

## CHINA: A BOOMING MARKET FOR CLOUD COMPUTING

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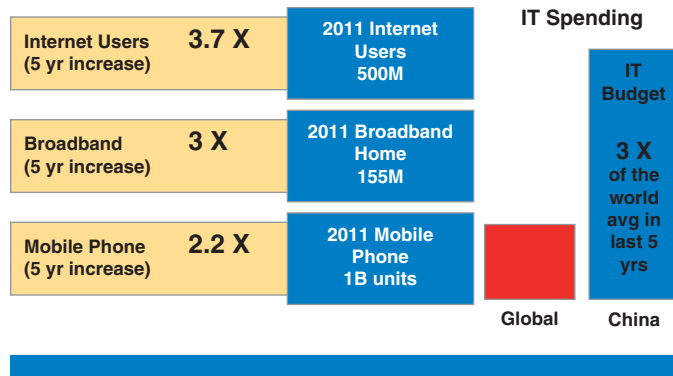
China is one of the most vibrant and active markets in the world. Unlike IT technology transitions of the past, for cloud computing and the Internet of things (IOT), the Chinese government has put a lot of effort in championing this round of IT infrastructure build-out. Cloud and IOT technologies have been positioned as having strategic importance for the transformation of its domestic economy. China has already started cloud pilot programs in five major cities and makes information technology, including cloud and IOT, one of the key areas of focus in its five-year plan (2011–2015). China is shoulder to shoulder in this round of IT technology transformation with the rest of world.

### Introduction

Over the last few years, China has emerged as the largest Internet market with more than 500 million Internet users, the largest PC market, and the largest smart phone market. China has many Internet companies such as Baidu, Alibaba, Tencent, similar to their “sister” companies in the US (Google, MSN, eBay, and so on). With the strong consumer interest for mobile Internet and strong government initiatives to drive, the momentum toward cloud computing has gone beyond technical innovations and become a part of the national strategy as part of the next five-year economic plan.

In the current five-year plan (2011–2015), it was clearly stated that “acceleration of the economic structure by cultivating a new business model, new energy, new material, new bio medicines, high-end manufacturing, new energy sources for automobiles, triple play, cloud computing, the Internet of things (IOT) pilot projects, and so on.” Over the last few years, the government-driven investments in next generation Internet (IPV6), upgrading broadband infrastructure, network security, digital TV and satellite communications was greatly increased. Cloud and IOT pilot projects in five major cities (Beijing, Shanghai, Hangzhou, Shenzhen, and Wuxi) have already started.

At the same time, cloud and mobile Internet services driven by the private sector, championed by leading Internet service companies such as Baidu, Tencent, Sina, Alibaba, Shanda, and Sohu, have taken off and become mainstream in China. Baidu has taken over 80 percent of the Internet search market in China, which attracts both mobile users and traditional PC users; Tencent has more registered users than Facebook; Alibaba/Taobao has more transactions and cash flow than the biggest department stores in China. The momentum of cloud and mobile Internet services is embraced and fueled by enthusiastic user communities that could amount to over 1 billion people!



**Figure 1: Booming cloud computing market in China**  
(Source: Intel Corporation, April 2012)

As shown in Figure 1, the Internet market in China has grown much faster than other parts of the world. China has the largest Internet user base—overall 500 million Internet users. The IT spending in the last five years is three times more than the world average. This sets a great foundation for a booming cloud computing market.

In the latest government report this year, RMB 660 Million (USD 100 Million) were allocated by the central government for cloud infrastructure as seed funds, and more matching funds from local government are expected. It was clearly pointed out that the government will accelerate the investment in next generation Internet (IPv6), digital TV network, satellite network, and high-speed, high volume network backbone. The government set the following cloud computing directions:

- Nationwide coordination of cloud computing business and related service development
- Balance the relationship of government-driven and market-driven initiatives
- Leverage cloud computing technology to boost the construction of e-Government, e-Commerce, and optimized distribution of social resources based on information technologies.

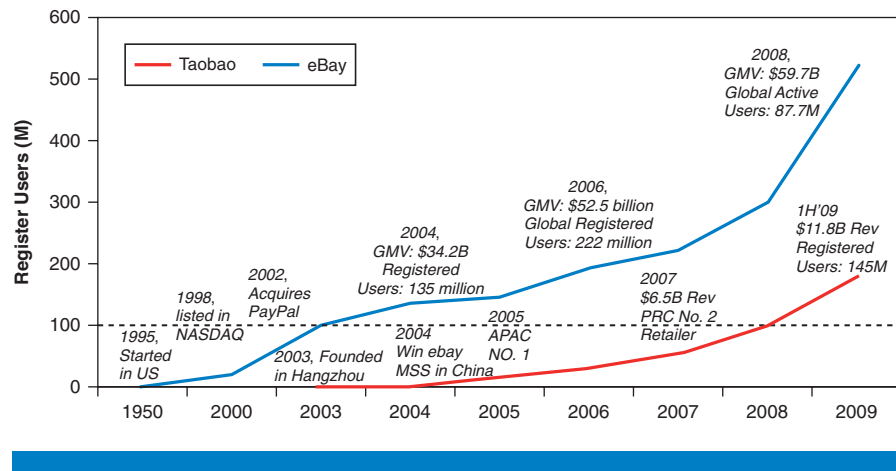
At the same time as the strong central government initiatives, local governments have become strong proponents of cloud computing as well. Over 20 cities in China have developed cloud computing plans. There have been special incentives for land, tax, and investment for cloud projects. For example, the “Cloud Sea (云海) Project” in Shanghai is targeted to focus on small business, financial services, healthcare, and media service, while in Beijing there is the “Harmony Cloud (祥云) Project,” targeting to improve information services in Beijing area for e-Government and small businesses. Hundreds of local IT businesses are participating in this type of local government cloud program. According to MIIT (Ministry of Industry and Information Technology), cloud computing is positioned as the fourth IT revolution after Mainframe, PC, and Internet. In the next three years, cloud computing could amount to 200 Billion RMB (USD 30 Billion) revenue in China.

The impact of cloud computing in China is not limited to information services. There are profound new requirements for the whole solution stack from computer hardware, systems software, middleware, to application software, and so on. There are also great many opportunities for local businesses to capture the cloud computing momentum to build vibrant ecosystems from backend data centers to diverse mobile devices, as well as compelling services on top of them. It is foreseeable that in the coming years, there will be more systematic and coordinated efforts toward building cloud computing infrastructure in China. The level of government investment and industrial policy guidance for the IT industry has been stronger in China than in other parts of the world. China could be the “land of opportunity” for cloud computing.

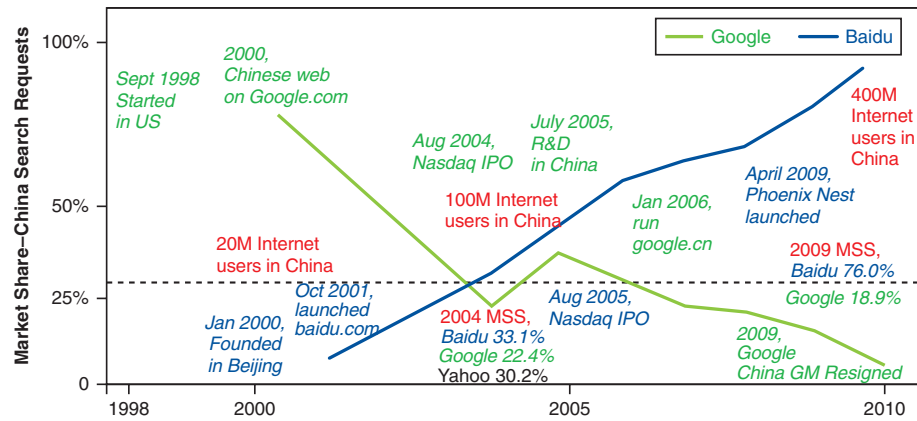
### Public Cloud Infrastructure and Services

Back in the late 1990s China was about five years behind the last wave of Internet build-out compared with the western market. However, the growth of Internet companies and Internet services has been phenomenal. China has developed its own complete Internet service ecosystem, parallel to that of the US. Figures 2 and 3 show that Alibab/Taobao, the biggest online store in China followed the similar pattern of growth to eBay in the US, while by 2011, Taobao had over twenty thousand servers handled transactions valued at more than 400 Billion RMB (USD 70 Billion). On a peak day, there could be overall 130 million independent visitors per day using Taobao. Baidu has been leading the Internet search market and took over three times the market share of Google in China as the local market leader. It has become the most popular search engine for both mobile and desktop platforms in China.

When it comes to this round of cloud build-out, Chinese companies are on the same page with their US counter parts. With favorable government policies and incentive programs, many Internet services companies have actively started their own cloud initiatives. Alibaba has started its AliCloud division to focus on



**Figure 2: Taobao versus eBay growth curve**  
(Source: China Computer World, November 2009)



**Figure 3:** Baidu versus Google MSS curve in China  
(Source: China Computer World, June 2010)

cloud infrastructure and service build out for its subsidiaries, including Taobao. Baidu has ventured into mobile Internet services and developed its branded mobile devices. Tencent has built large data centers and developed mobile Internet services to serve up to 700 million registered customers.

Meanwhile, three big telecommunications vendors in China, China Telecom, China Mobile, and China Unicom, positioned cloud and related mobile Internet services as the next strategic frontier for building their future competitive advantages. China Telecom started a dedicated cloud company to oversee its IDC (Internet data center) business and build out its cloud infrastructure for additional service opportunities. China Mobile has spent a significant amount of research resources and developed big cloud solutions since 2010. China Unicom is leading the local cloud customer requirement definitions as one of the Steering Committee members of ODCA (Open Data Center Alliance).

On the software and solutions front, local players are also very active. The Chinese government has clear directions on open source policy. They want local business to use open source solutions where possible. While most of the PC users are still using Microsoft Windows\* OS, all the local Internet service providers use Linux\* for their data center and server systems. Like in other parts of the world, Android\* has gained strong momentum in the smart device OS market. Android in China is also the preferred OS for most local smart device vendors, despite the strong presence of Apple and iOS\* products.

When it comes to virtualization and cloud middleware, open source is by far the most preferred choice. Most of the leader local vendors (such as Baidu, Tencent, Alibaba, Neusoft, and Huawei) have developed their own VM management cloud middleware based on open source virtualization VMM like Xen or KVM. Popular proprietary solutions from VMware and Microsoft are targeted for evaluation and small-scale implementations, but are not the first choice for large-scale production deployments. On the other hand, there are so

many competing cloud middleware solutions based on underlying open source virtualization solutions that they have caused confusion to cloud operators trying to select the most appropriate solutions for their business. Further standardization and consolidation are needed to drive up the quality and drive down the confusion of open source cloud middleware solutions.

## Vertical Cloud Computing Opportunities

At the same time the public cloud services are driven by leading Internet service providers and next generation network infrastructure are built by telecommunications companies, cloud services for vertical markets are gaining more momentum as well. A lot of the forecasted cloud revenue could be service revenues from SMB (small and medium business). There are about 30 to 40 million SMB in China. In the past, the level of IT technology usage has been very low due to the complexity of hardware and software deployment and management. Cloud computing presents a more feasible solution for scalable and manageable way to provide services. The Chinese government has made information technology applications for SMB a key driver for cloud infrastructure build-out. The goal is that in the next three years, 25 percent of service providers for SMB will leverage cloud technology.

Another vertical market that attracts large government investments is education. The Chinese government has pledged to invest 4 percent of its GDP (approximately US 200 billion according to 2011 GDP) for education by 2015. Of the total education investments, 5 to 6 percent will be for information technology. The government has just recently released the guidelines for education information systems for the next decade, in which cloud technology was clearly called as a key to developing and deploying education services to K-12 schools, university research, and continuous education for workforces. Many universities and research institutes are devoted to education cloud services research. New education usages and methodologies are emerging based on cloud and mobile Internet technologies. According to the education information systems guidelines issued by the Ministry of Education (MOE), by 2015 the education cloud foundation should be developed that covers major cities and universities.

As China becomes an aging society (by the United Nations definition, more than 10 percent of population is older than 60 years old), healthcare and preventive medical services are becoming more and more important. The Chinese government continues its focus on healthcare information systems. In the current five-year plan, the government programs have expanded the healthcare information systems more toward the preventive side. According to the Ministry of Civil Affairs (MOCA), China will invest up to 500 billion RMB (USD 80 billion) in the next 10 years in research and development of senior-friendly communities where sensors and IOT technologies will be used for frontend and cloud infrastructure and services for the backend.

China also has its own sophisticated banking and financial systems. The financial communities are looking for ways to consolidate their IT services by outsourcing part of their services to secured data center operators. Moreover, with the financial and B2B and B2C services becoming more customized and personal in the cloud context, more devices, more data, more customers present more service opportunities. At the same time, security and privacy requirements for financial services, as well as for the entire mobile cloud computing segment at large, are becoming more stringent than ever. More innovative hardware and software combined security solutions are needed. Moreover, China has its special security regulations that require local vendors to play more active roles in developing localized security solutions that serve this diverse market with billions of customers.

## Key Technology Challenges and Opportunities Ahead

Given the tremendous cloud market opportunities in China, the technical challenges are equally formidable. While China is facing many of the same technology challenges as the rest of the world, the customer requirements and market conditions in China could present some unique technology development opportunities that will continue to brew a dynamic cloud ecosystem. For the first time in computer industry history, China is at the same level with the western world in terms of market opportunities and usage model innovations. There are few “mature” technologies or usage models to copy or buy from other markets. The following is a summary of some of the key challenges we are facing in the industry; some of them are the same challenges we are facing in other countries as well:

- **Security:** this is the most important for cloud services in all markets. The Chinese government has special regulations on cryptography algorithms and encryption products. Many international security solutions may not be applicable “as-is.” They have to be adapted, integrated, and deployed through local solution providers. Moreover, there are many new security requirements that are unique to market in China, such as banking and payment systems integrations.
- **Connectivity:** the cloud computing model depends on interconnected computing devices from servers to smart devices. There are many networking technologies ranging from 10G Ethernet, to InfiniBand\*, FCoE (Fiber Channel over Ethernet), Wi-Fi\*, and WiDi. Most of these technologies that worked well in other markets should be applicable in China. On the other hand, China has run out of IPV4 addresses and has decided to have broad IPV6 deployment. This will be the first IPV6 deployment of this magnitude in the world. The technology and implications to new applications and services are still evolving. With IPV6, the way we operate data centers and manage connected devices could be quite different. Interoperating between IPV4 and IPV6 networks also presents interesting challenges.

- **Green data center:** energy efficiency of the datacenter has become a universal problem that goes along with the boom of cloud data centers. In China, this problem has become more important, as data centers in China are traditionally not very efficient. With the increasing number of cloud data centers, the Chinese government has set specific goals to improve data center energy efficiency by 40 percent in the next five years. There are two aspects of green data centers: a) at design time, optimize data center layout and use the most energy-efficient servers, storage devices, and network infrastructure designed for centralized management; b) during the operation time of the data center, the central management tools can dynamically monitor the data center workload and resource utilization so that data center can be managed in the most energy-efficient manner by enforcing management policies through management tools. There are challenges for both data center design and operations in China.
- **Cloud manageability:** Besides power management at the data center, cloud resources and services management are essential to successful cloud businesses. A large cloud operation typically requires more than one data center. Cloud management tools have to be able to cover cross-data-center management of both virtual and physical resources, which include cross-data-center workload migration, disaster recovery, service quality assurance, billing, and customer intelligence. In China, open source cloud management solutions are not ready for prime time; proprietary solutions are either homegrown or too expensive. The lack of robust cloud management tools become a major challenge for broad cloud deployment.
- **Cloud software ecosystem:** besides the hardware infrastructure required, cloud computing and related services are built on top of a sophisticated software stack. This is not something a single company can fulfill. A healthy software ecosystem that covers all layers of the cloud stack and different market segments is needed. In addition, the Chinese government strongly promotes open source based solutions. Many software companies in China have built their businesses on open sources software at different levels. With the favorable government policy and established open source community, open source cloud software ecosystem has a good chance to emerge in China.
- **System integration services:** cloud services require much systems integration effort to put together. Without “the last mile” integrations, there will not be complete solutions with a compelling user experience. The promise of cloud computing will not delivered. With the vast market and large user population, China needs experienced cloud systems integration vendors to put cloud solutions and services together. This could be an organic part of a cloud company. It could also be independent cloud systems integration services provided by a third party.
- **Cross-smart-device usages/applications:** systems integration could also include application development and porting to support diverse smart devices for different segments and usages. As HTML5 becomes popular, an HTML5-based user experience becomes the key. China has over 100,000

developers in the HTML5 interest groups. There is a good foundation to focus on the culture and behavior of Chinese users to define and develop unique HTML5-based smart applications for cloud services that span all kinds of smart devices from PCs and laptops to tablets and smart phones. On the other hand, we have to deal with the security challenges inherent from HTML5 and make sure that HTML5 runtime engines are optimized to protect user data and deliver the best performance for given devices.

In addition, there should be new strategic thinking about cloud services development in China. Granted that there are still technology gaps to realize the grand vision of cloud computing, China is still behind the western countries in many areas. Nevertheless, as stated in the early part of this article, China is a close follower in cloud solutions, and even a leader in some areas with its strong government programs. One of the strategies could be the “fast second” strategy, which means to learn and follow what works in other market first and then apply these technologies to the vast market opportunities and build out solutions unique to China. Over time, cloud services in China could be leaders in the world. To achieve this, we need broad collaboration with international players at the same time focusing on original innovations to solve unique challenges in China. Chinese cloud solution vendors should embrace international standards where possible and play active roles in standard organizations, such as W3C, DMTF, IETF, and so on.

## Summary and Conclusion

China has emerged as a leading market for cloud computing. With its large user population, vibrant market dynamics, and comprehensive government programs, China presents unique business opportunities to grow cloud service infrastructure. While China faces some of the same technical challenges as other markets, it also has unique requirements in many areas. China has the opportunity to closely follow the technology trends and develop cloud services for China. This may be an opportunity for the Chinese IT industry to lead.

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## Author Biographies

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