



## The Market for Wi-Fi® in China: Opportunities, Enablers and Challenges



Prepared by **Analysys International**



Sponsored by the Wi-Fi Alliance

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## I. Executive Summary

With its large population and burgeoning urban middle class, China is emerging as a key market for a wide variety of technology and consumer electronics products. Wi-Fi is no exception. After an initial period of hype in 2001-2002, followed by a period of disorder and transition, a maturing market for Wi-Fi products and services is beginning to take shape in China, and is expected to gain strength and grow in the coming years. By 2008, revenue for non-embedded Wi-Fi equipment (access points, external PCI cards, etc.) is expected to reach RMB 10 Billion. There is also significant growth to be had from laptops, phones and consumer electronics devices shipping into China with Wi-Fi functionality on board.

With China's embrace of the PC, the mobile phone, and consumer electronics, Wi-Fi brings a compelling value proposition to the China market. The mature, proven technology, complementary to mobile networks, provides high-quality connectivity for a wide variety of devices at a low cost. Continued cost declines for Wi-Fi chips in the market, and in the devices they populate, will increase demand for Wi-Fi.

The market in China is divided into three segments. First is Telecom Operators Segment (21% in 2006), which includes hotspot deployments and provisioning of consumer home W-Fi equipment. The Enterprise Segment (63% of the market) includes university campuses and corporate WLAN/wireless data collection. The Consumer market includes individual consumers purchasing and deploying a Wi-Fi network in the home (16% in 2006).

The interaction between government control, telecom operators' power, and vendor competition presents some inhibitors to the market, but demand for Wi-Fi products in the enterprise and consumer markets is likely to emerge with strong growth in the coming years. Consumer electronics with embedded Wi-Fi functionality and converged mobile/Wi-Fi phones will bring Wi-Fi to a wide array of Chinese users, including those who might never own a computer.

This paper outlines the key market drivers, enablers, and challenges to Wi-Fi in the China market. At a glance, the following key points emerge:

- Increasing competition among silicon providers, and the decreased prices it will bring about, is expected to drive innovation and inclusion of Wi-Fi functionality in a wide variety of devices.
- Chinese telecom operators, who initially invested heavily in hotspot deployments, have shifted focus to the provisioning of home Wi-Fi networks as a value added service to basic broadband access. Consumers also purchase equipment on their own and set up networks in their home.
- Widespread product interoperability, robust security, and simpler configuration are key factors that will enable market growth in all segments in China (enterprise, home user, and telecom deployments).
- It is expected that most operators will later provide voice and data services over converged and Voice over Wi-Fi mobile phones, but the business model for these services is not year clear in the China market. However, with nearly 400 mobile subscribers in place and dramatic growth expected in the coming years, this presents an attractive opportunity for handset manufacturers.
- In the core PC networking segment, pure access point (AP) devices are giving way to devices with stronger routing and firewall functions. Similarly, the network for non-embedded Wi-Fi cards will shrink and ultimately disappear as Wi-Fi functionality becomes standard in PC equipment, particularly laptops.
- Laptop shipments into China are increasing and expected to reach 8 million units by 2009. Laptop pricing is decreasing, enabling a larger group of Chinese enterprises and consumers to



purchase them. Laptops remain the first target device for Wi-Fi in China, with 90% of Chinese shipments Wi-Fi enabled by 2007.

- The enterprise market segment, already taking shape in China, will be the most attractive in the near term, with the home user market growing more slowly, driven by consumer electronics and converged phones.
- The public access (hotspot) market in China currently boasts some 10,000 hotspots, including 1,000 at universities and colleges. Investment in public access has currently slowed, but may be driven by the opportunities to provide Value Added Services and advertising in the future.

Though the Chinese market for Wi-Fi products and services remains immature, there is opportunity across the value chain of silicon, devices, and services in the long term.



## II. Research Methodology

Analysys International arrived at the conclusions presented in this white paper primarily by analyzing primary and secondary market information.

Analysys International conducted in-depth interviews with representatives from major telecom operators including China Telecom, China Netcom (CNC), China Railcom, China Mobile and China Unicom. In addition, Analysys International interviewed major vendors participating in the China market, including Lenovo, Dopod, Potevio, UTStarcom and ZTE.

The secondary data provided is drawn from the following sources:

- Publicly-available industry information
- Data provided by relevant government departments
- Relevant economic data
- Annual and quarterly reports of enterprises
- Analysys International database

Analysys international depends on the information obtained through interviews with operators, manufacturers and channels to reach its conclusions on market size. In addition, Analysys International relies upon data provided by manufacturers on the types of products they offer and their operating revenues and marketing activities. As such, the quality of the information reported shall have a considerable impact on the final content of the reports.

The data reported by Analysys International undergoes repeated cross checks. Analysys International is confident that the reported data is accurate and meaningful.



### **III. About Analysys International**

Analysys International is the leading Internet based provider of business information about Technology, Media and Telecom industry in China. We provide data, information and advice to 50,000 clients worldwide representing 1,500 distinct organizations, deliver over 150 consulting engagements a year, and hold more than 20 events that draw in over 8,000 attendees. Our clients include executives from companies as technology vendors, vertical information technology users, as well as professionals from professional service companies, the investment community and government agencies.

### **IV. About the Wi-Fi Alliance**

The Wi-Fi Alliance is a global, non-profit industry association of more than 250 member companies devoted to promoting the growth of wireless Local Area Networks (WLANs). With the aim of enhancing the user experience for mobile wireless devices, the Wi-Fi Alliance's testing and certification programs ensure the interoperability of WLAN products based on the IEEE 802.11 specification. Since the introduction of the Wi-Fi Alliance's certification program in March 2000, more than 2,500 products have been designated as Wi-Fi CERTIFIED™, encouraging the expanded use of Wi-Fi products and services across the consumer and enterprise markets.

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## Table of Contents

I. Executive Summary .....	2
II. Research Methodology .....	4
III. About Analysys International .....	5
IIV. About the Wi-Fi Alliance .....	5
Table of Contents .....	6
Chapter 1: Overview of the China Wi-Fi Market .....	8
1.1 Introduction and Overview of Current Market .....	8
1.1.1 Wi-Fi Semiconductor Vendors .....	9
1.1.1 Wi-Fi Semiconductor Vendors .....	10
1.1.2 Wi-Fi Equipment Vendors .....	10
1.1.3 Wi-Fi Network Equipment Products .....	11
Chapter 2: Insight into the China Wi-Fi Market .....	13
2.1 Channel Relationships for Wi-Fi .....	13
2.2 Market Drivers .....	13
2.2.1 Internet and Broadband Penetration .....	14
2.2.2 Affordability of Notebook Computers .....	15
2.2.3 Number of Available Hotspots .....	17
2.2.4 Wi-Fi Mobile Convergence and Voice over Wi-Fi .....	18
2.3 Technology and Technical Challenges .....	19
2.3.1 Interoperability .....	19
2.3.2 Security .....	20
2.3.3 Quality of Service .....	21
2.3.4 802.11n .....	21
2.3.5 Spectrum Allocation Issues .....	22
2.3.6 Coexistence with Other Technologies .....	22
2.4 Market Growth and Trend Forecast .....	23
2.4.2 Market Size Development .....	23
2.4.2 Market Development Trend Analysis .....	24
Chapter 3: Market Opportunities .....	26
3.1 Telecom Operator Market .....	26
3.1.1 Home User Market and the Digital Home .....	26



3.1.2 Wi-Fi Mobile Phone.....	27
3.2 Enterprise Market.....	27
3.2.1 Internal Enterprise Network .....	27
3.2.2 Enterprise Network Operators .....	28
3.3 Home User Market.....	29
Chapter 4: Conclusions and Recommendations.....	30
4.1 Market Highlights .....	30
4.2 Opportunities and Recommendations to Vendors and Manufacturers.....	30
Description of Stages in Technology Hype Cycle.....	32
List of Acronyms.....	33



## Chapter 1: Overview of the China Wi-Fi Market

### 1.1 Introduction and Overview of Current Market

Beginning in 2001, the China Wi-Fi industry experienced a period of growth in three primary application markets:

#### ***Telecom Operators Market***

Home Internet Service and Provisioning of Wi-Fi Equipment: Telecom operators provide Wi-Fi internet access service for home users for a monthly fee.

Hotspot Application: Telecom operators set up a publicly-available Wi-Fi network for use by any person with an account. The fees, generally calculated by the minute of use, are paid according to the stipulations of individual operators.

#### ***Enterprise Network (Customer Premises Network)***

Campus/Educational Application: Wi-Fi network is constructed by the educational institution for use by students and teachers.

Corporate Application: Wireless LAN access to a corporate network or for specialized use such as wireless data collection in an industrial environment (factory or warehouse).

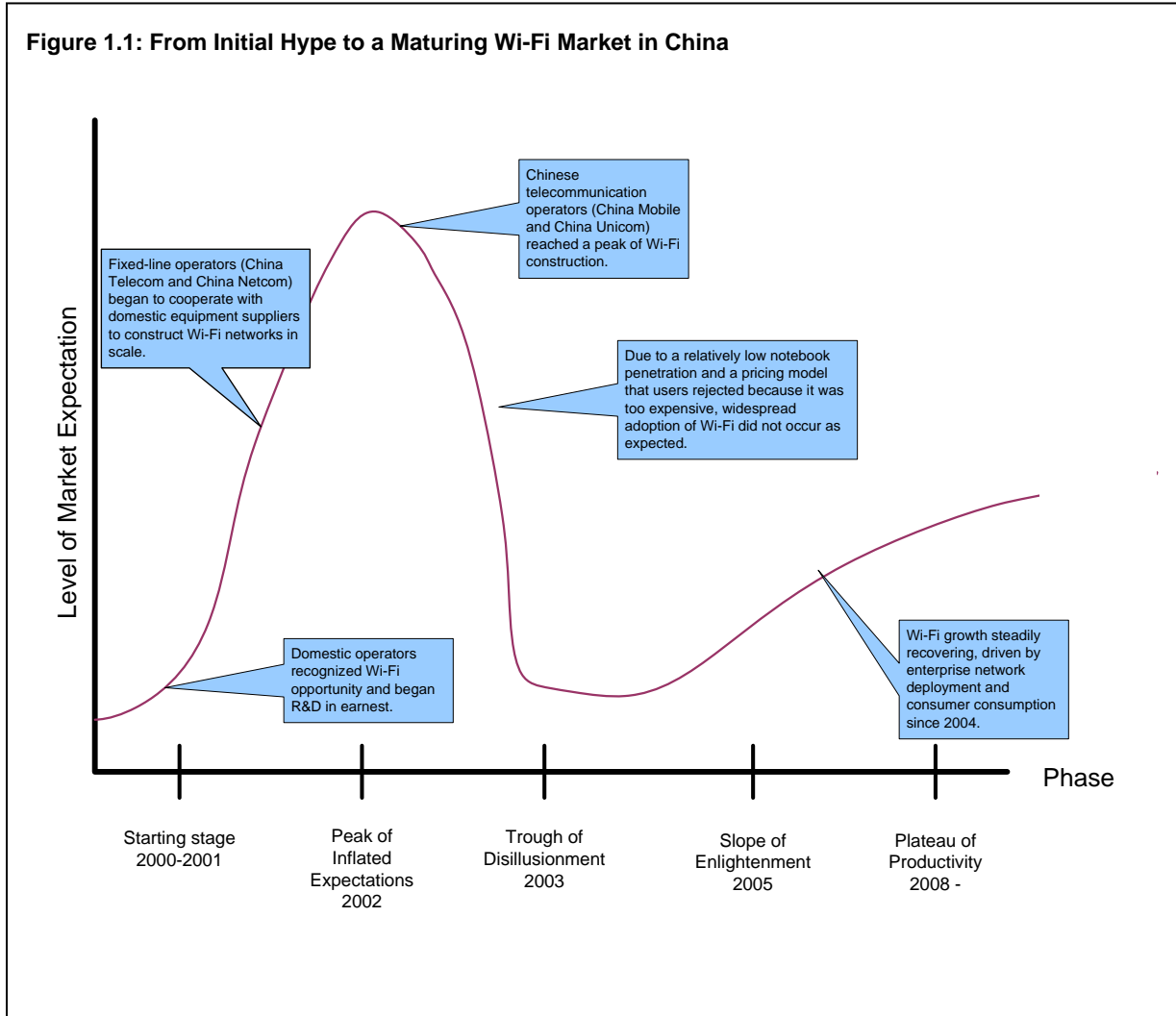
#### ***Consumer/Home Use Market***

Individual users purchase Wi-Fi equipment and set up their own Wi-Fi network, using the telecommunication provider's cable network for access.

This growth was driven primarily by Wi-Fi's advantages in mobility, data rate, and user demand in all three segments. However, because of early difficulty in building viable subscription models and the relatively small number of hotspot users, laptop owners and broadband subscribers, telecom operators slowed their rates of investment in Wi-Fi businesses, and the market slowed.

Today, however, growth in the Consumer/Home Use and Enterprise segments is gaining momentum and the Chinese Wi-Fi market has entered a new stage of rational growth. The increasing popularity of broadband, new applications for Wi-Fi in phones and consumer electronics, and technological investments are propelling sustained market growth.

**Figure 1.1: From Initial Hype to a Maturing Wi-Fi Market in China**



*Note: Descriptions of the stages in the Technology Hype Cycle, developed by Gartner, are contained in the appendix of this paper.*



### 1.1.1 Wi-Fi Semiconductor Vendors

The following firms currently dominate the WLAN chip supplier market:

- Agere
- Atheros
- Broadcom
- Conexant
- Intel
- Marvell
- Texas Instruments

Atheros products in the China market are currently developed mainly through the cooperation of Shenzhen TP-LINK Technology Co., Ltd, commonly promoting TP-LINK brand wireless broadband router products.

### 1.1.2 Wi-Fi Equipment Vendors

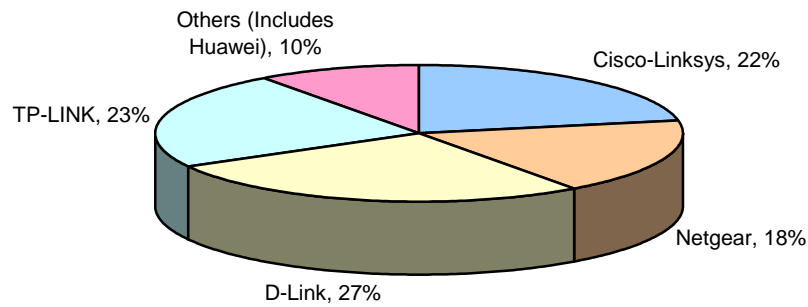
The major brands of the Chinese WLAN equipment market include

- Cisco-Linksys
- D-Link
- Huawei/3Com
- Netgear
- TP-LINK
- ZTE

TP-LINK, Huawei/3Com and ZTE manufacture equipment domestically and consequently can leverage cost advantages to extend lower prices in the market. All three manufacturers have domestic R&D institutions, production bases and sales networks.

D-Link, Cisco-Linksys and Netgear are all international giants in the Wi-Fi area, with good reputations for quality. All three of these firms outsource domestic Chinese production to agent factories and in-source R&D and marketing functions.

**Figure 1.2: Market Share of Wi-Fi Product Vendors at June 2005**



### 1.1.3 Wi-Fi Network Equipment Products

At the present time, the following products constitute the majority of the Chinese Wi-Fi market.

<b>Network Side</b>	Access Point (AP)	Receives and transmits wireless signals; can be seen as a wireless hub.
	Wireless Router	Integrates the functions of an Access Point and broadband router (generally connected to DSL). One notable feature is support for firewall functions. Most wireless routers contain an Ethernet converter with four ports.
<b>Client Side</b>	PCMCIA Card	Inserted into the PCMCIA slot of a laptop computer to send and receive data.
	Embedded Wi-Fi Chip	Internal Wi-Fi chips such as Intel Centrino® or comparable chips from other manufacturers, embedded into laptop computers.
	USB Interface Wireless Network Card	Network card inserted into USB port, especially for connection of desktop computers
	PCI Card	Network card inserted into the PCI slot of desktop computers.

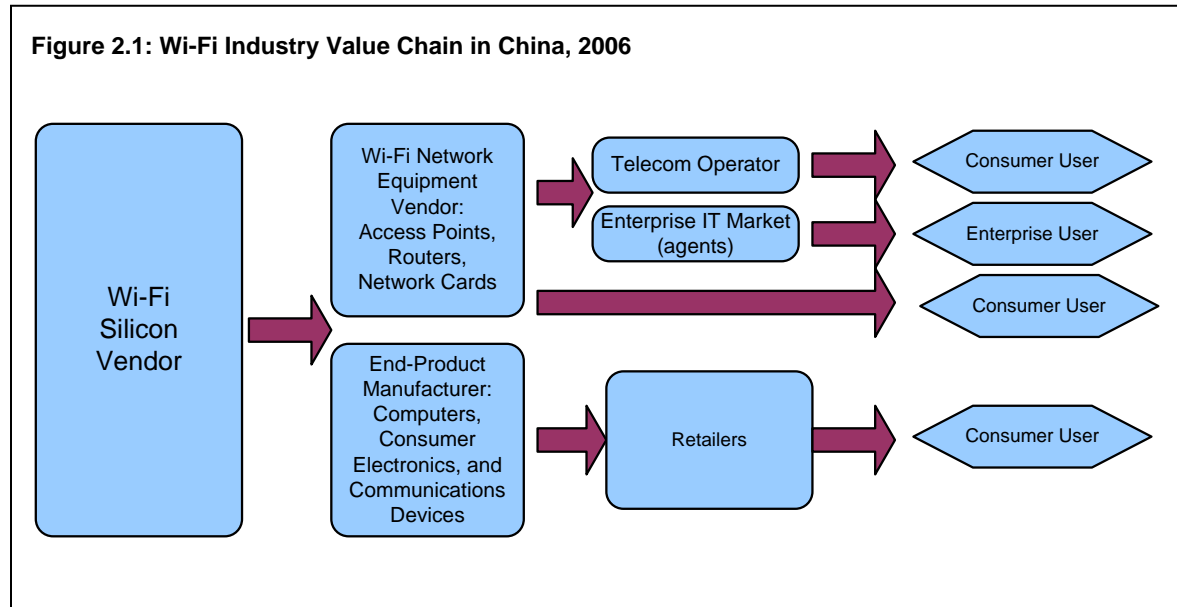


Wi-Fi functionality is predominantly found in laptop computers in China, but an increasing number of consumer electronics shipping in the China market are including Wi-Fi functionality. In addition, the convergence of Wi-Fi and cellular technology in phones is beginning to take shape.

In 2006, the trend of wireless internet access via a computer on a WLAN in either the office or home is becoming well-established in China. Meanwhile, the adoption of the mobile office (in which telecommuting on a laptop connected to a home or public access WLAN will be widely accepted) and the networked digital home (with Wi-Fi a predominant networking method) lie just ahead.

## Chapter 2: Insight into the China Wi-Fi Market

### 2.1 Channel Relationships for Wi-Fi



Currently, R&D investment is focused on the silicon/chip development, and advances in semiconductor technology in turn drive product development innovations. Silicon manufacturers provide Wi-Fi chips to Wi-Fi network equipment vendors, as well as to manufacturers of end user equipment including computers and consumer electronics.

Wi-Fi equipment reaches end users via a variety of channels. Consumer end users purchase equipment directly in retail outlets, or may receive the equipment from a telecom operator as part of a Wi-Fi service agreement. Retail outlets include large department stores (traditional outlet for consumer electronics in particular), and “supermarkets” for consumer electronics, IT products and telecommunications equipment are gaining popularity.

The IT products marketplace for enterprise is a very important distribution channel in China. Almost all types of IT products are sold to the enterprise buyer by agents who purchase them in the marketplace, with some of the very large resellers buying from vendor representatives directly.

### 2.2 Market Drivers

The Chinese market for technology and telecom products is vibrant and growing. Changes in consumer and enterprise demand patterns are driving strong growth, as is technological evolution, which enables development of new products and services. Moreover, macroeconomic growth, the increasing affordability and ubiquity of laptops, and government support for internet availability are impacting the development of the Chinese technology market as a whole.



The Chinese Gross Domestic Product has grown at an average rate of 8.8% each year from 2000 to 2005, and economic growth in this range is expected to continue for the next several years, according to the National Bureau of statistics in China.

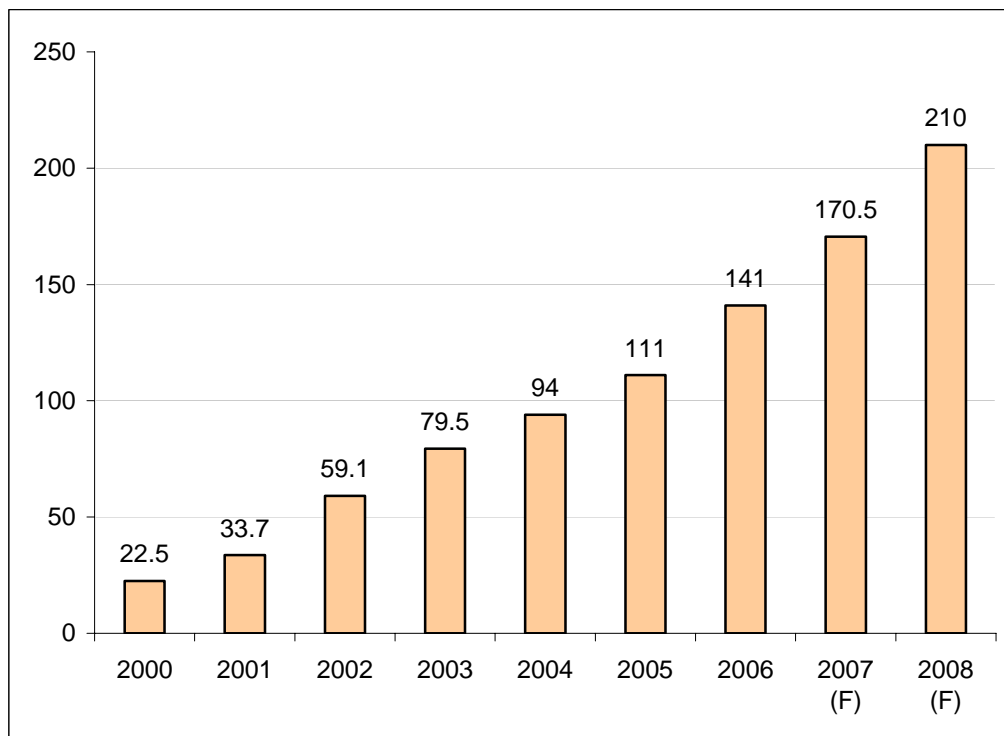
### 2.2.1 Internet and Broadband Penetration

Broadband internet connectivity is a key development focus, as it underpins a wide variety of products and services for Chinese consumers and enterprise users. Within the broadband segment, wireless network connectivity presents tremendous advantages above and beyond mobility. Wi-Fi network deployments are flexible, scalable, easily upgraded, and easy to maintain. Moreover, the Wi-Fi data rate enables a wide variety of latency-sensitive applications, including voice, audio and video.

In recent years, the number of internet users in China has grown at an average annual rate of 30% over the last 6 years, with a forecast for a similar growth rate in the near future. Similarly, the number of internet users will continue to rise and exceed 200 million by 2008.

Figure 2.2 shows that the number of internet users, accessing at work, home, school and other locations, doubled from 2002 – 2004 and reached 111 million by the end of 2005.

Figure 2.2: Internet Users in China, in Millions





The proportion of broadband subscribers within the total number of internet users is also growing. According to the statistics of the China Internet Network Information Center (CINIC), the amount of broadband users reached 64.3 million, or 58% of total users, by the end of 2005.

While the total number of internet users has grown quickly in recent years, in 2005, internet penetration in the total China population remains at 8.5%, still very low compared with developed markets. Consequently, there remains a strong opportunity in this market.

“The 11<sup>th</sup> Five-Year Development Plan of China,” which is issued by the central government and addresses domestic social and economic development initiatives states that by 2010, the number of internet users will exceed 200 million. Strong government support will drive the internet access market to mature quickly. Increased availability of content delivered over broadband, pricing models which are affordable to Chinese consumers, and technology innovation will be critical factors in driving this market forward.

### 2.2.2 Affordability of Notebook Computers

Laptops equipped with Wi-Fi have become more widespread in China since the Intel launch of Centrino. Unit pricing for laptops is an important driving factor for the market in China. Figure 2.3 shows the laptop shipment forecast and installed base estimates.

Figure 2.3: China Laptop Shipment and Installed Base 2001-2008

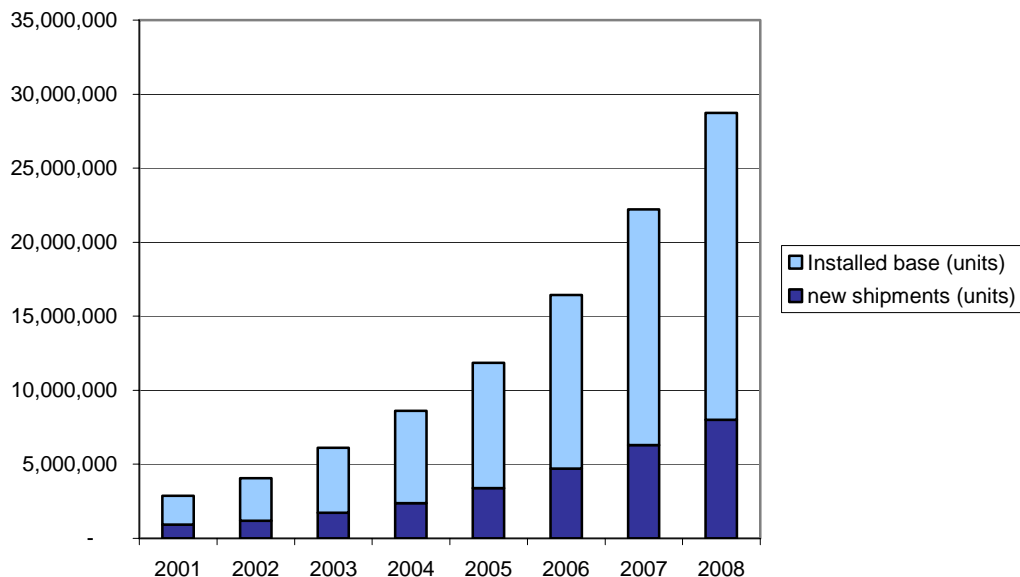


Figure 2.4 shows the laptop shipments, market size and price forecast.

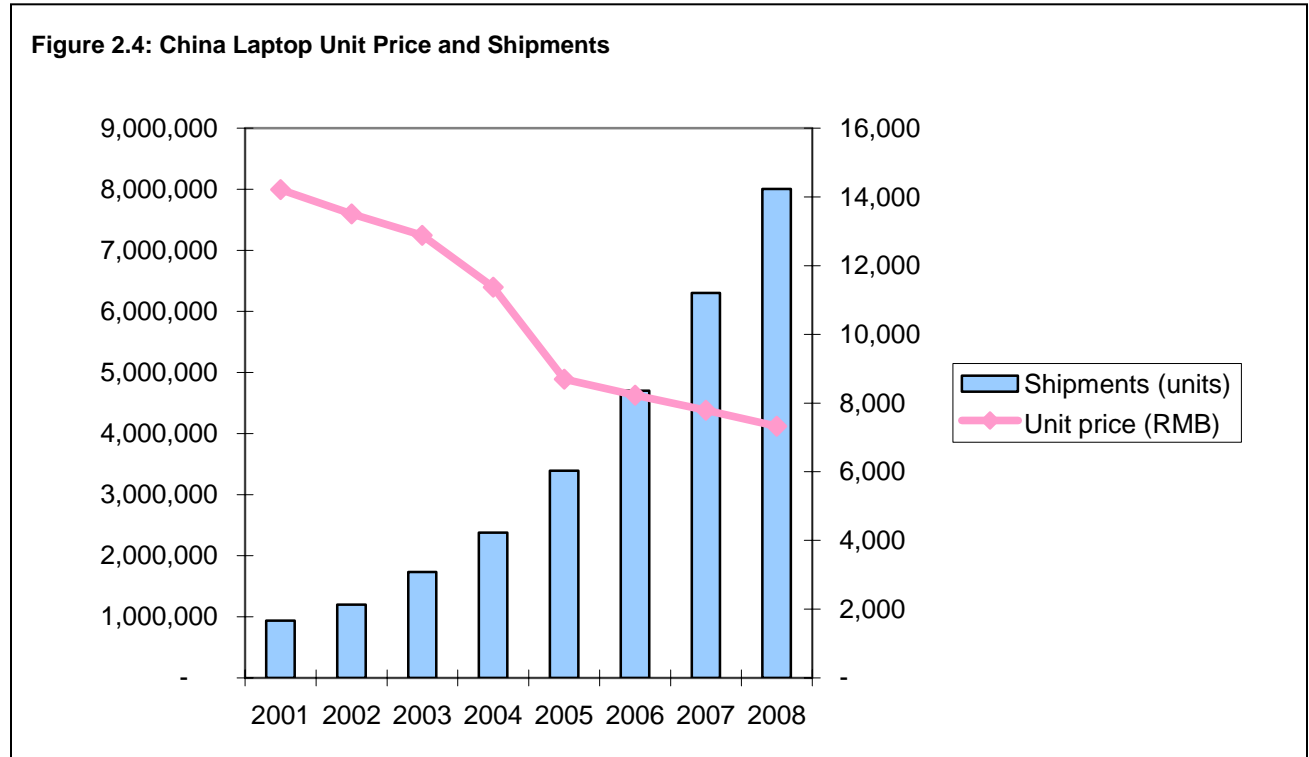
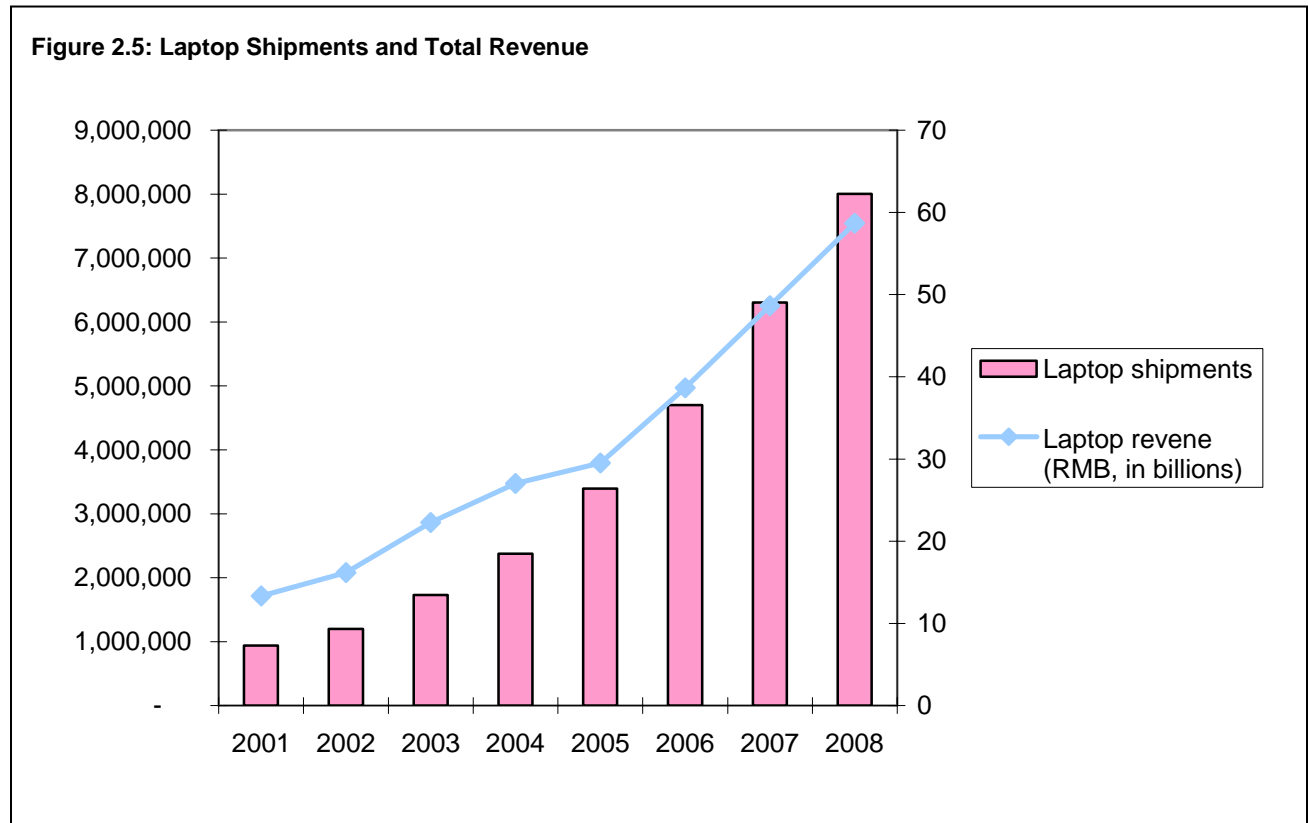


Figure 2.5 reflects the projected size of the market in RMB as compared with total shipments, demonstrating that laptop prices will become more affordable by 2008.



One of the major drivers of the laptop market is mobility. Because Wi-Fi is a good solution for mobile office and entertainment applications, it is forecast that by 2009, 90% of in-store laptops will be shipped with embedded Wi-Fi functionality.

### 2.2.3 Number of Available Hotspots

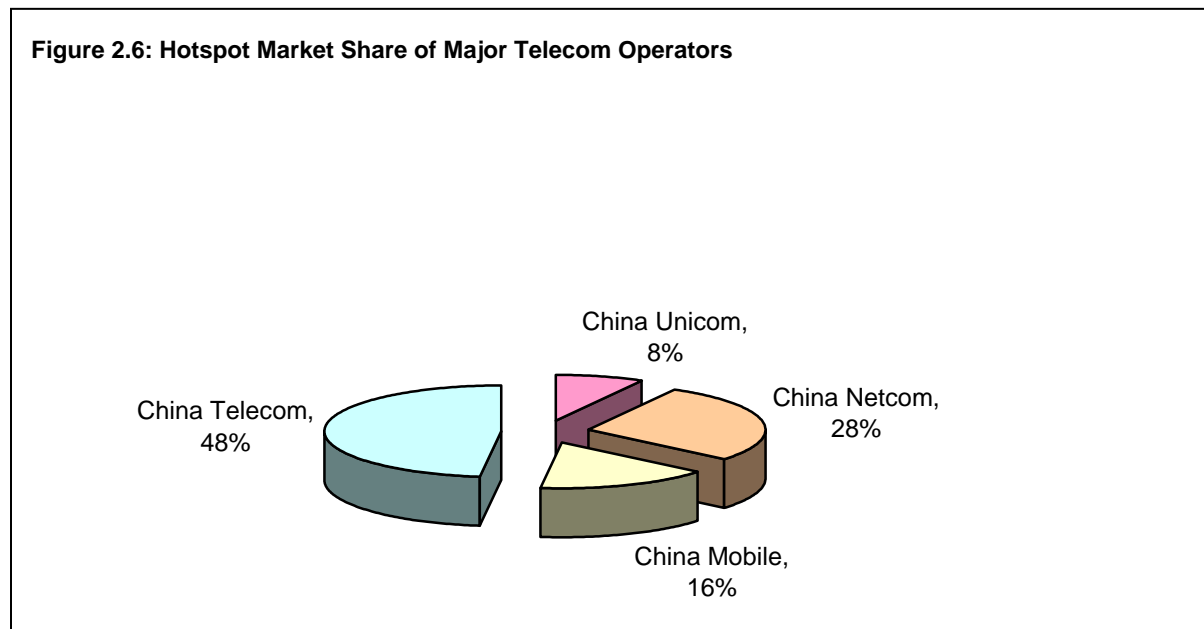
After an initial period of heavy investment in hotspot deployments, the major Chinese telecom operators slowed down development (see figure 1.1). Now, hotspot deployment is accelerating again, and it is expected to continue to grow in response to user demand, as is the home user market, the other primary source of Wi-Fi related revenue for telecom operators. Once home usage is more widespread, hotspot demand will increase, giving more lift to converged Wi-Fi mobile phones.

Major operators in China are competing to deploy WLAN on telecommunications network platforms in order to develop value-added services such as VoIP that will enhance revenue. After several years of development, there are approximately 10,000 hotspots in China, mainly distributed in key urban hotels and airports in Beijing, Shanghai, Shenzhen, Guangzhou, Dalian, Wuhan, Xi'an, Shenyang, Changchun, Changsha, and Suzhou. Colleges and universities are also deploying WLAN in order to improve the work efficiency of students and faculty and extend network connectivity in an affordable, scalable fashion. More than 1000 university hotspots are currently in place. The vast majority of hotspots are operated by

telecom companies, with the exception of the hotel environment, in which there is a mix of carrier-deployed hotspots and hotspots deployed by the hotel themselves in order to capture the revenue.

In locations such as restaurants and cafes, however, hotspot deployment is relatively immature, and there is still opportunity for development as the number of mobile Wi-Fi users increases. It is expected that as home and enterprise use of Wi-Fi grows, telecom operators will again focus on deployment and operation of hotspots as a revenue source.

Figure 2.6 outlines the operating hotspot market shares of the major telecom operators.



#### 2.2.4 Wi-Fi Mobile Convergence and Voice over Wi-Fi

China's mobile phone market has grown quickly in recent years and is now the largest in the world. Mobile subscribers exceeded 380 million in 2005, with an average 60 million subscribers added each year. The Chinese mobile market size is expected to reach nearly 600 million subscribers in 2008 and 700 million in 2010.

Traditional voice service is the main revenue source for China Mobile and China Unicom, but data and multimedia services are becoming increasingly important. Because of the additional bandwidth required to support these richer applications, there has been strong interest in 3G in China, and though licenses have not yet been issued at the time of this report, they are expected to be issued within 2006. Wi-Fi, with its growing availability and attractive data rate, has potential to become a complementary service to 3G in converged mobile phones.

Voice over IP over WLAN, or Voice over Wi-Fi, also presents a strong opportunity in China for manufacturers of both converged cellular/Wi-Fi handsets and VoIP-only devices. Landline VoIP, provided by Ministry of Information Industry of the People's Republic of China (MII) is already quite well-established



in the enterprise environment in China, and as Wi-Fi gains increasing traction in that space, the flexibility, portability, and affordability presented by these devices will make them an attractive tool for enterprise users.

In the home user market, because only telecom operators currently have the legal right to offer VoIP services, consumer adoption of VoWi-Fi will be slower. Three market inhibitors must be considered in this situation. First, government regulations prohibit the routing of Voice traffic from the internet to a telephone handset. Second, high usage fees at hotspots are preventing many Chinese consumers from considering such a service. Finally, the protracted wait for 3G services, soon to be ended, has distracted the carriers from other areas of focus. Telecom operators must identify ways to ensure continued profitability when offering VoIP services over Wi-Fi before they can be expected to offer the service on a large scale. Analysys International believes that legal consumer VoWi-Fi services will not be launched in China until after 3G licenses have been released.

## **2.3 Technology and Technical Challenges**

### **2.3.1 Interoperability**

Interoperability plays a critical role in widespread adoption of any networking technology. In developed markets, interoperability has propelled strong market growth of Wi-Fi. When even multi-vendor Wi-Fi networks are easy to deploy and scale, and when users can be confident of the ability to easily connect a client device in a variety of networks, the benefits of Wi-Fi are quite compelling. Moreover, interoperability across vendors helps Wi-Fi equipment maintain affordability, reduces product returns, and enhances ease of use. As Wi-Fi functionality integrates into consumer electronics and phones, interoperability becomes more important than ever.

Interoperability is not ensured by compliance with IEEE standards alone. The Wi-Fi Alliance has played an instrumental role in testing and certifying interoperability of Wi-Fi equipment since the launch of its Wi-Fi CERTIFIED® program in March 2000. Since that time, more than 2,500 devices have earned certification. A partial list of key Wi-Fi CERTIFIED programs (current and planned) is listed below.



<b>Wi-Fi Alliance Certification Programs</b>	
<b>Program Name</b>	<b>Description</b>
802.11a	Core MAC layer certification for operation in 5 GHz band. Mandatory to test and pass if a device operates in this band. (Note: Many devices support 802.11 a and b/g; all devices must pass tests for all modes).
802.11b/g	Core MAC layer certification for operation in 2.4 GHz band. Mandatory to test and pass if a device operates in this band.
WPA2™ (Wi-Fi Protected Access 2)	Security certification, based on IEEE 802.11i. There are two types of WPA2: Consumer and Enterprise. Enterprise certification includes Extensible Authentication Protocol (EAP) certification for 5 EAP types. All Wi-Fi CERTIFIED devices must test and pass WPA2.
WMM™ (Wi-Fi Multimedia)	Optional program for Quality of Service, tests features for Wi-Fi networks that assign different data streams to priority levels, improving the user experience with applications such as voice, video, and gaming.
WMM™ Power Save	Optional program tests features for Wi-Fi networks that extend battery life in small form factor devices when using multimedia applications such as voice, video and gaming.
Wi-Fi Mobile Convergence (2006)	Optional program to include RF performance mapping of Wi-Fi radios in converged phones. Currently, Wi-Fi Alliance certifies converged phones for core 802.11 a/b/g interoperability and security.
Voice over Wi-Fi Consumer (2006)	Optional program to support interoperability of Voice over Wi-Fi handsets designed for use in the home and small office environment.
Simple Config (2006)	Optional program to support ease of use in deploying secure home networks.
Voice over Wi-Fi Enterprise (2007)	Optional program to support interoperability of Voice over Wi-Fi handsets designed for use in the enterprise environment.
802.11n (2007)	Core interoperability support for devices based on the 802.11n standard.

### 2.3.2 Security

As with wired networks, security is a large concern among enterprise and consumer Wi-Fi users alike. Wi-Fi offers strong network security measures. The existing effective solutions include those products certified for WPA (the legacy form of Wi-Fi Protected Access) and the now-mandatory WPA2. Users may also wish to employ a VPN (Virtual Private Network) for an additional measure of security.

The WPA and WPA2 programs, with extended EAP testing for enterprise devices, supports the current authentication landscape and offer IT managers not only greater interoperability but broader vendor choice. WPA and WPA2 also offer options for personal/home users. A certification program for simple configuration of home networks, including security setup, is slated for launch in 2006.



### 2.3.3 Quality of Service

IEEE developed 802.11e to address the issue of Quality of Service in Wi-Fi networks, and the WMM (Wi-Fi Multimedia) program is derived from a portion of that standard, which adds QoS to the MAC (Media Access Control) layer and provides multimedia support to Wi-Fi networks by prioritizing different data streams.

QoS and multimedia support are key enablers of Wi-Fi's continued successful migration into consumer electronics and phones. Broadband service providers regard QoS support as a critical element when providing users with the high-value-added Video on Demand (VoD), Audio on Demand (AoD), and voice services that are increasingly in demand.

The Wi-Fi CERTIFIED WMM Program launched in September 2004. With an ample throughput rate and data prioritization provided by WMM, Wi-Fi is an excellent technology to handle voice calls, streaming high-definition video and interactive gaming applications under a wide variety of traffic and environmental conditions.

WMM prioritizes traffic demands from different applications and extends Wi-Fi's high quality end-user experience from data connectivity to voice, audio, and video applications under a wide variety of environment and traffic conditions.

WMM allows a network owner to set four priority levels, which correspond to different types of traffic:

- Voice - highest priority
- Video - second highest priority
- 'Best effort' (applications like internet surfing and email) - third highest priority
- 'Background' (applications which are not latency-sensitive, such as printing) - low priority

The WMM program includes an optional certification called WMM Power Save that leverages the WMM framework to increase low-power 'dozing' time and therefore increase battery life in small form factor devices.

In WMM Power Save, individual applications determine how often the client device needs to communicate with the access point and how long it can remain in a 'dozing' state. This gives battery-operated devices more flexibility in managing power consumption and a longer battery life. In a typical voice application, the Wi-Fi Alliance estimates battery life improvements ranging from 15 to 40%.

Device manufacturers and application developers can learn more by downloading two white papers produced by the Wi-Fi Alliance and available for free download at [www.wi-fi.org](http://www.wi-fi.org):

- "WMM Power Save for Mobile and Portable Wi-Fi CERTIFIED® Devices"
- "Wi-Fi CERTIFIED® for WMM™ -- Support for Multimedia Applications with Quality of Service in Wi-Fi Networks"

### 2.3.4 802.11n

As the forthcoming high-throughput physical-layer standard, IEEE 802.11n represents the next generation of Wi-Fi networks, enabling a data rate of more than four times the current speed of 802.11a/b/g networks. The IEEE 802.11n task group is expected to ratify a final 802.11n standard in late 2007.

The Wi-Fi Alliance launched work in December 2005 to begin development of an interoperability program in support of a ratified 802.11n standard. Wi-Fi Alliance spokespeople have stated that it does not plan to certify equipment for 802.11n in advance of the ratification of the standard but is working in parallel to IEEE in the interest of readiness when it is released.



### 2.3.5 Spectrum Allocation Issues

The 2.4 GHz band, used in 802.11b and 802.11g, is an unlicensed band in China. However, 802.11a requires a license to work between 5.15 – 5.85 GHz. Within this spectrum, 5.725 - 5.825 GHz are allocated for Wi-Fi. In order to procure a license for operation in that band, a device must undergo a battery of tests and pay a fee. (See Ministry of Information Industry of the People's Republic of China (MII)'s *Xin Bu Wu* [2002] No. 277) It is understood that more spectrum within the 5 GHz is earmarked to Wi-Fi between 5.15 to 5.25 GHz and 5.25 GHz to 5.35 GHz. Before these bands are officially allocated, carriers need to request this spectrum from the MII.

### 2.3.6 Coexistence with Other Technologies

Wi-Fi technology continues to evolve to be quite suitable for a variety of applications, including voice and multimedia on PC oriented devices, mobile phones, and consumer electronics alike. 802.11n will bring significant throughput enhancements to Wi-Fi technology.

Mesh networking, in which data is routed among nodes rather than through a central network, and a continuous connection can be maintained even when some connections are blocked, will further extend Wi-Fi's reach, flexibility and suitability for a wide range of applications, including citywide public access deployments. Wi-Fi technology is continuing to evolve via a stable roadmap, paving the way for exciting product development innovations well into the coming years.

With the recent announcements of WiMAX fixed and mobile technologies and the impending allocation of 3G mobile licenses in China, there has been quite a bit of discussion in the media regarding how the technologies will coexist in this market. The technologies are complementary, and the choice of wireless networking technologies involves a variety of optimization tradeoffs, including data rate, range, power consumption, Quality of Service, cost, and spectral efficiency.

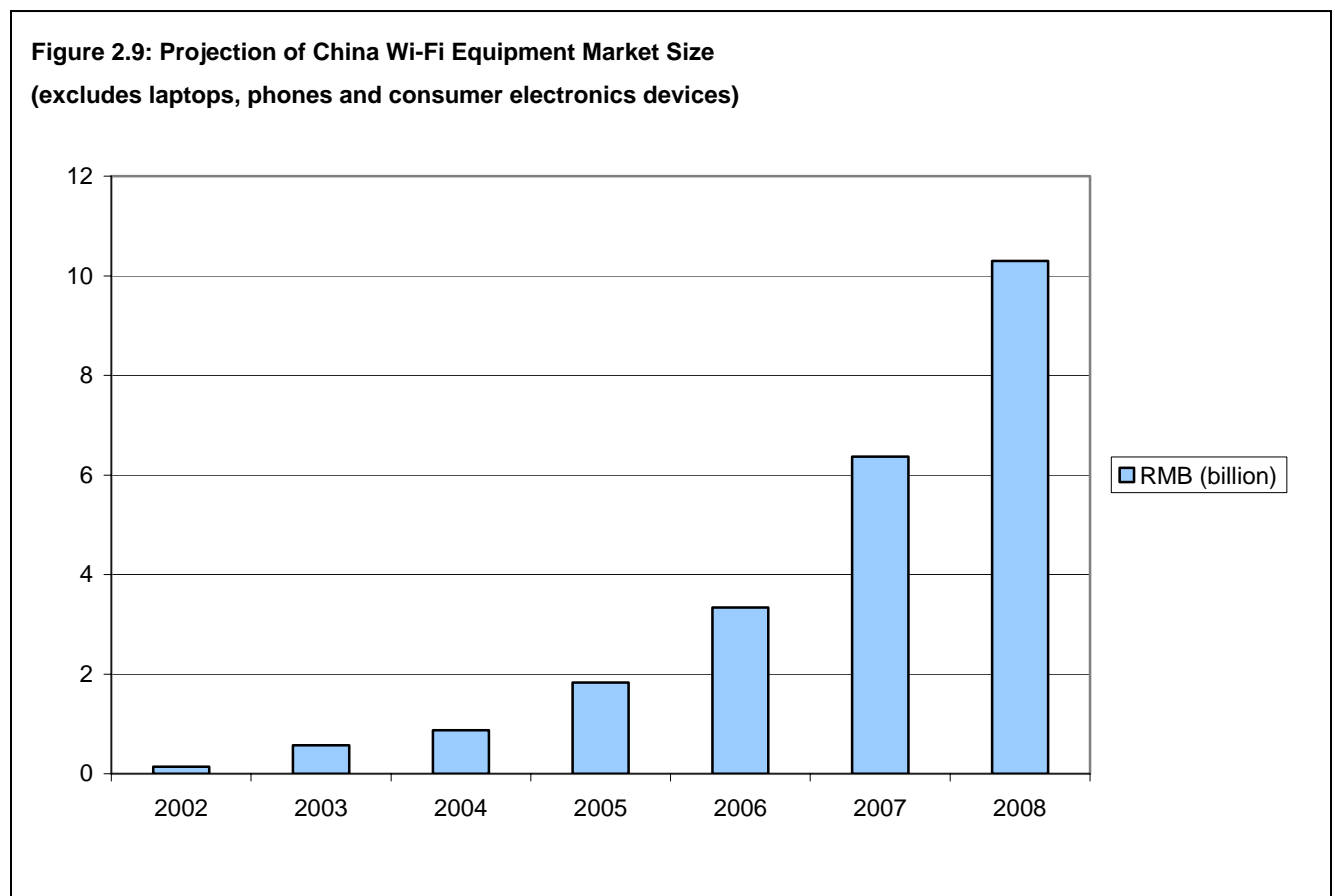
**Fig. 2-7: Different Technologies for Different Networks:**

PAN (Personal Area Network)	LAN (Local Area Network)	WAN (Wide Area Network)
<ul style="list-style-type: none"><li>• Bluetooth®</li><li>• Ultra-Wideband</li></ul>	<ul style="list-style-type: none"><li>• Wi-Fi® 802.11a/b/g</li><li>• Wi-Fi® 802.11n</li></ul>	<ul style="list-style-type: none"><li>• 2G Cellular</li><li>• 3G Cellular</li><li>• WiMAX®</li></ul>

## 2.4 Market Growth and Trend Forecast

### 2.4.2 Market Size Development

The Chinese Wi-Fi market, which started in earnest in 2002, has grown at an average annual rate exceeding 50%. The following figure addresses the market growth for non-embedded Wi-Fi equipment, such as client cards and access points, which excludes the contribution from laptops and other devices with embedded Wi-Fi functionality. The market for non-embedded equipment is expected to exceed RMB 10 billion (approximately US\$124 million) in 2008.

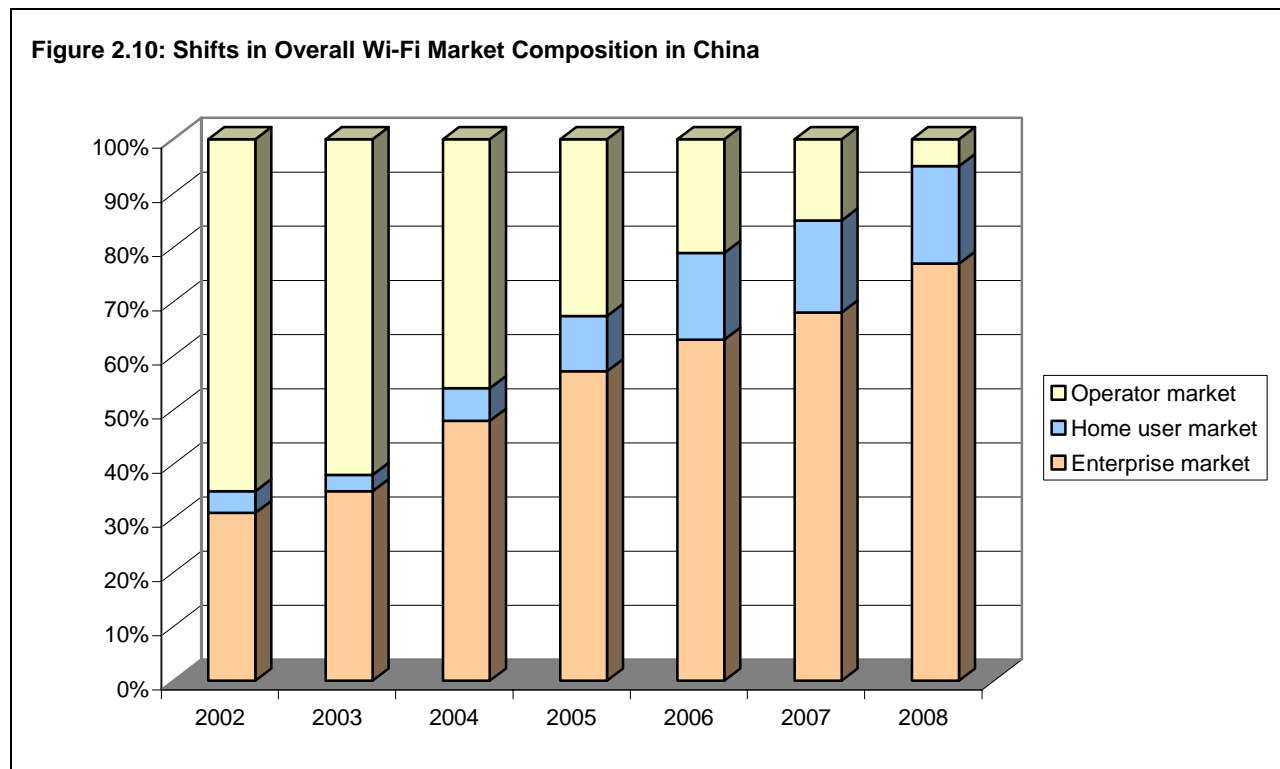


By the end of 2007, more than 90% of laptops shipped in the China market will include embedded Wi-Fi chips, and consumer electronics and phones are becoming an increasingly large portion of the overall market of Wi-Fi enabled equipment.

## 2.4.2 Market Development Trend Analysis

### Shifting Market Composition

The market for Wi-Fi in China is evolving from one primarily dominated by the operator hotspot market, into one in which enterprise applications are primary, followed by a growing home user market. Operators will shift focus from hotspot investment to other Wi-Fi-related revenue streams, primarily the provisioning of home Wi-Fi networks. The following diagram reflects this shift.

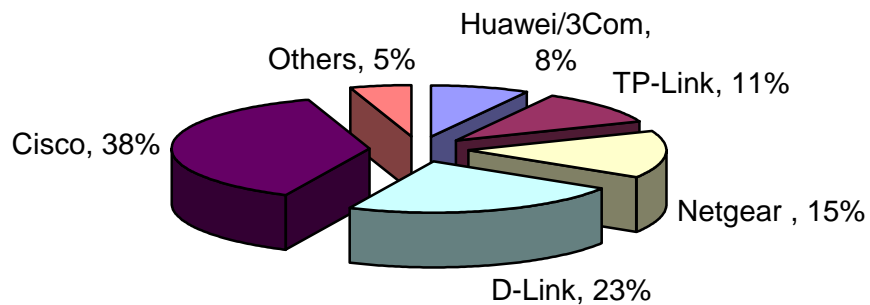


In the home user market, which will represent 16% of the total market by 2006, Wi-Fi products with lower price to performance ratios will gradually become mainstream.

### Increased Competition, Decreasing Chip Prices

It is expected that the number of silicon providers entering the Chinese market will increase. With the fast growth of the Chinese consumer market and the opportunity presented by China's large population, there will be marked interest from Taiwanese chip original design manufacturers (ODMs) in particular. By 2007, the competition in the silicon space will intensify, driving pricing down further.

**Figure 2.11: Consumer-Focused Market Share of Manufacturers in China**



Decreased chip pricing will pave the way for Wi-Fi to be included in a wider variety of products without having a substantial impact on the cost of production.

**Wi-Fi Functionality Increasingly Built-In**

Lower chip prices will enable inclusion of Wi-Fi functionality in a wider array of devices such as consumer electronics, where Wi-Fi will be an added feature rather than the primary function of the device. Consumers will come to expect Wi-Fi in consumer entertainment devices as the *de facto* method for internet connection. More and more handsets with built-in Wi-Fi, either converged with traditional cellular technologies or standalone Voice over Wi-Fi devices, will become more widely adopted.

Pure access point (AP) devices are beginning to give way to devices with stronger routing functions and firewall capability, accounting for 90% of the entire market for non-embedded Wi-Fi equipment. The market for external WLAN cards will also shrink and ultimately disappear, as the installed base of legacy PC equipment is either aged out of use or has already been Wi-Fi enabled via an external card. By 2007, the trend in client-side PC devices will be almost entirely to include embedded chips.

### Chapter 3: Market Opportunities

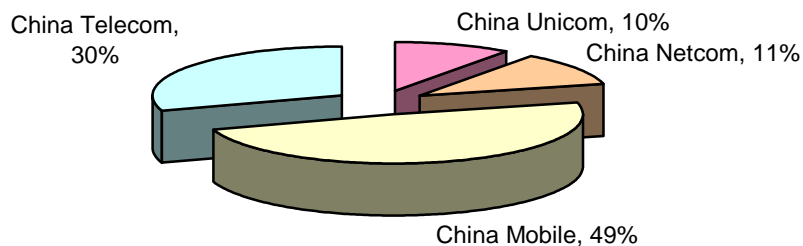
Manufacturers of Wi-Fi devices face three promising markets segments in China: the telecom operator market, the enterprise market, and the home user (consumer) market.

#### 3.1 Telecom Operator Market

Operation of public access hotspots and provisioning of home Wi-Fi networks to broadband subscribers provide Chinese telecom operators with Wi-Fi-related revenues. For all four companies in 2006, Wi-Fi-related revenue constitutes less than 1.2% of total revenue. Telecom operators have reduced their investment in hotspot deployments and do not regard hotspot deployment as a major focus of development. Nevertheless, there is considerable potential for operators to provide home broadband users with Wi-Fi networks, and further out, to support converged Wi-Fi/mobile phones.

The overall market shares of the four major players are depicted below.

**Figure 3.1: Market Share of the Major Telecom Operators**



#### 3.1.1 Home User Market and the Digital Home

The home user (consumer) market presents an attractive opportunity for telecom operators and device manufacturers alike. While the networking of a variety of devices (computer, media server, entertainment devices) has not yet seen wide adoption in China, increasing affluence and the emerging middle class, will help propel demand for broadband connectivity and a variety of more sophisticated devices and multimedia content. Wi-Fi is an optimal and affordable networking technology for the digital home, providing ample throughput and good Quality of Service for latency-sensitive applications.



Because broadband network users currently represent only a very small proportion of the Chinese middle class, there is strong growth opportunity in this area. Telecom providers have recognized this and set their sights on developing the market. The availability of rich content over broadband will serve as a compelling lever to sell broadband connectivity in the coming years.

Moreover, because consumer electronics devices have a much larger unit shipment rate than PC-based devices, as Wi-Fi becomes increasingly included in these devices, demand for Wi-Fi connectivity to broadband networks is expected to increase. There is a large untapped market potential among Chinese consumers who might never purchase a laptop, but who purchase televisions, gaming consoles, and audio players. While the market for Wi-Fi enabled consumer electronics is still in the introductory stages in China, it presents potential in the coming years.

### **3.1.2 Wi-Fi Mobile Phone**

The Chinese telecom operators have conducted continuous research into various access modes to find the best solutions for wireless broadband connectivity in China. Wi-Fi technology presents a compelling complement to traditional cellular connectivity for a variety of reasons. Moreover, the very large market of mobile subscribers in China presents a compelling opportunity for Wi-Fi growth.

Wi-Fi Mobile Convergence (WMC) presents Chinese mobile carriers with a unique opportunity. It allows them to offer advanced new services to their subscribers, lowering churn and increasing average revenue per user, while increasing network capacity and coverage, and improving spectrum management. Subscribers will also benefit from convergence as it brings broadband connectivity and seamless coverage to their handsets, and gives them the convenience of a single handset and lower costs. In China, converged mobile networks could capitalize on the increasing ubiquity of Wi-Fi networks and the affordability and versatility of the technology.

There are currently two barriers to growth of Wi-Fi/mobile convergence in China. First, the widespread, if illegal use of VoIP for long distance connectivity has negatively impacted revenue from traditional landline long distance service, and the telecom operators have not developed a mature profit model for this disruptive technology. Moreover, the government currently restricts the qualification of VoIP service to telecom operators.

However, it is expected that the consumer-oriented telecom services will eventually respond to consumer demand for converged phones. Like the currently-popular camera in mobile phones, Wi-Fi connectivity will become a widespread feature in mobile phones.

## **3.2 Enterprise Market**

In China, an enterprise invests directly in the construction of a WLAN infrastructure and pays a fee to the telecom operators for network access via wired backbone. There are two models for WLAN deployment on an enterprise scale: internal WLAN connectivity for employees and data collection, and deployment of public access networks (hotspots) in service industries such as hotels and Western-style restaurants (Enterprise Network Operator).

### **3.2.1 Internal Enterprise Network**

The enterprise deployment of WLAN will become the most important market driver in China. Wi-Fi is an excellent choice for enterprise networks because of its reliability, interoperability across vendors, and scalability. Moreover, Wi-Fi in the enterprise supports an increasingly competitive Chinese workforce with the ability to connect in a variety of locations and improved productivity.

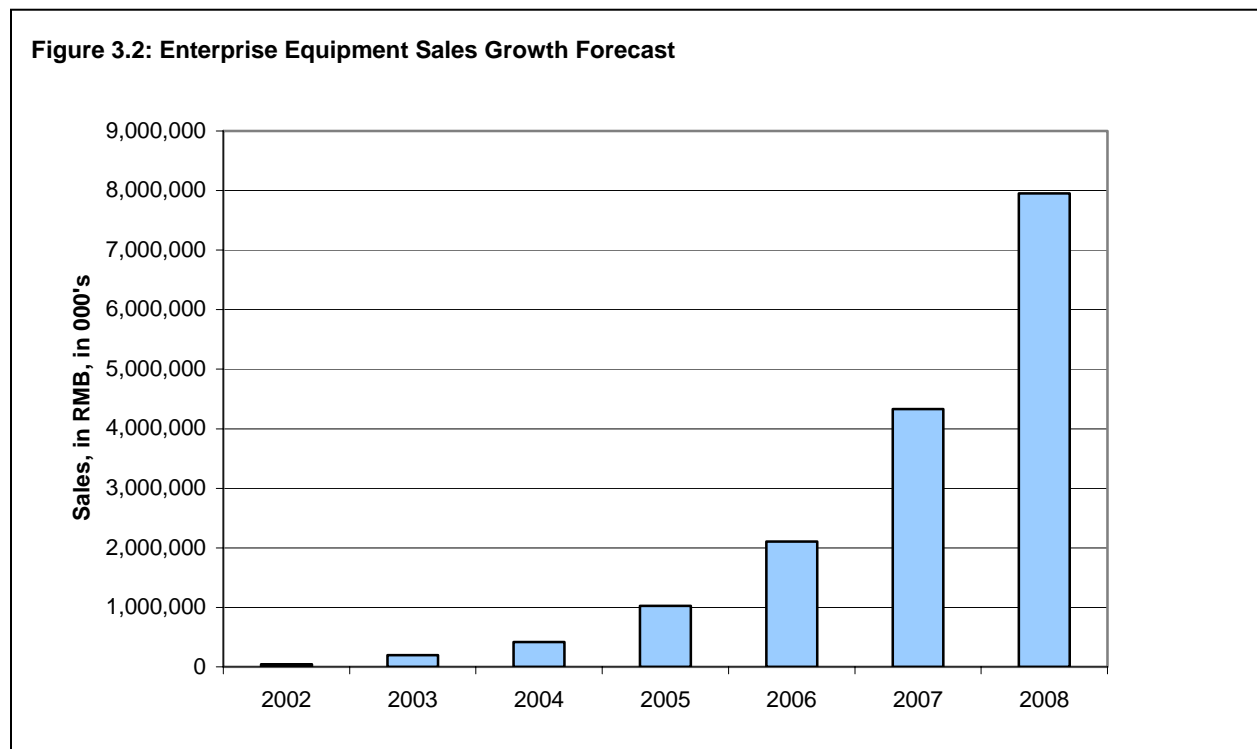


Internal deployment of WLANs in the enterprise has taken place in a wide variety of industries in China. Enterprises use WLAN for PC internet access as well as data acquisition in industrial environments such as warehouses and factories. In addition, colleges and universities have seen widespread adoption of Wi-Fi.

Improved efficiency is the compelling driver of enterprise adoption, with reduced laptop pricing a key enabler. Meeting rooms are often equipped with Wi-Fi access to the network, though entire offices may not have coverage. Although Wi-Fi equipment has become increasingly affordable, enterprises in China remain very cost-conscious, and this inhibits adoption of Wi-Fi where a compelling business case has not been made. Companies will become successful in this segment when they articulate a clear value proposition for Wi-Fi usage, focusing on improved productivity and efficiency of the work force.

Voice over Wi-Fi may present the most compelling reason for adoption of Wi-Fi in the enterprise. With VoIP, long distance calling fees are significantly reduced. Currently there is no policy restricting the use of VoIP in the enterprise environment, and VoIP is very widely used. The additional mobility afforded by Wi-Fi handsets will present a compelling offering when enterprises invest in a VoIP infrastructure or upgrade existing equipment.

The following table depicts the sales growth of Wi-Fi equipment for the enterprise environment, excluding laptops and phones.



### 3.2.2 Enterprise Network Operators

An Enterprise Network Operator concentrates on business service industries such as commercial property management companies, restaurants, and hotels. Though providing wireless broadband service



can improve the enterprise image and differentiate the core offerings among consumers, it is not a core focus of business development and does not generate significant profit. It is likely that as demand for Wi-Fi connectivity increases, the opportunity for profit in this realm will also increase.

There are three primary avenues for revenue generation for an Enterprise Network Operator: direct fee assessment, Value Added Services (VAS) and advertising.

Direct fee assessment is done on the basis of users' internet access time or the amount of data transferred. Direct fee assessment can only become a strong source of income in areas in which there are concentrated amounts of business users and high demand (office buildings, Western-style business hotels, etc.) In other locations, direct fee assessment is only a small contributor of income and more profitable opportunities exist with VAS and advertising.

There are various combinations of VAS and advertising in place today, varying by individual network operator strategy. VAS offerings can include home page design tools, online gaming, and online video. Advertising models require a large user base to generate significant revenue, but can leverage location-specific tools for very targeted campaigns.

The development and adoption of Wi-F/mobile phones in particular will benefit from the growth of the Enterprise Network Operator market. Once Wi-Fi is in higher demand, wireless broadband networks will be available in large numbers of most business estates and service industries, making the opportunity for converged devices quite compelling, because of the widespread availability and affordability of coverage. However, as Chinese enterprises take an aggressive approach to cost control, a higher contribution will be demanded from Wi-Fi network operation and this may inhibit growth.

### **3.3 Home User Market**

The home user (consumer) market refers to the situation in which a home broadband subscriber directly purchases a Wi-Fi access point or switch and deploys a Wi-Fi network for home use. Since the installation of Wi-Fi products is fairly straightforward and the related frequencies are unlicensed, there is notable growth potential for Wi-Fi in this segment. The home user market emerged in mid-2003 and grew throughout 2004 and 2005. Rapid development is expected in 2006-2007.

Chinese consumers are increasingly demanding internet access, especially those who own or have access to laptops. The current Chinese laptop installed base of 6.95 million units includes laptops which are used by employees of corporations, but which can also be used at home in non-working hours. Most Chinese consumers who use a laptop at work have relatively high purchasing power for other entertainment devices.

More and more families own or use multiple computers at home, and even more families own a variety of consumer electronics devices. Digital home networking using Wi-Fi will see increased adoption as broadband penetration and computer ownership rates increase. Similarly, the increased availability and affordability of converged Wi-Fi/mobile phones and single-mode Wi-Fi handsets will drive adoption of Wi-Fi in the home environment.

The China real estate market is experiencing a period of dramatic growth, with widespread construction of high-rise residential apartment buildings in urban areas. For these buildings, installation of a centrally-managed building-wide Wi-Fi network is preferable to having individual residents operate small Wi-Fi networks and risk potential RF interference. Moreover, Wi-Fi network availability will be a compelling amenity among consumers seeking a residence. Both telecom operators and Enterprise Network Operators can capitalize on this as-yet undeveloped market.



## Chapter 4: Conclusions and Recommendations

### 4.1 Market Highlights

The Chinese market for Wi-Fi remains in a disordered transition period after a period of initial hype earlier in the decade. However, there is tremendous growth opportunity for Wi-Fi equipment makers and service providers alike. The interaction between government control, telecom operators' power, and vendor competition presents some inhibitors to the market, but demand for Wi-Fi products in the enterprise and consumer markets is likely to emerge with strong growth in the coming years. Consumer electronics with embedded Wi-Fi functionality and converged mobile/Wi-Fi phones will bring Wi-Fi to a wide array of Chinese users, including those who might never own a computer.

#### **Key Market Facts:**

In 2005 the annual revenue for non-embedded Wi-Fi equipment exceeded RMB 1.5 Billion (laptops excluded). It is projected that by 2008, the Chinese Wi-Fi market will exceed RMB 10 Billion.

More than 10,000 hotspots exist in China, covering major airports, 4- and 5-star hotels and some Western-style cafés and restaurants (most notably, Starbucks and McDonald's).

The number of internet users in China exceeded 111 million by the end of 2005, and the number of broadband users reached 64.3 million in the same time. With increasing prosperity among a very large population, broadband penetration has a significant growth opportunity.

China mobile subscribers reached nearly 400 million in 2005 – it is the largest mobile subscriber market in the world. As Wi-Fi/mobile convergence gains ground, it can provide a richer, more dynamic wireless broadband experience to millions of people in China.

There were more than 3 million laptop shipments into the Chinese market in 2005, and it is estimated that in 2009, shipment volume will reach 8 million units, of which more than 90% will be Wi-Fi enabled.

### 4.2 Opportunities and Recommendations to Vendors and Manufacturers

The Chinese Wi-Fi market might be segmented into three categories: consumer (home user) class, enterprise class, and telecom operator class. Each of these markets presents unique requirements and purchase criteria when deploying Wi-Fi networks, and these unique needs could form the basis of an effective market segmentation strategy.

The enterprise market merits special attention. In addition to basic WLAN equipment, there is a need for security and network management solutions. Moreover, there are strong opportunities for Voice over Wi-Fi, as VoIP is already embraced by enterprises in China for its affordability and features.

Wi-Fi is increasingly being used for data acquisition in industrial and warehouse environments. Wi-Fi equipment vendors should focus on the Fast-Moving Consumer Goods (FMCG), logistics, and service industries for opportunities.

With the expanding market size for Wi-Fi devices, Wi-Fi equipment vendors will gradually occupy the dominant position in the value chain. First-mover advantage, including brand awareness among Chinese consumers, is still available.

The home user market is driven by ease of use and functionality. Ease of installation, interoperability and use will be central to purchase decisions. As Wi-Fi functionality appears in a wider array of devices, these factors become more important than ever, especially as users unfamiliar with computers begin to use Wi-Fi in consumer electronics and mobile phones. Certified interoperability via the Wi-Fi CERTIFIED



program will extend advantages to manufacturers as familiarity with the brand increases among Chinese consumers.



## Appendix:

### Description of Stages in Technology Hype Cycle

#### ***Peak of Inflated Expectations:***

As the peak crests, the number of vendors offering the technology increases. These vendors are primarily start-up companies and small vendors that try to use the increasing amount of hype for their marketing benefit. A growing number of Enterprises start to examine how the technology may fit within their business strategies, although most do not take action at this stage. Venture capitalists may be interested in selling some of the start-ups that they equipped with early funding.

As problems with first-generation products become visible, often because the technology is pushed to its limits, negative publicity starts to push the technology into the Trough of Disillusionment ( for example, Web services in 2002 and biometrics in 2003).

#### ***Trough of Disillusionment:***

Because the technology does not live up to Enterprises' and the media's over inflated expectations, it is rapidly discredited. Some of the early trials end in highly publicized failures. Media interests wanes, except for a few cautionary tales. A significant amount of vendor consolidation and failure occurs. Later-stage investors may be interested in funding vendors during this phase because equity is fairly inexpensive after the "microbubble" at the Peak of Inflated Expectations has burst.

However, amid the disillusionment, trials are ongoing and vendors are improving products based on early feedback regarding problems and issues. Some early adopters find some benefit in adopting the technology. For some slow-moving technologies (for example, biometrics), workable and cost-effective solutions emerge and provide value in niche domains, even while the technology remains in trough.

#### ***Slope of Enlightenment:***

Focused experimentation and real-world experience by an increasingly diverse range of Enterprises lead to a better understanding of the technology's applicability, risks and benefits. Vendors seek mezzanine or later-round funding for marketing and sales support to pull them up the slope. Second- and third-generation products are launched, and methodologies and tools are added to ease the development process. The service component declines as a percentage of the sale.

#### ***Plateau of Productivity:***

The Plateau of Productivity represents the beginning of mainstream adoption, when the real-world benefits of the technology are demonstrated and accepted. Technologies become increasingly embedded into solutions that increasingly are "out of the box", with decreasing service elements as the technology matures.



As a high-profile technology matures, an “ecosystem” often evolves around it. The ecosystem supports multiple providers of products and services, and also a market for related products and services that extend or are based on the technology (for example, virtual private networks in 2003).

The final height of the plateau varies according to whether the technology is broadly applicable or benefits only a niche market.

### List of Acronyms

3G	Third Generation
AoD	Audio on Demand
ARPU	Average Revenue Per User
CDMA	Code Division Multiple Access
CTIA	Cellular Telecommunications and Internet Association
EAP	Extensible Authentication Protocol
EV-DO	(CDMA) EVolution Data Optimized
FMCG	Fast-Moving Consumer Goods
GSM	Global System for Mobile Communications
IEEE	Institute of Electrical and Electronics Engineers
MAC	Media Access Control
MIMO	Multiple-Input-Multiple-Output
ODM	Original Design Manufacturer
PDA	Personal Digital Assistant
QoS	Quality of Service
VAS	Value Added Services
VoD	Video on Demand
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
WLAN	Wireless Local Area Network
WMC	Wi-Fi Mobile Convergence
WMM™	Wi-Fi Multimedia™
WPA™	Wi-Fi Protected Access™
WPA2™	Wi-Fi Protected Access 2™