

Empirical Research on Cloud Computing Industry Development Strategy in Shanghai, China: SWOT Model

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Abstract—Shanghai is the commercial, international economic, international financial center of mainland China. As an international industrial competition and develop key strategic resource platform, the cloud computing industry has a very important strategic significance for Shanghai development. By empirical research Shanghai cloud computing industry status quo in four typical Districts, Yangpu, Zhabei, Pudong, and Changning, This paper used SWOT model to analyze Shanghai cloud computing industry conditions. At last got eight practical significance suggestions, like, Infrastructure building, enterprise training, research and development of key technologies, form cloud computing industry policies, talent introduction and etc.

Key words—Cloud computing; SWOT; empirical research; development proposals

I. INTRODUCTION

Shanghai is the commercial center of mainland China, and its GDP ranks first in the whole country, Shanghai is working to build itself into the international economic center, the international financial center, the International Trade Centre and the international shipping center. As an international industrial competition and develop key strategic resource platform, the cloud computing industry has a very important strategic significance for Shanghai development, such as, gathering resource integration, promoting industrial restructuring and upgrading, accelerating modern service industry development, Stimulating emerging strategic industries and innovative business model.

Shanghai announced "cloud computing industry base in Shanghai, the financial support policy implementation measures" Clarifies the spatial distribution, industrial location,

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top ten projects and other methods of the cloud computing August 2010, Shanghai Municipal Economic and Information Commission officially released the "Shanghai to promote cloud computing industry development action plan (2010-2012)", i.e. "sea of clouds Plan" September 2011, industrial park. Yu Primus Industry Market Research Center released the "Shanghai 2012-2013 Annual Cloud Computing Industry Development Report", which is mainly research Shanghai cloud computing industry-related policies, the environment, business, human resources, technology, products, service and other related activities. [1] In the year of 2013, under the policy guidance of "sea of clouds Plan", Shanghai accelerates the pace of cloud computing industrial development, and it has been basically completed the city cloud computing infrastructure, and now is being vigorously promote the development of new applications and the strategic layout. [2]

II. CLOUD COMPUTING INDUSTRY CHAIN

As an important application mode Internet era, under the impetus of Amazon, Google, IBM, Microsoft and other companies, Cloud computing has become a global concern emerging industries focus, from a promising business concept evolved into the fastest growing areas of information services branch in just a few years. [3] Chinese cloud computing industry ecosystem is being construction, and under the supervision of the government, cloud computing service providers , providers of hardware and software, network infrastructure and service , cloud computing terminal equipment manufacturers of consulting and planning, delivery, operation and maintenance, integration services, and etc. together constitute cloud computing industry ecosystem for government, corporate and individual users.

In general, the cloud computing industry chain is divided into three layers: the first layer, provide cloud services for the terminal market; the second layer, provide intermediary services for service providers; third layer, provide the hardware for the service provider. Cloud computing industry chain division characterized by: first, the existing monopolies might break, providing opportunity access to new businesses, and a number of currently unknown company could grow up. Second, the market will expand and enterprise cost may reduce. As cloud computing technology matures, the outsourcing of production enterprises and service providers may increase.

Third, through mergers, restructuring, strategic alliances and other industrial integration, of industry resources in all aspects of the behavior will increase, is likely to form a larger wave of corporate mergers information. [4]

III. EMPIRICAL RESEARCH ON SHANGHAI TYPICAL URBAN CLOUD COMPUTING INDUSTRY STATUS QUO

A. Yangpu: Country innovative pilot District

Yangpu District is known as Shanghai's Knowledge Innovation Zone. With more than 5,000 technology companies, Yangpu District gets the first in Shanghai center Districts. At the same time, it brings together Fudan University, Tongji University and other 14 domestic famous universities, and it has more than 20 million college students. This high-tech industry development has provided full support. Abundant talents provide its support to the development of high-tech industry. [5]

In early 2010, Yangpu was chosen as the first Shanghai national pilot innovative District. In order to speed up the innovative district construction, Yangpu takes cloud computing industry as a priority development of industrial, and focus on developing the "Shanghai Cloud Computing Innovation Base." Major development projects include: the cloud base, cloud entrepreneurship, cloud talents and etc. Yangpu specifically developed five support policies for the cloud computing industry, they are special supporting funds, enterprise rent subsidies, purchase intermediary services, personnel ancillary services, and professional platform services.

B. Zhabei District: promote cloud computing industry base construction

The important initiatives to promote cloud computing industry base construction of Zhabei District include:

--First, Zhabei initiates more than 500 million RMB to establish industrial development investment funds, and constantly improve the park ancillary services.

--Second, promote three data centers, China Telecom, China Unicom, China Mobile and other infrastructure operator projects settled, and accelerate the establishment of Microsoft Innovation Incubation Center, cloud computing United laboratory R & D base. [6]

--Third, Actively guide enterprises to independent innovation, companies of the cloud base have successfully developed the "cloud building blocks", which are independent intellectual property rights, and also the first domestic containerized data centers, as well as cloud middle-wares, cloud databases and cloud operating systems.

--Fourth, Zhabei cloud computing industry base promote cloud computing demonstration projects, such as healthy cloud, SMEs clouds, cloud-government, which combined intellectual business district, wisdom parks, intelligence community. Currently, the enterprises of the base have accumulated reporting more than 30 high-tech industrialization projects, and a total investment nearly 28 billion RMB. [6]

--Fifth, Introduction of foreign capital: "Shanghai Cloud Computing Industry Base" of Zhabei signed strategic agreements with Microsoft, and Dell, Oracle as well as Intel,

worldwide famous companies, to cooperate in the content of the products in the cloud computing and cloud joint cooperation. They will build cloud computing laboratories and cloud computing comprehensive centers with Shanghai University and etc.

C. Pudong New District: create "Pu soft Ebizal" IT Services Cloud

As Shanghai international financial center, the international shipping center, the large aircraft and location of the Disney project, Pudong will generate greater demand for cloud computing services to fast driving finance, shipping, logistics and other areas developing mode change. In 2011, Pudong New District GDP reached 548.4 billion Yuan, of which electronic information industry output value of 252.986 billion Yuan, accounting for 35.8 percent of Shanghai; software and services industry operating income 140 billion Yuan, accounting for half of Shanghai. There are about nearly 60 cloud related business. [7] Cloud computing applications of Pudong New District are mainly concentrated in manufacturing and software, information services field. The former main layout in Zhangjiang, Jinqiao, fully protected areas, such as Cambridge and port industrial park, and the latter is more scattered, mainly located in Lujiazui, Zhangjiang, Jinqiao, Waigaoqiao, three forest, North Cai areas. Some software and information services companies of this region are doing the development and application of cloud computing, while the port is currently under construction Software Park, Software Park Royal Bridge, chuansha Software Park will gather such enterprises. Currently, Pudong is building the Harbor Software Park, Royal Bridge Software Park, Chuansha Software Park, and will gather the these kinds of companies.

In 2011, Pudong New District carries out the "Pu soft Ebizal IT services cloud," provides regional cloud (public cloud) services in an effort to SME growth and expansion. "Pu soft Ebizal IT services cloud" is the first software park by the construction and operation of full-service IT public cloud. This service cloud will provide nationwide SME infrastructure including hardware, a complete development platform, application software ordering and other cloud computing services, thereby greatly reducing operating costs. It is the first domestic full-service public cloud, which helps SMEs to develop, and this cloud platform is responsible by the Shanghai Pudong Software Park Wise Technology Co., Ltd. The first batch of "Pu soft Ebizal service cloud" first settled in Shanghai Pudong Software Park to meet nearly 500 companies and Zhangjiang Hi-Tech Park small and medium sized technology companies' needs. After the gradual expansion into the Yangtze River Delta regions, "Pu soft Ebizal service cloud" planned set up branches in Beijing, Guangzhou and other places. [8]

D. Changning District: construction of "cloud computing innovation demonstration Wisdom Science and Technology Park"

From the information technology infrastructure to strengthen and perfect service to start, Changning District vigorously promoting the "wisdom of cloud computing technology innovation demonstration zone" construction. Changning

District and China Telecom, Shanghai University of Engineering National University Science Park, Shanghai Huigu White cat Science and Technology Park signed a strategic cooperation agreement to jointly promote the park construction, strengthen the information technology infrastructure, and strive to build optical networks and wireless Technology Park and Technology Park, enterprises settled in the park to improve broadband usage environment, rich broadband business applications. At the same time, constantly improve settled enterprises services for SMEs and high-tech companies within the park, to provide a package of cloud computing services, such as cover cloud hosting, cloud storage, cloud applications, and build an integrated management platform, cover the park rental, reporting, certification, property and other information services for enterprises to provide convenient and efficient information services, and use China Telecom's global Eye platform to build the park video monitoring center, the introduction of Tianyi intercom, wireless Patrol, positioning scheduling, mobile office and other applications, to enhance the park overall technological level of service. [9]

IV. SHANGHAI CLOUD COMPUTING INDUSTRY SWOT ANALYSIS

A. Strength

1) *Government planning clearly and large support:* According to the Shanghai Economic Information Committee officially released the "Shanghai to promote cloud computing industry development action plan (2010-2012)" disclosure, Shanghai to promote the development of cloud computing industry focus on five aspects: First, the core technology breakthroughs in virtualization. Second, develop of cloud computing management platform. Third, build cloud computing infrastructure. Fourth, encourage cloud computing industry applications. At last, build cloud computing security environment [10].

2) *Cloud computing industry supporting the environment constantly improve:* As one of China's five cloud computing services innovation demonstration cities, Shanghai "sea of clouds Plan" was officially launched over the past year, the proposed "Ten Facing" development goals, "the six projects", and the two major industrial bases has made progress. Shanghai has started a number of independent R&D key technology projects, "clouds Industry Alliance" has more than 140 member units, and "clouds venture capital fund" has taken shape [11].

3) *The level of information Continuous upgrade:* In front of big data industry chain, Shanghai has good foundation. As early as 1996, Shanghai proposed the construction of International Harbor strategy. Today, the information level of Shanghai leads domestic first, such as FTTH coverage, wireless LAN coverage density, MAN egress bandwidth. Shanghai has good foundation to develop into a large data "hub"[12].

By 2013, Shanghai will achieve fiber-optic broadband network urbanization full coverage area, covering more than 7.5 million households, the full implementation of optical network service 48 hours launched service initiatives; average Internet bandwidth of 18M, average access bandwidth

(including application bandwidth) 32M, reach the international advanced level; WiFi built more than 10,000 field point, the new IDC / DC total rack reached 20,000; international sea cable communication capacity of 5T, Internet, international exports reached 660G, egress switching capacity continue to maintain the scale of the country first[13].

B. Weakness

1) *The existing cloud computing market is small, and the application is still at an early stage:* As China's cloud computing industry as a whole in its infancy stage, the problems facing both the personal side, such as the application stage, information technology facilities, and also common side, such as security, intellectual property and legal perfect. Development of information technology will be an important support for building Shanghai into "Easy business, Easy life" modern international city.

2) *Cloud computing underlying technology of and IT infrastructure of Shanghai need to be improved:* How to build cloud computing infrastructure is Shanghai cloud computing development need to be addressed. Some suggestions, such as: By relying Ericsson, BenQ, Simcom, Fujian Communications, Quancheng communication, East China Civil Aviation and other international famous enterprises, promote applications and development of the mobile communication system equipment, terminal products, special silicon and software. Speed up the industrialization process of mobile communications ASIC and software, digital trunking communication products, mobile communications equipment, key accessories and test equipment. Encourage key enterprises to develop information resources data analysis, collection, processing and other value-added services platform. Strong apply business platform for telecommunications networks, radio networks and computer internet, triple play service platform.

3) *Shanghai cloud computing industry's business model to be a breakthrough:* One of the bottlenecks to be a breakthrough of Shanghai cloud computing industry is how to strengthen the cooperation between the Shanghai government and telecom operators, third-party data centers and industry information centers. Such as, applying demand - oriented integrating the various types of information infrastructure resources and building demand for the integration of different enterprises cloud computing center, forming infrastructure services (IaaS, PaaS) or application service (SaaS) capabilities to businesses and the community in the development.

4) *A larger increase in the cost of network access:* Shanghai "wireless city" plans to use TD-SCDMA, TD-LTE, WLAN and other technical means to build a full range of wireless city concept for the area, for all types of users with seamless high-speed voice and data communications services. [14] At present, cloud computing operators return on investment is declining. Some problems, like, the companies can't promote hierarchical pricing structure to the end user, intelligent mobile end users consume a lot of resources to generate resource constraints, operators do not want to sell a large quantity of access services without restriction to the big users, and cloud service on a remote terminal. Therefore, how to reduce the cost

of access is another bottleneck when Shanghai aims at achieving "the Twelfth Five-Year Plan of wireless city".

C. Opportunity

1) *Wisdom City*: Shanghai Municipal Government and China Telecommunications Corporation signed the "build Shanghai smart city 2012-2013 strategic cooperation agreement." Under the agreement, China Telecom will invest 14 billion Yuan promote Shanghai smart city construction projects, improve their overall level of information from the wisdom government, the wisdom livelihood, the wisdom industry, three fields within two years. Shanghai will support China Telecom to create "high-speed broadband, intelligent, full coverage," the next generation of integrated information network to promote the triple play, and strengthen information exchange capacity communications hub. [13] And make Shanghai become one of the best communication quality, network bandwidth, comprehensive service and tariff competitive city in the country. China Telecom will focus on the "Wisdom Government, Wisdom Livelihood, Wisdom Industry" three major areas to promote e-government, social management, education, community life, health, urban transport, logistics and transport, financial sector, industrial parks and other industries of the information applications work.

2) *Shanghai "the sea of clouds Plan"*: China's "Twelfth Five-Year Plan" proposed focusing on the development of strategic emerging industries, and cloud computing industry is the first deployment emerging information industry in the country. As the main carrier of the implementation of the Shanghai "sea of clouds Plan", Yangpu District inaugurated cloud computing innovation base in October 2010, and become one of the important forces pushing industrial development. [15]

3) *Shanghai actively build cloud computing industry alliance*: In order to actively build a cloud computing technology and services platform, docking the Yangtze River Delta region and the national demand for services cloud computing industry, expanding Shanghai cloud computing solutions demonstrate the scope of radiation, the Shanghai Municipal People's Government and Huawei Technologies Company signed a cloud computing strategic cooperation agreement in 2011. Shanghai Municipal Government will support Huawei's participation in the Shanghai "clouds Industry Alliance" construction, and at the same time combine software and information services enterprises of Shanghai to actively expand the foreign services.

Huawei will build a global cloud computing Joint Laboratory in Shanghai, making cloud core technology R & D team with Shanghai enterprises and research institutes, and giving software and information services support to Shanghai enterprises and helping them transition to cloud computing industries and meanwhile promoting Shanghai cloud computing industry chain development. Huawei will also carry out a comprehensive cloud computing high-end talent cultivation in Shanghai, and building cloud computing presentation and experience centers to popularize cloud computing concept.

4) *Foreign Capital Introduction*: In November, 2012 Shanghai built "public cloud." According to the memorandum

signed by Shanghai Municipal Government, the Pudong New District and Microsoft, Microsoft will be based in Shanghai, and offer Office365 and Windows Azure services to the whole country. And according to the agreement, in the "cloud era", Shanghai will be the first introduce Office365 and Windows Azure in the government. [16]

Since the establishment of China's first "cloud computing platform for teaching and research" by Microsoft Asia-Pacific R & D Group and Shanghai Jiao Tong University in 2011, they have partnered to set up two cloud computing courses. By utilizing the latest virtualization technology to build a campus private cloud, multiple teaching and research have shared benefits from the scalable computing resources. Through the Windows Azure academic Pass Project launched by Microsoft globally, relevant teachers could apply in bulk for free Windows Azure passes for student, so that cloud computing platform could be supplied for practical teaching. [17]

D. Threats

1) *Security issues of cloud computing industry*: "Cloud security" consists of two levels: First level, worry about data security issues from the user's level, including loss of data due to unreliable system, as well as leakage of privacy or trade secrets due to attacks from opponents or hackers. Second level, may worry about the state-level security issues. Since public cloud computing environment supplied by external vendors and could be shared with others, this could result in theft of sensitive data of the country's economic, military, government departments as well as research, thereby threatening the country's economic and social security.

2) *Data security is critical*: construct data backup center, information security system, complete virus protection and network attack prevention system. Improve and upgrade the existing information security devices, information security certification system, and information security management system.

3) *The risk of end-users, a variety of security threats*: such as: worms, viruses, Trojans, hacking, information lost, tampering, destruction, internal and external leakage, and electronic espionage etc. in the computer system.

4) *Security issues of virtual computing platform*: ① attack on the user's data by making use of security vulnerabilities of virtualization software; ② Since virtual machines shared physical memory with each other, there is possibility that user's confidential data may leak out through the memory; ③ Hackers can launch denial of service attacks by using VM, and may also hire "virtual machines" to attack "cloud" computing platforms.

5) *The patent protection of cloud computing technology lacks relevant legal safeguards*: Enterprise and cloud computing service providers have the relationship between buyers and sellers. Since it is a trading relationship, the relationship about the interests involved. And all the allocation of benefits should be determined by the relevant contract or agreement, so that once there are benefits conflict, it is able to be resolved through legal channels. The existing policies of Shanghai are not much, includes only "Promotion plan of Shanghai to implement Shanghai Intellectual Property Strategy Outline" and a few other policy. How to nurture and introduce a

number of legal services and accounting services agencies, which focus mainly on businesses such as knowledge innovation, scientific and technological achievements implementation, and Intellectual property rights etc.

How to accelerate the development of the knowledge innovation industry and trade organizations? How to promote assembles of industry organizations such as rating agencies on industrialization of scientific research, qualification identified agencies, software industry association, E-commerce business associations, and private entrepreneurs association etc. The answers for above questions are important means to solve the corresponding bottlenecks of Shanghai.

V. STRATEGY RECOMMENDATIONS ON SHANGHAI CLOUD COMPUTING DEVELOPMENT

A. *Strengthen the construction of Shanghai cloud computing infrastructure*

It should be with the guideline of demand and application, integrate all kinds of social information infrastructure resource, and promote the traditional telecom operators and other third-party data center to transit to the service providers of cloud computing infrastructure. Introduce integrated cloud infrastructure and platform services for different business needs, form the new service modal paid by resource using, and improve the efficient use of infrastructure resources continuously. Support qualified county government and large enterprise groups to build new cloud computing infrastructure with energy-saving, environmental protection, low-carbon characters. Guide a variety of information technology applications projects to rely on cloud computing infrastructure gradually, form the leading edge of Shanghai in the cloud computing infrastructure services field, and have the radiation capacity for Yangtze River Delta in cloud computing infrastructure services field.

B. *Strengthen the training of Shanghai cloud computing enterprises*

Strengthen the professional supporting business incubation, improve industrial cooperation system. With the promotion of Shanghai Economic and Information Technology Commission for "sea of clouds Plan", "SME cloud" etc. as an opportunity, select a number of SMEs which have distinctive characters, strengthen innovative capacity, and advantage in the business field of cloud computing to train mainly and continuously, boost them to a new level. With the sea of clouds union as a carrier, guide the market-oriented cooperation, promote leading enterprises and SMEs to launch collaboration and division, and form the industrial cooperation system. Build Shanghai cloud computing platform for product promotion, construct cloud computing products and experience center.

C. *Encourage research and development of key technology of cloud computing*

Encourage each district and county governments of Shanghai, research institutions, and cloud computing tech enterprises to establish the national laboratories and industrial technology platforms for public service of cloud computing.

Take the task of research and develop of cloud computing key technologies, and spread to industry field. Encourage qualified large enterprises independently or jointly with universities, and research institutes to set up R & D institutions, engaged in the research of cloud computing key technologies. Encourage enterprises to strengthen international exchanges and cooperation. During the stages of introduction, digest, absorbing, and re-innovation of cloud computing technology, based on the commercial use, master the key technology of cloud computing gradually, and achieve synchronization of technology and service model innovation. [18]

D. *Build "government cloud" in Shanghai, lead and drive the development of cloud computing in different district*

Regarding the specific task of e-government construction during the national "the Twelfth Five Years Plan", relying on cloud computing data center, managed to build Shanghai "government cloud application platform". Promote cross-sector collaborative applications. [19] Implement the transition of Shanghai E-government to the cloud era. Improve the management capacity and efficiency of government agencies. Focusing on the Integration of underlying database such as geographic information, legal, and population etc., establish the underlying database of government affairs. Set up Information exchange platform and public cloud data centers of Shanghai, managed to achieve the unified planning, unified collection, unified development, and unified maintenance of data resource. Make government information retrieval and location-based services more efficient and convenient, by centralized storage and sharing. [20]

E. *Optimize Shanghai cloud computing policy and legal mechanisms, speed up the legislation in the data privacy field, improve cloud security*

Strengthen legal advocacy, increase judicial protection, make enhancement in the field of data privacy, information security protection, and intellectual property protection. Make use of fiscal policy to increase the proportion to support business R & D: Guide financial institutions to tilt to the cloud industry, help to finance. Provide tax breaks or subsidies to some extent. Introduce targeted support policies in the fields of account, housing and children's education for talents.

F. *Form the Shanghai cloud computing industry alliance*

Set up "Shanghai cloud computing industry alliance", by organizing cloud computing products and solutions provider, industry application vendors, related hardware vendors, universities and research institutes and users. Strengthen the communication and business cooperation between enterprises of cloud computing industry chain upstream and downstream. With the higher education institutions and research institutes as the majority, domestic and foreign enterprise and evaluation agencies of cloud computing technology as union, establish "Cloud Computing Joint Laboratory" of cooperative production, study, research and application purpose: Relying on Industry Promotion Agency, gathering social forces to conduct a joint cloud computing research and development of key technologies and application software, establish a leading cloud computing open source community.

G. Increase the efforts of talent introduction and training

Introduce technology development and industrialization leading talents of cloud computing, by doing the "Thousand Talents Program", "Pujiang Talents Program" and etc. Training thousands high-end talents on cloud-computing technology development and industrialization fields, with universities and research institutions as the majority, and human resources certification training institutions as union. Support the cooperation between enterprises and institutions of higher learning, between research institutes, training and consulting agencies. Support Shanghai universities to strengthen the construction of relevant disciplines, train a number of outstanding talents, and form talent echelon. To improve information security system as the goal, and implement the information security level protection system as the main line, pay great efforts to strengthen the implementation of security responsibility of cloud computing public service platform, which belongs to information security key units. Deepening such information security basic work, like Security Evaluation, Electronic Certification, and Emergency Preparedness etc., which is highly associated with cloud computing.

H. Promote the establishment of standards for cloud computing in Shanghai

Promote cloud computing model information security standards, the standard formulation and implementation, and build safety certification system for cloud computing services environment data security, and provide support to privacy protection. Focusing on cloud security technology, and standards definition of cloud computing, including:

--First, Basic standards represented by technical concept, and reference model. Cloud computing key technologies and product standards represented by massive data management, and interactive browsing.

--Second, Service Operations and Resource Management Standards represented by quality evaluation of cloud service model, and cloud governance practices.

--Third, Information security standards represented by the protection of safety, the monitoring of information security, and security audit of cloud platform. Improving the user's trust of cloud computing services, through technology and standards to protect cloud security [21].

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