Research on Multi-point Competition Behavior under the Background of Digital Innovation

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Abstract

Based on the layered modular architecture of products emerging under the background of digital innovation, this paper analyzes the multi-layer and complementary effects of digital innovation on competition of product market, and proposes a multi-point competition model under digital innovation. According to this model, two new multi-point competition strategies for product market are proposed: cross-layer indirect attack strategy and cross-layer direct attack strategy. Taking Apple and Google as examples, this paper analyzes the application of the new multi-point competition model under digital innovation. In theory, it has enriched the traditional multi-point competition model, and in practice provided guidance for enterprises to cope with the competition challenges under digital innovation.

Keywords

Digital innovation, layered modular architecture, product market, multi-point competition model, multi-point competition strategy.

1. Introduction

The development of digital technology represented by big data, Internet of things, mobile Internet and cloud computing has become the core driving force of global digital economy, accelerating the digital transformation process of various industries[1].In the process of digital transformation, enterprises implement digital innovation to integrate digital technologies into existing products and services, thus generating endless new products and services, greatly expanding the functions of traditional products and services[2]. As enterprises increasingly embed digital technologies into physical products, the architecture of product has changed, creating a new product architecture: a layered modular architecture. This has led to new competitive characteristics on products, and the traditional competitive landscape of various industries has been challenged.

In the traditional multi-point competition model, enterprises compete on complete products, and products produced by different enterprises can be almost replaced. However, due to the layered modular architecture of products formed under the background of digital innovation, enterprises not only compete on the final complete products, but also compete on the components of different layers of products. And because of the complementarity between different layers of components, components produced by different enterprises can't be completely replaced. As a result, the competition in product market has undergone significant changes, which requires the improvement of the traditional multi-point competition model to meet the needs of analyzing multi-point competition under the background of digital innovation.

However, research on the improvement of the traditional multi-point competition model to adapt to the changes in product market under the background of digital innovation is rare. Therefore, this paper analyzes the competitive behaviors of enterprises more deeply from the perspective of technological changes that lead to changes in product architecture and thus changes of the competitive characteristics in product market. It establishes a new multi-point competition model under the background of digital innovation, and proposes new multi-point competition strategies, providing references for enterprises to develop competition strategies in digital transformation.

2. Overview of Related Theories

2.1 The Theory of Digital Innovation

2.1.1 Digital Innovation

Yoo, a well-known scholar in the field of information technology management, has conducted pioneering research on digital innovation. Yoo et al. [3] define digital innovation as the combination of digital technology and physical components to produce new products, emphasizing the popularity of digitalization has led to the formation of a new layered modular architecture that will lead to profound changes in the way organizations organize innovation. Fichman et al. [4] highlight the integration of digital technology and physical components of products and the emergence of new products, new processes and new business models, emphasizing that enterprises need to make changes in technology, organization and other aspects to adapt to new development model. Zhao Xing and Dong Xiaosong [5] point out that digital innovation is the use of digital technology to recombine digital and physical components to create new products to enhance and expand the value of products and services, open up new areas of enterprise development, and challenge existing market pattern, eventually leading to a shift in business models and production models in that field. Yu Jiang et al [6] think that digital innovation is a process in which digital technologies and physical components are combined to create new products or provide new services. Their study find that in the process of digital innovation, the embedding of digital capabilities changes the process by which products and services create value.

The unique nature of digital technology makes digital innovation quite different from analog innovation in the industrial age. Organizations in various industries have begun to use digital innovation as the cornerstone of their value creation and strategy development [7,8]. In the past few years, many fields of information systems, strategy, operations, and the economy have studied the nature and significance of digital innovation by integrating concepts and phenomena such as platforms and ecosystems [9-11]. But these research on digital innovation still lacks a coherent conceptual framework and theoretical tools to gain a deeper understanding of the specific ways in which digital technology drives products, processes, and business model innovation. Henfridsson et al. [12] propose a value space framework to analyze value creation in digital innovation, emphasizing the role of reorganization and linkage of digital component in digital innovation, and opening up a new agenda for information systems to study the content and process of digital innovation.

2.1.2 Product Architecture under Digital Innovation: Layered Modular Architecture

One of the key success factors for digital innovation is the development of a layered modular architecture that integrates digital and physical products. Benkler [13] points out that the layered architecture of digital technology consists of four layers: devices, networks, services, and contents. The device layer can be further divided into a physical machinery layer (e.g., computer hardware) and a logical capability layer (e.g., operating system) that provides control and maintenance for the physical machine and connects it to other layers. The network layer is similarly divided into a physical transport layer(including cables, radio spectrum, transmitters, etc.) and a logical transmission layer (including network standards such as TCP/IP or peer-to-peer protocols).The service layer deals with application functionality that directly serves users as they create, manipulate, store, and consume contents. Finally, the contents layer includes data such as texts, sounds, images, and videos that are stored and shared. Rooted in Simon's [14]design theory, modular architecture offers an effective way to reduce complexity and to increase flexibility in design by decomposing a product into loosely coupled components interconnected through prespecified interfaces. Physical products with a modular architecture can be decomposed into different components that can be recombined [15].When digital technology is combined with modular architecture products, a layered modular architecture emerges.

Hylving [16] proposed a layered modular architecture diagram. As shown in Figure 1, each component of the modular physical product is connected to the device layer of the digital technology to integrate the data and functions of the traditionally independent physical components, while the

elements of device layer can be combined with elements of other layers to create novel products and services. For example, automakers deploy wireless Bluetooth technology (service layer) and add new software (service layer)on existing embedded digital devices such as car audio systems (device layers) so that they can be used with mobile phones to make hands-free calls, thus creating a new digital service for car users. Whereas components in a modular product fall under a single design hierarchy, components in a layered modular architecture participate in multiple heterogeneous design hierarchies. This cross-layer coupling enhances the generativity of products and services.

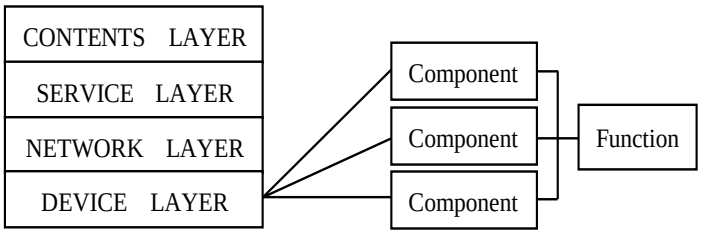

Fig. 1 Layered Modular Architecture

In summary, digital innovation is the process of using digital technology to recombine digital and physical components of a product or service to produce a new product or to provide a new service. The first wave of changes triggered by information technology has produced tremendous growth in productivity and the economy. Despite the transformation of the value chain, the product itself is not affected. In the context of digital innovation, digital technology is becoming an integral part of the product itself, and the products have a layered modular architecture.

2.2 Traditional Multi-point Competition Theory and Strategy

2.2.1 Multi-point Competition

The theory of multi-point competition originated from the economics of industrial organization. Multi-point competition mainly involves competition among enterprises across multiple markets[17]. Chen Mingzhe et al.[18] define multi-point competition as the state of competition in multiple regional and product markets, including competitive performances such as attack ,counterattack and cooperation.

2.2.2 Traditional Multi-point Competition Model and Strategy

Based on the research of previous scholars, the scope of multi-point competition includes multiple segmented markets, regional markets, product markets the combination of the three. Therefore, the traditional multi-point competition model is shown in Figure 2.

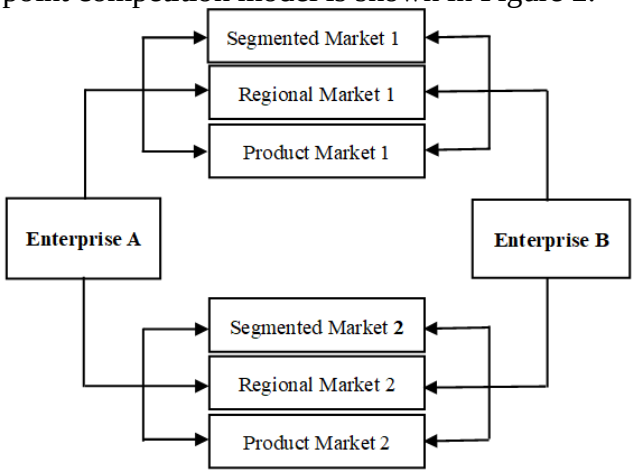

Fig.2 Traditional Multi-point Competition Model

According to interpretation of the multi-point competition model by Lan Hailin [19], assume that Enterprise A and Enterprise B have at least two identical segmented markets, two identical regional markets or two identical product markets that have contacts ,then there is the possibility of potential

cross-segment market, cross-regional market or cross-product market retaliation between the two enterprises which make them endure each other, so using multi-point competition can avoid fierce competition. Assume that Enterprise A has a larger share in Market 1 and Enterprise B has a larger share in the corresponding Market 2, both are in a temporary equilibrium state. If A attacks B in Market 2, then B has two choices to protect his market: one is to counterattack in Market 2, and the other is to counterattack in Market 1. If the two enterprises are equally competitive, they will not be able to gain an advantage in this competition. Finally, the two sides will have to abandon the competition of this round and return to a balanced state.

Regarding the strategy of multi-point competition, Edwards [20] points out when an enterprise competes with another enterprise in multiple markets that overlap, it will not only retaliate in the market attacked by the opponent, but may also counterattack in other related markets of the opponent. Based on previous research, Lan Hailin [19]proposes three basic strategies for multi-point competition: positive attack strategy, trick-attack strategy, and trick-out strategy. Enterprises can also combine these strategies.

3. Multi-point Competition Model under the Background of Digital Innovation

3.1 The Impact of Digital Innovation on Multi-point Competition in Product Market

The layered modular architecture of products emerging under the background of digital innovation complicates the competition in product market, which is manifested in the following two aspects.

(1)Competition in product market is multi-layered

A fully digital product consists of different layers of components, including the device layer, network layer, service layer, and content layer. As shown in Figure 3, for the same product market, enterprises not only compete on the final complete product, but also compete on the components of the device layer, network layer, content layer and service layer. For example, in the e-book market, Apple's iBook and Amazon's Kindle store compete at the content layer, while Apple's iPad and Amazon's Kindle reader compete at the device layer. Therefore, under the background of digital innovation, the competition of enterprises in product market is multi-layered, the points of multi-point competition increase, and the scope of multi-point competition expands.

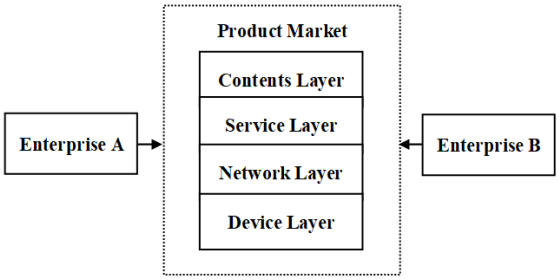

Fig.3 Competition in Product Market Is Multi-Layered

(2)Different layers of product market are complementary

In addition, different layers of digital products embedded in digital technology are not completely independent of each other, and the platforming of digital products and services often makes these layers complementary. For example, Office (service layer) based on Windows system and the computer (device layer) with Windows system are complementary; The application (service layer) in the Apple Store is complementary to Apple's hardware device (device layer). And thus components of the same layer from different enterprises cannot be completely replaced. For instance, Office based on Windows system can not replace Apple's iWork.

The complementarity between layers changes the competitive effects of different layers of product market. As shown in Figure 4, the attack behavior of Enterprise A on Component a (content layer) not only affects the market share of the same Component a (content layer)of Enterprise B， but also may affect the market share of a different Component b(content layer) or Component c of other layers

such as device layers of Enterprise B. For example, in the PC market, due to the complementarity between the operating system (device layer)and the application (service layer), Microsoft's development of a new Windows operating system (device layer) will not only affect the market share of Apple's Mac OS X (device layer), but also affect the market share of Apple's computer at the device layer and Apple's iWork at the service layer.

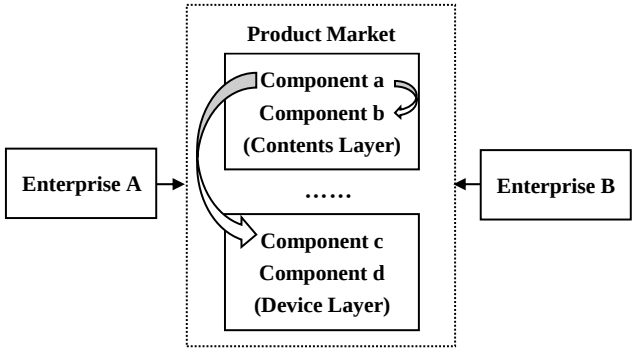

Fig.4 Different Layers of Product Market Are Complementary

3.2 Multi-point Competition Model under the Background of Digital Innovation

According to the impact of digital innovation on multi-point competition, that is, the multi-layered competition of enterprises in product market and the complementarity between different layers of components, this paper establishes a new multi-point competition model whose difference from the traditional multi-point competition model is mainly reflected in the product market.

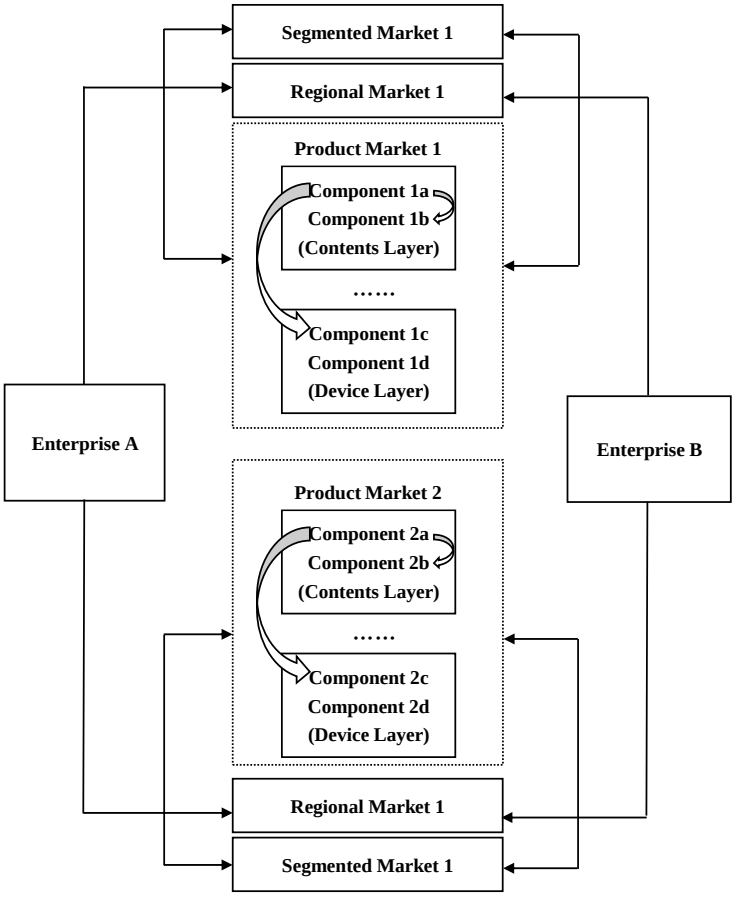

Fig.5 Multi-Point Competition Model under the Background of Digital Innovation

In Figure 5, under the background of digital innovation, enterprises will compete on the four layers of components: devices, networks, services and contents. The new multi-point competition model

divides the product market into different layers. By taking into account the multi-layered competition in the product market, the traditional multi-point competition model is improved.

Meanwhile, due to the complementarity between different layers of components, the competitive behavior of competitors on a certain component will affect different components of the same layer and other layers of the enterprise, which is different from the traditional multi-point competition model that actions of competitors in a certain product market will only affect the corresponding product market of the enterprise. In the new multi-point competition model, assuming that Enterprise A attacks on Component 1a (content layer) of product Market 1, then not only the market share of Component 1a(content layer) but also the market share of Component 1b(content layer)or Component 1c(device layer) of product Market 1 of enterprise B will be affected. Similarly, the offensive actions of Enterprise A in the product Market 2 will have a similar effect. The complementarity between layers of product market is shown by the wide arrow in Figure 5, which further improves the traditional multi-point competition model.

3.3 Multi-point Competition Strategy of Product Market under the Background of Digital Innovation

According to the new multi-point competition model, this paper proposes two new competition strategies: cross-layer indirect attack strategy and cross-layer direct attack strategy based on the original competition strategy. It is assumed that Market a and Market b are component markets of different layers of the same product, and there is a complementary relationship between Market a and Market b.

(1)Cross-layer indirect attack strategy

Assume that Enterprise A conducts business on Market a, and Enterprise B conducts business on Market b. There is no competition between them. For Enterprise A, when it finds that Enterprise B is ready to enter Market a to seize its market share, based on the complementarity between Market a and Market b, then Enterprise A can enter Market b across layers ,indirectly consolidating its position on market a of another layer by capturing market share in market b. As shown in Figure 6, Enterprise A achieves its competitive goals through a cross-layer indirect attack strategy.

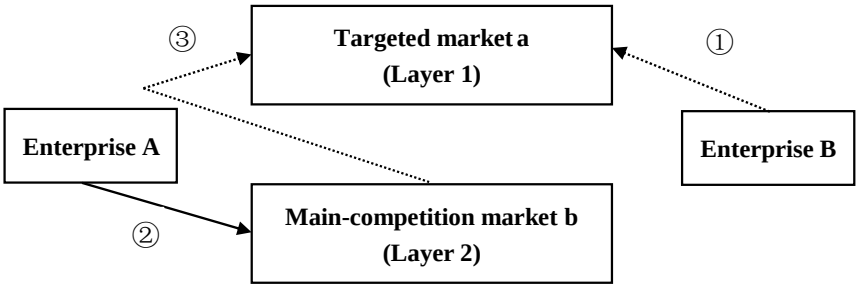

Fig.6 Cross-Layer Indirect Attack Strategy

(2)Cross-layer direct attack strategy

Assume that Enterprise A conducts business on Market a, and Enterprise B conducts business simultaneously on Market a and Market b. They compete on Market a. For Enterprise A, When it finds that due to the complementarity between Market a and Market b, Enterprise B's behavior on Market b consolidates its market position in Market a, thereby seizing Enterprise A's market share in Market a, then Enterprise A can enter Market b across layers and directly compete with Enterprise B in market b to obtain a certain market share, thus protecting its position on the market a of another layer. As shown in Figure 7, Enterprise A achieves its competitive goals through a cross-layer direct attack strategy.

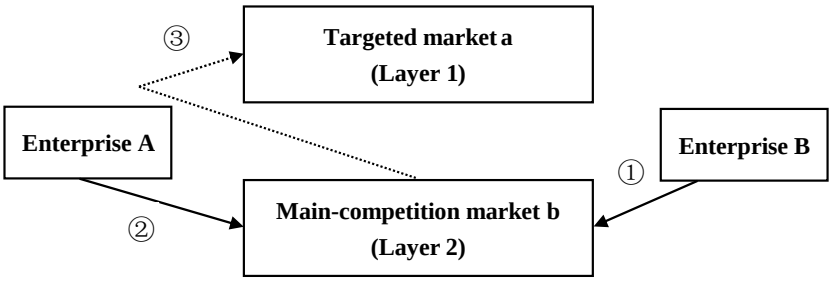

Fig.7 Cross-Layer Direct Attack Strategy

4. Multi-point Competition Case in Product Market under the Background of Digital Innovation

Google and Apple are used as examples to verify the new multi-point competition model and strategies by analyzing their competitive behavior in the smartphone market.

4.1 Layered Modular Architecture of Smartphones

As shown in Figure 8, the smartphone represents an obvious layered modular architecture. Both Apple and Google provide components at the device, service, and content layers. The components and services at the network layer are primarily provided by telecom operators. Apple and Google's smartphone market have obvious multi-layered features, and there are strong complementarities between different layer of components.

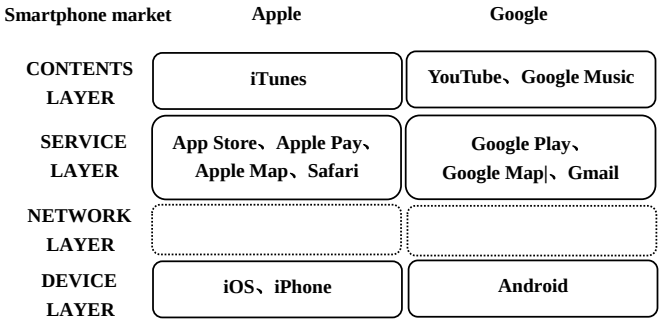

Fig.8 Layered Modular Architecture of Smartphones

(1)Analysis of multi-layer

Apple and Google have many components on the device, service and content layers of smartphones, and there is competition among them. For example, at the device layer, the iOS operating system and the Android operating system compete directly; at the service layer, Apple Map and Google Map compete directly; at the content layer, Google Music and iTunes compete directly.

(2)Analysis of complementarity

For instance, the component iTunes (content layer)in Apple's smartphone market is complementary to its hardware iPhone (device layer) and can only be used on iPhone. When iTunes offers more music and enriches its content, it will have an advantage over Google Music. And this advantage may also make Apple's hardware iPhone (device layer) more competitive, which also affects Google's market share of Android (device layer).For another example, the opening of Google's Android system (device layer) enables more mobile phone manufacturers make Android-based mobile phones, thus seizing the market share of Apple's iOS operating system and iPhone (device layer), while mobile applications embedded in Android also affect the market share of related service layer of Apple.

4.2 Analysis of Multi-point Competition Strategy in the Smartphone Market

(1)Cross-layer indirect attack between the service layer and the device layer

Background of attack: in the early days, Google mainly conducted business on components of the service layer such as Google Map, Google search engine, Gmail and components of the content layer such as YouTube in the smartphone market, while Apple mainly conducted business on components

of the device layer of smartphones, including its mobile operating system and iPhone. Google provided components of the service layer such as maps, search engine and mail for Apple's iPhone, and also made its YouTube compatible with Apple's QuickTime player. The two companies worked closely together. But with Apple's growing position in the device layer of the smartphone market, Google felt a crisis. Google realized that in the future, Apple may replace mobile applications on its devices with Apple's own applications, and seize Google's market share in mobile applications at the service layer.

Process of attack: Google entered the operating system market(device layer), indirectly consolidating its position in mobile applications(service layer)by seizing market share in the operating system. In 2005, Google acquired the emerging technology company Android, so it continued to promote the development of Android operating system, against Apple's iOS system. At the same time, Google embedded its mobile application on the highly compatible Android platform, allowing its advertising and other value-added services to run smoothly on the platform.

Result of attack: the launch and upgrade of Android system increased threat to Apple's iOS system. Google's Android system attracted a variety of mobile phone manufacturers to produce phones of Android system, so Android had a large number of users. Although Google didn't charge directly for its open Android system, it indirectly expanded its market of mobile application by developing a mobile operating platform across layers.

As shown in Figure 9, Google used a cross-layer indirect attack strategy in the process.

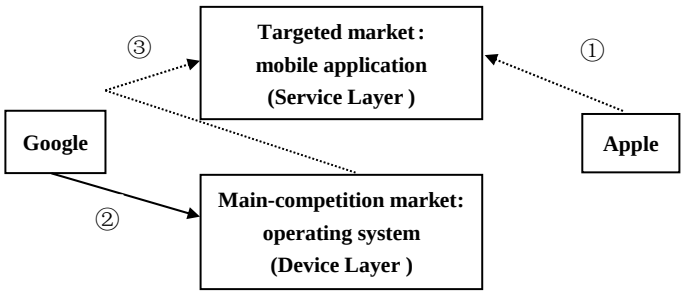

Fig.9 Cross-Layer Indirect Attack Between the Service Layer and the Device Layer

(2)Cross-layer direct attack between the service layer and the device layer

Background of attack: Google and Apple competed fiercely on the operating system. After the launch of iPhone, Apple planned to launch a more complete application store based on this terminal. Apple's App Store had grown at a rapid pace since its launch on July 11, 2008. By the end of 2009, the number of applications exceeded 100,000. The boom in the App Store had made the iOS operating system on iPhones popular among consumers. At the same time, due to the lack of rich applications on the Android system, it was at a disadvantage.

Process of attack: Google entered the application store market(service layer), indirectly consolidating its position in Android system(device layer) by seizing market share in the application store. Three months after Apple's App Store went live, Google's Android Market followed the line. On the one hand, Google strongly supported free apps to be sold in the Android Market, making free apps growing. On the other hand, Google adopted a more open model that applications can be released without review.

Result of attack: Google's free strategy made its Android Market develop rapidly. By the end of 2010, the number of applications soared to 200,000. Although it still lagged behind Apple's 300,000, the development of Android Market enabled Google's operating system to have competitiveness and protected its market share in the operating system.

As shown in Figure 10, Google used a cross-layer direct attack strategy in the process.

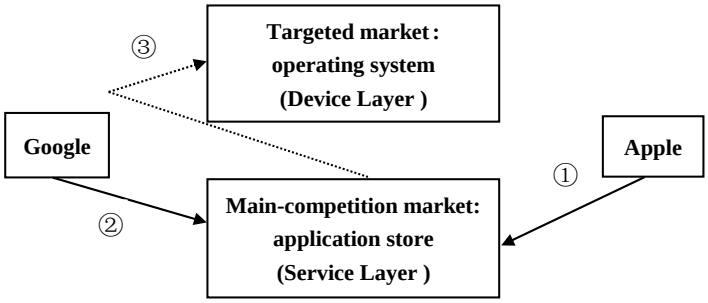

Fig.10 Cross-Layer Direct Attack Between the Service Layer and the Device Layer

5. Conclusion and Enlightenment

The research in this paper has the following practical implications for enterprises.

(1)Identify competitors based on the layered modular architecture. Digital innovation blurs the boundaries between industries, changes the way and rules of competitive interaction, deepens the degree of competition among enterprises, and thus challenges the identification of competitors.Based on the layered modular architecture,on the one hand, the enterprise can figure out which layer its core products are at, and then better identify its competitors at the corresponding layer and protect its core layer; on the other hand, the enterprise can clarify the layer of competitors' core products and make targeted competitive actions to consolidate its core layer effectively.

(2)Emphasize the platform development of components and strengthen the complementarity between different components. Some layers of digital components can serve as a platform. For example, Apple's App Store provides developers with an application trading store to attract developers while provides users with rich apps to attract users, to make full use of the growth of their platforms to achieve service innovation and value creation. Therefore, enterprises are encouraged to build digital component platforms to control the combination of specific components, and center on platform-based digital components to form a more flexible and scalable innovation ecosystem.

(3) Focus on the application of cross-layer competition strategy. In the context of digital innovation, the competition of enterprises in the product market can be achieved through cross-layer, which provides enterprises with new strategic choices. When the enterprise is the competition initiator, the cross-layer indirect attack strategy can be adopted; when the enterprise is the competition counterpart, the cross-layer direct attack strategy can be adopted.

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