing and matching of components. The term modularity is widely used in studies of [technological](#) (engineering) system, [organizational](#) systems ([Langlois, 2002](#)), and also [biological system](#) ([Callebaut and Rasskin-Gutman, 2005](#))

Modularity in Technological system

Modularity is not a new idea in the field of technological design ([Simon, 1962](#)), and it becomes more important along with the increasing complex modern technology ([Baldwin and Clark, 1997; 2000](#)).

Product systems are deemed “modular”, for example, when they can be decomposed into a number of components that may be mixed and matched in a variety of configurations ([Baldwin and Clark, 1997; Schilling, 2000](#)). The components are able to connect, interact, or exchange resources (such as energy or data) in some way, by adhering to a standardized interface. Unlike a tightly integrated product whereby each component is designed to work specifically (and often exclusively) with other particular components in a tightly coupled system, modular products are systems of components that are “loosely coupled” ([Orton, 1990](#)).

Modularity in Organization System

Organizational systems are said to become increasingly modular when they begin to substitute loosely coupled forms for tightly integrated, hierarchical structures ([Schilling and Steensma, 2001](#)). For instance, when the firm utilizes contract manufacturing rather than in-house manufacturing, it is using an organizational component that is relatively more

independent than building such capabilities in-house: the firm can switch between contract manufacturers that perform different functions, and the contract manufacturer can similarly work for different firms. As firms in a given industry begin to substitute loose coupling with organizational components that lie outside of firm boundaries for activities that were once conducted in-house, the entire production system (which may encompass many firms) becomes increasingly modular. The firms themselves become more specialized components. Using loosely-coupled structures enables firms to achieve greater scope flexibility and scale flexibility (Schilling and Steensma, 2001). The firm can switch relatively easily between different providers of these activities (e.g., between different contract manufacturers or alliance partners) compared to building the capabilities for all activities in house, thus responding to different market needs more quickly. However, these flexibility gains come with a price. Therefore the organization must assess the flexibility gains achievable, and any accompanying loss of performance, with each of these forms.

Modularity in Biologic System

In biology, the term modularity may be used in multiple ways as in some of the other disciplines (Callebaut and Rasskin-Gutman, 2005). For example, it may be used to refer to organisms that have an indeterminate structure wherein modules of various complexities (e.g., leaves, twigs) may be assembled without strict limits on their number or placement. Many plants and sessile benthic invertebrates demonstrate this type of modularity (by contrast, many other organisms have a determinate structure that is predefined in embryogenesis) (Andrews, 1998). Modules can be considered as biological individuals (Hull, 1980, Roth, 1991) that can be delineated from their surroundings or context, and whose behaviour or function reflects the integration of their parts, not simply the arithmetical sum.

The term has also been used in a broader sense in biology to refer to the reuse of homologous structures across individuals and species. Even within this latter category, there may be differences in how a module is perceived. For instance, evolutionary biologists may focus on the module as a morphological component (subunit) of a whole organism, while developmental biologists may use the term module to refer to some combination of lower-level components (e.g., genes) that are able to act in a unified way to perform a function (Bolker, 2000). In the former, the module is perceived a basic component, while in the latter the emphasis is on the module as a collective.

Biology scholars have provided a list of features that should characterize a module (much as Fodor did in *The Modularity of Mind* (Fodor, 1983)). For instance, Raff (1996) provides the following list of characteristics that developmental modules should possess: discrete genetic specification, hierarchical organization, interactions with other modules, a particular physical location within a developing organism, and the ability to undergo transformations on both developmental and evolutionary time scales. To Raff's mind, developmental modules are "dynamic entities representing localized processes (as in morphogenetic fields) rather than simply incipient structures ... (... such as organ rudiments)" (Raff, 1996: 326).

Another stream of research on modularity in biology that should be of particular interest to scholars in other disciplines is that of Gunter Wagner (Wagner, 1996; Wagner and Altenberg, 1996). Wagner's work explores how natural selection may have resulted in modular organisms, and the roles modularity plays in evolution. Wagner's work suggests that modularity is both the result of evolution, and facilitates evolution - an idea that shares a marked resemblance to work on modularity in technological and organizational domains.

Modularity in Business Ecosystem

This paper proposed a framework of modular architecture of a business ecosystem (see **Figure 1**) based on literature review on both current academic research and secondary data including company online materials, news, reports, and other secondary documentations. And also here we developed three propositions to summarize our findings.

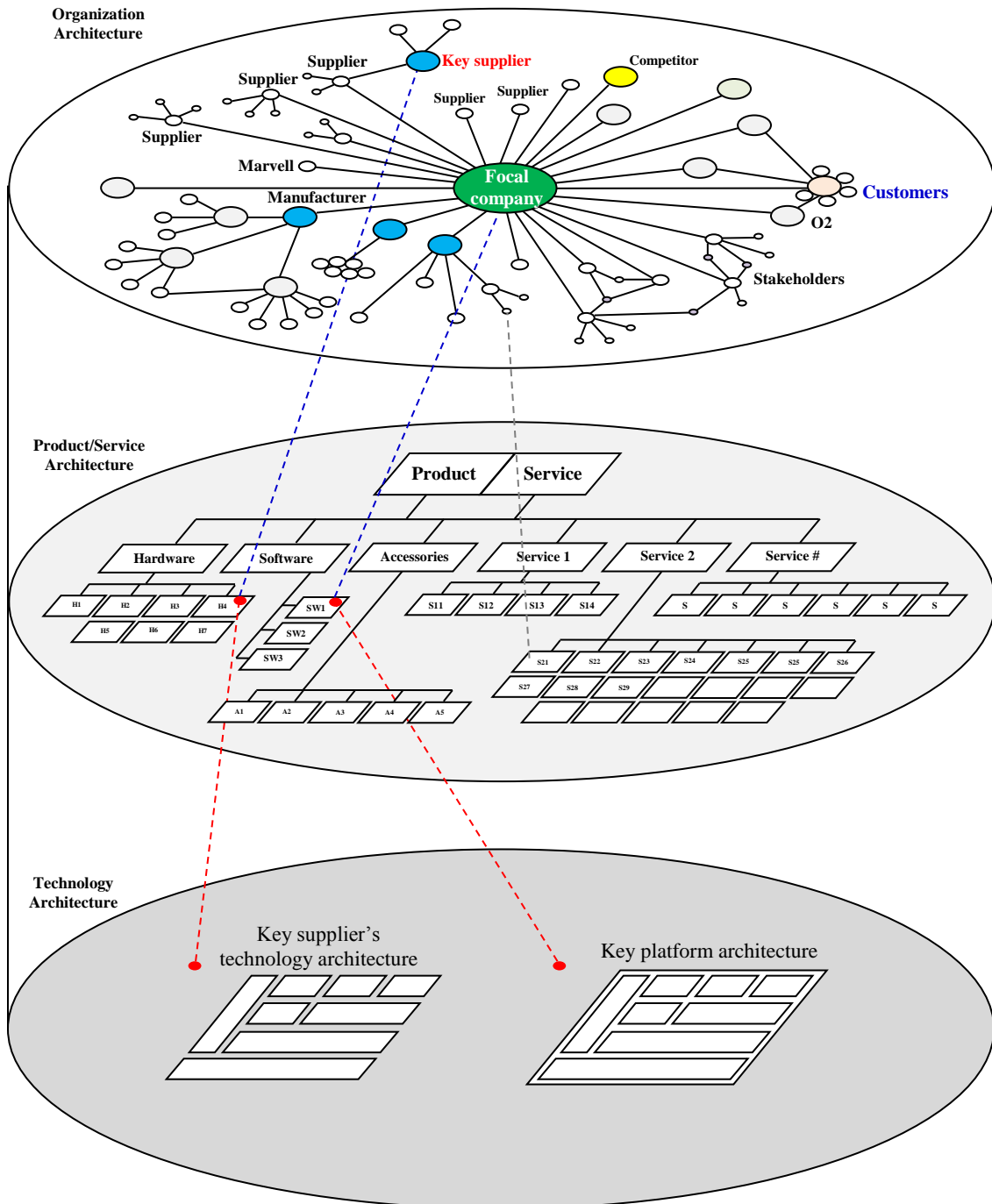


Figure 1 Modular Architecture of a Business Ecosystem

Three layers of the business ecosystem architecture

Business ecosystem is a complex system including huge number of actors and inter-dependent relationships.

As a keystone (Iansiti and Levien, 2004a; b) actor in the business ecosystem, the most important thing is to develop an innovative platform for the co-evolving of all the partners in the networked complex system. For example, Microsoft creates a platform with operations system and developing software. Wal-Mart has a Retail Link as the platform to share information among suppliers. Li Feng's supply chain is a platform to integrate thousands of suppliers, manufactures and distributors to fulfil customer requirements. For its complex nature, operations strategies and the necessary tools and mechanism are essential for its nurturing and sustainable evolution.

Based on this, we propose that the architecture of a business ecosystem is consisted with three layers including organization architecture, product/service architecture, and technology architecture. This is also in line with the results of Rong *et al.* (2013). Technology architecture is an implicit side of a business ecosystem. A new business ecosystem is always founded on some innovative technology development. Both organization architecture and product/service architecture is the explicit side of the business ecosystem. Organization architecture shows the organizational structure of the complex system with varies actors, and product/service architecture presents the offerings from the organizations based on their technology architecture.

Proposition 1: A business ecosystem can be regarded as a modular complex network, and it is consisted with three modular architecture layers: organization, product/service, technology.

Three types of module in the business ecosystem

Modular architecture layer could be regarded as physical elements of a business ecosystem, just like different modular components in a complex product. Same as in product, physical element normally reflects specific function in the product. Here we clarified three functional modules reflecting actors' roles and functions at different architecture layer in the business ecosystem. This follows the same pattern as modularity in biology.

These three modules are evolutionary module, developmental module and fundamental (morphological) module. Different module acts different roles and reflects different functions in organizational, product/service, and technological architecture layer. For example in Apple's ecosystem, Apple is obviously an evolutionary module, which always leads the evolutions of the business ecosystem through innovating the platform for example the iOS and its SDK. App developer is more like a developmental module, who develop new apps to customers based on any new platform development released by Apple. The developmental module plays a role of enhancing and facilitating the evolution of the business ecosystem. An important feature of developmental modules is their reusability. Those suppliers of hardware and accessories, mobile network operators, OEMs are more like a fundamental module providing basic services to the whole business ecosystem to ensure the continuity of the business ecosystem.

Proposition 2: There are three functional modules at three architecture layers in the business ecosystem, and they reflect respectively evolutionary, developmental, and fundamental roles and functions.

Nurturing business ecosystem with modular logic

For a product design, if modular logic applied in the development and design process, it is believed that the product could better satisfy customer's demand with high variety of product choice. Nurturing business ecosystem with modular logic is not just meaning that the organization of the business ecosystem is modularized, and the modularity should be applied to larger range during nurturing it. Its application includes product design, technology design, service design, process design, and also platform design. From this point of view, modularity of the business ecosystem of course will reduce the complexity of such a huge network structure, and also it will be much more efficient to response to uncertainties in the real business world, in particular uncertainty issues concerning technology, application, and market (Rong *et al.*, 2013) .

Proposition 3: Nurturing business ecosystem with modular logic may mitigate the complexity of the business ecosystem, and also it can tackle the uncertainties in the business ecosystem within a context of dynamic economics.

Discussion

This is a conceptual paper addresses on the modularity of business ecosystem and also developed three propositions for future research agenda. Since the business ecosystem is too complex and hard to identify the boundary, it is necessary to simplify the business ecosystem and capture the core construct of a business ecosystem. As a result, we have proposed a matrix structure of a business ecosystem: vertical dimension is multiple level- technology, application and organizational architecture, the horizontal dimensional is the three modules such as evolutionary, development and fundamental.

In terms of multiple level analyses, we have found the previous studies only focus on single level. For example, [Adner and Kapoor \(2010\)](#) have proposed a structure to present a business/innovation ecosystem by introducing the connection between supplier, focal firm, customers and complementor. However, it is still lack of a systematic perspective and not sufficient to catch the nature of a business ecosystem. It partly focuses on the organizational architecture of business ecosystem, but failed to address the application and technological level and how those three levels interaction. Hence, it is necessary to conduct a multiple level analysis of business ecosystem by linking the technology, application and organizational level architecture.

Besides multiple level analyses, we also proposed three different modules in each level which comprehensively organize various activities at that level. Modules could be more generalized which regardless of different roles, applications, technology's attributes. Modules are combination of different items and function at an appropriate way.

In the future, it is necessary to link those different level analyses and explore how those modules operate in each level, further how those modules have cross-level inter-active effects.

Conclusion

Along with the transition from firm competing with firm to business ecosystem competing with business ecosystem ([Rong et al., 2014](#)), nurturing a business ecosystem has been proven by successful cases like Apple, Microsoft, and ARM, that it can bring competitive advantages to companies. One key issue of nurturing a business ecosystem is to understand the roles and functions of different actors in the business ecosystem.

This paper clarified three layers of modular architectures and three categories of modules in a business ecosystem. It is not only extends the research on modularity to business

ecosystem context, but also enhances current research on business ecosystem with understandings on the structural elements of a business ecosystem.

The proposed architecture framework in Figure 1 could be adopted as a multiple level analysis tool for future research on business ecosystem issues, and the developed proposition could be verified and refined in future research in particularly with empirical cases.

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