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Summary

Factors Leading to Emergence of “GiganTechs”

- **Human User Interface.** User-friendliness is critical if complex technologies are to gain mass acceptance. Just as the first round of graphic user interfaces (GUIs) made personal computers much less intimidating for the average user, we believe “human user interfaces” (HUIs) will revolutionize the way that we interact with technology, and help to unobtrusively blend technology into even more aspects of our lives.
- **Development of the “Digitally Networked Ecosystem”—DNE.** The DNE is a globally interconnected infrastructure of *networks* (wide area networks, metropolitan area networks, local area networks, personal area networks), *servers* and *devices* (PCs, mobile phones, cars, etc.). In the same way that DNA is the building block of the human body, the DNE will be the building block of the new Information Age. Driving the build out of the infrastructure of the DNE:
 - **Customer Empowerment.** In the Agricultural Age, customer choice was limited by geography. Customization was possible, but the choice of vendors was limited to the local artisan. In the Industrial Age, mechanization and standardization gave rise to uniform manufacturing procedures and the production line, yielding greater efficiencies. But customer choice was frequently limited to standardized goods. In the Information Age—with choice not limited by constraints such as geography, government regulations, trade restrictions—customers are empowered to demand from suppliers the unique product or service that satisfies their specific needs.
 - **Mass Customization.** Given customer empowerment, suppliers must tailor their products to meet the needs of individual customers—both consumer and corporate. Mass customization involves selling highly individualized products on a mass scale.
 - **Fragmentation.** As companies strive to offer mass customization, this invariably leads to fragmentation—i.e., many companies offering many competing technologies—as well as deeper tech penetration into society.
 - **Deeper Tech Penetration.** As technology becomes easier to use, it penetrates deeper into physical products, the DNE, and society.
 - **Consolidation.** Fragmentation will be followed by attrition, i.e., the disappearance of non-viable technologies. And given the impracticality of a fragmented, hybrid world, there will be massive tech consolidation, which will concentrate power in the hands of **GiganTechs**. The companies that first gain critical mass in a portion of the DNE will be in a strong position to establish the dominant technology in that sector.
- **GiganTechs** are companies that will dominate the technologies and platforms of major segments of the DNE. Access to plentiful capital is critical for **GiganTechs**—high-tech research and development is requiring more resources such as advanced facilities, highly skilled talent, and legal support for the protection of intellectual property.
- 16 **GiganTechs** that are likely to emerge/consolidate their position in the first decade of the new millennium: **Applied Materials, AOL Time Warner, Celestica, China Mobile, Cisco, Flextronics, IBM, Intel, Microsoft, Nokia, NTT DoCoMo, Qwest, Sony, Texas Instruments, Taiwan Semiconductor, Vodafone.**

September 1, 2006

“Good morning. This is your wake-up call.” Still a bit groggy after just a few hours of sleep, I ask George, my personal virtual assistant (PVA), “What time is it? Where exactly am I?” My PVA tells me that it is 6 a.m. Friday, September 1, 2006, and that I am in room 501 at the Hilton London Heathrow Airport hotel. I named my PVA “George” after a concierge that I met many years ago at the George-V Hotel in Paris, and I customized the PVA’s voice to sound male and in his mid-forties with a slight European accent.

I ask George if I can sleep for just a few more minutes, but he informs me that I have an early morning meeting in the City, and then have to return to Heathrow for a flight to Tokyo. As I reluctantly pull myself out of bed, George tells me that he has had room service prepare a fruit salad and yogurt for breakfast, instead of my usual eggs Benedict and bacon. Puzzled for a moment by George’s breakfast order, I quickly remember that my dietary preferences have changed, given my doctor’s recent insistence on low cholesterol food.

Later, as I head to the hotel lobby to meet the waiting car, George digitally reconfirms today’s itinerary, checks me out of the hotel, and sends a copy of the bill (converted into U.S. dollars) to our company’s accounting department. George has arranged with the concierge that my luggage will be taken from the hotel and shuttled to a holding bin for the afternoon flight to Tokyo. In addition, George uploaded my itinerary to the luggage, and will constantly monitor the location of the luggage throughout the trip. Once in the lobby, George locates the car that is to pick me up, and then navigates me through the hotel parking lot to the car.

As I seat myself in the back of the car, George tells me that, in the past 12 hours, I have been contacted (by voice, text mail and video mail) 46 times, but nothing was urgent. George advised 20 of the contacts that they should get in touch with me when I return to the office, two weeks hence. He forwarded six of the contacts to my colleagues in the U.S. for immediate action, and translated one voice message from Japanese to English and archived it for me. I shall review it, and the other archived messages, on the airplane to Tokyo later today. Something else to read on the plane will be the customized news articles that George has scanned off the newswires.

On the monitor in the back of the car, George patches in a video call from my wife, who is visiting Jordana, our daughter, currently at college in California. My wife mentions our forthcoming vacation, prompting George to split the screen and display the details of the cruise I have booked for Saturday, October 14, 2006. Unprompted, George also displays the confirmation from Tiffany’s for a Monday, October 16 delivery to the cruise ship of the anniversary present for my wife.

The conversation with my wife over, I tell George to switch to my son’s dorm room in New England, and, sure enough, David is playing an interactive video game with his brother, Seth, who is 500 miles away in Washington, D.C. In David’s room, I pop up on the flat screen on the wall (almost as big as life) and ask him why he is not getting some rest for his big exam tomorrow. My son’s yawn indicates that his day is ending. My day is just beginning. George’s day never ends.

From GUI to HUI

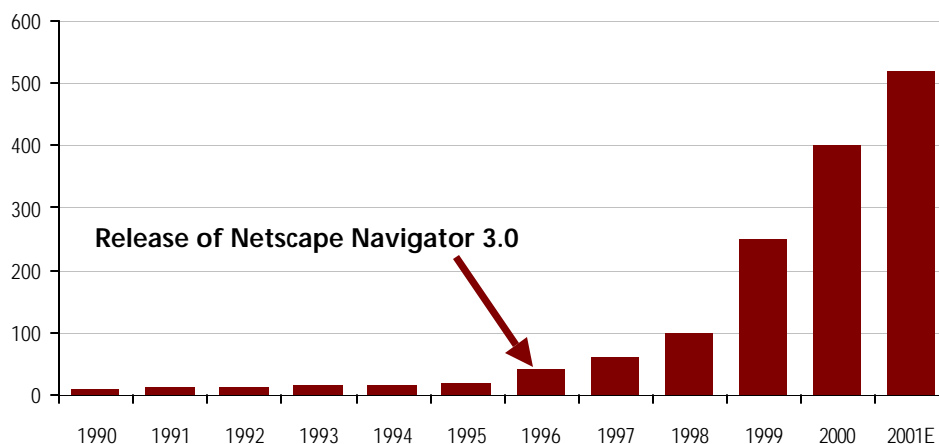
Advances such as personal virtual assistants will revolutionize technology interaction

User-friendliness is critical if complex technologies are to gain mass acceptance

The scenario above is *not* science fiction. In just five to ten years, personal virtual assistants such as George will likely be *science fact*. *And advancements such as PVAs will revolutionize the way that we interact with technology*. In the same way that graphic user interfaces (GUIs) made personal computers less intimidating for the average user, we believe “human user interfaces” (HUIs), such as George, will help to unobtrusively blend high tech into even more aspects of our lives.

User-friendliness is critical if complex technologies are to gain mass acceptance. When the Internet was first created, there was no graphical user interface. Consequently, the skill set needed to navigate through the abstract data flows restricted use of the Web to an elite set of users. With the creation of Mosaic and other early browsers, text and images became available to anyone connected to a personal computer. The browser, having brought user complexity down by increasing intuitiveness, spurred explosive use of the Internet. Indeed, as Chart 1 illustrates, the release of Netscape Navigator 3.0 in 1996¹ coincided with explosive growth in the number of individuals using the Web.

Chart 1: Number of Internet Users, Worldwide (Millions)



Source: Paul Bunne Communications

The process of simplifying technology so that it “invisibly” blends into everyday life is not new. For example, early automobiles had such complex technologies that many car owners had to employ professionals to start and maintain the vehicles. Over time, those technologies evolved and became much simpler, so that today millions of people use this complex machine with ease.

¹ Netscape Navigator 3.0 was the first version of the Netscape browser that included enhanced multimedia capabilities and communication and collaboration tools.

To make technologies more intuitive, even more complex technologies are required

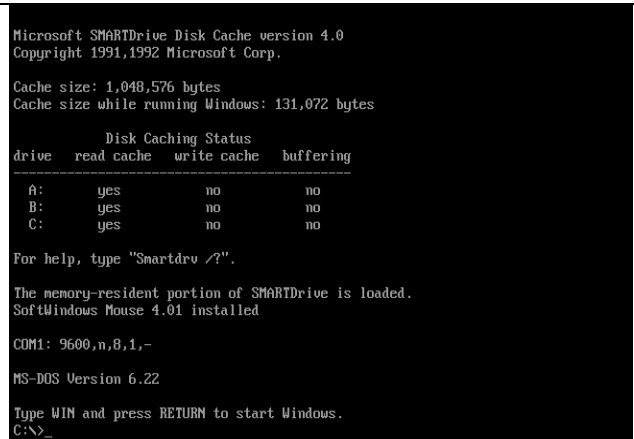
The paradox, however, is that in order to make technologies more intuitive, even more complex technologies are required. So, for example, graphic user interfaces such as Windows XP (Chart 2) require far more processing power and memory than did earlier DOS interfaces (Chart 3). As Microsoft's XP Version of Office and IBM's Websphere Voice Server roll out natural language speech recognition, the processing requirements will increase further still. And human user interfaces, such as George, that use voice recognition technologies require even more powerful processors and much more memory.

Chart 2: Windows XP



Source: Company Reports

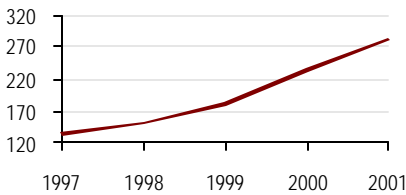
Chart 3: MS-DOS



Source: Company Reports

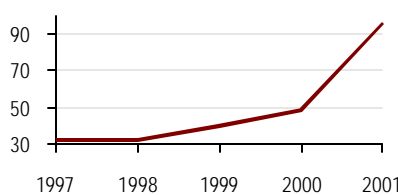
Chart 4, Chart 5, and Chart 6 below show the increased requirements for a speech recognition application to run on a personal computer. As the capabilities of the software have grown to allow for greater accuracy and responsiveness, the average technology requirements have also grown for processing (from 133 Mhz to 283 Mhz), memory (from 32 MB to 96 MB), and hard drive storage space (from 115 MB to 352 MB).

Chart 4: Processing Requirements for Desktop Speech Recognition (Mhz)



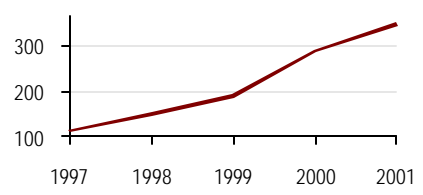
Source: UBS Warburg LLC

Chart 5: Memory Requirements for Desktop Speech Recognition (MB)



Source: UBS Warburg LLC

Chart 6: Hard Drive Requirements for Desktop Speech Recognition (MB)



Source: UBS Warburg LLC

Mobile phones will be the primary contact point with the digitally networked world

PVA technologies such as George will be far too complex, and will require too much processing, memory and storage to operate within a small device such as a mobile phone. But the beauty of a PVA is that it is *virtual*, and the end-user point of contact is simply a voice. So, *in the near future, the mobile phone will be the primary point of contact that most individuals have with the digitally networked world.* In other words, the actual processing and intelligence for PVAs such as George will reside entirely on servers or mainframe computers located in a mobile operator's data center.

To appreciate the future functioning of a PVA, let's walk through the section "September 1, 2006" one technology at a time.

- *Personal virtual assistants.* As mentioned, the intelligence for PVAs such as George will be located on servers and networks, *not* on the actual device that users interact with. The processing for the PVA will be done on a server, which will then communicate with the device via a high-bandwidth ubiquitous digital network. Text-to-speech technology will enable George to speak. Speech recognition technology will allow George to "understand" commands. (Intelligent software agent technologies will be used to monitor and filter information, and make "recommendations" based on advanced problem-solving algorithms.) Personalization software will facilitate customization, so that George will sound like a "male in his mid-forties with a slight European accent" or like a "female in her early twenties with an Australian accent."
- *Rules-based preferences.* The PVA will "know" behavioral patterns through rules-based preferences. In other words, just as it is possible today to set rule preferences in Microsoft Outlook so that, for example, all e-mail from a particular user is automatically sent to a specific folder, so too will it be possible to program a PVA for your general lifestyle preferences. In addition, five to ten years in the future the PVA will be able to fine-tune those preferences through some *limited* learning capabilities.
- *Personal area networks.* Technologies such as Bluetooth (a wireless technology) will allow PVAs to interface with pervasive intelligent devices in hotel rooms, cars, airports, etc. PVAs will be "mobile agents" that can work across multiple technology platforms and interface with travel reservation systems, hotel billing systems, and corporate accounting systems. Global positioning satellite (GPS) systems (with Bluetooth communications) will allow luggage to be tracked globally, and cars to be located in parking lots.
- *Information mining.* Text mining will enable PVAs to dynamically search for news articles based on established preferences. Information mining (with text-to-speech and speech recognition technology) will be used by PVAs to "listen in" on conversations and offer information about the subject under discussion (of course, only when the end user authorizes such activity).

Huge advances in user interfaces will lead to a material increase in technology penetration rates in the next few years. After all, the primary way that we interface with technology today has not changed that much since the introduction of the Macintosh desktop user interface in 1984². As the rate of technological progress accelerates further, human user interfaces will play a critical role in reducing technological complexity. The HUI will be the key factor that assimilates technology into our everyday lives and allows us to leverage the capabilities of forthcoming technological advances.

**HUIs will be key factors that
assimilate technology into
our everyday lives**

² The first graphical user interface was developed by Xerox. The first business computer with a graphical user interface and a mouse was the "Lisa," which Apple unveiled in 1983. Although, Lisa never caught on, Apple continued with the GUI concept.

DNE—Digitally Networked Ecosystem

The DNE is the building block of the new Information Age, as DNA is the building block of the human body

Many of the functions of the PVA of the future described above, e.g., rules-based preferences and information mining, are not that challenging to develop *from a technological perspective*. The real challenge lies in the *development of a supporting infrastructure*—what we call the digitally networked ecosystem. The DNE—which will provide ubiquitous intelligence (i.e., software and processing power) and connectivity—needs to be *fully* developed and integrated into everyday life. The DNE will be the building block of the new Information Age, in the same way that DNA is the building block of the human body.

The first step in the development of the DNE has been, of course, the Internet. By “Internet” we do *not* mean the uncertain world of dot-coms. Rather, “Internet” refers to a digitally networked world. As we noted in “The Information Revolution Wars,” May 9, 1999:

“There’s a lot more to the Information Age, and a lot more substance too, than the multitude of ‘.com’ IPOs that have been flooding the market. More than just a communication tool, the Internet is a revolutionary new technology . . .”

One way that the Internet is revolutionary is that it *empowers the end user*. Thanks to the Internet, end users (both corporations and consumers) can seek out those particular suppliers that satisfy their *unique* needs. No longer are end-users obliged to tolerate the product offering that suppliers have to offer. Rather, *suppliers must tailor their products to meet the needs of individual end users*. This process of selling highly individualized products on a mass scale can be labeled “mass customization.”

Mass customization is a key factor spurring the development of the DNE

Mass customization is a key factor spurring the development of the DNE. In other words, as companies adapt their business models and develop technologies to offer mass customization, they contribute to the gradual build-out of the DNE. So, for example, the late 1990s rush by companies in a multitude of industries to establish Web sites was a small step in the development of the DNE.

As we envision it, the DNE is a globally interconnected infrastructure of *networks* (wide area networks, metropolitan area networks, local area networks, personal area networks), *servers* and *devices* (PCs, mobile phones, cars, etc.)—see Chart 7. In order to be attached to, and leverage the capabilities of, this DNE, it will be necessary for society to be “reconnected” (wired or wirelessly). This does *not* mean that the existing communications infrastructure will have to be ripped out and replaced. Rather, service providers will need to offer new forms of access to consumers, such as “fiber-to-the-home,” “fiber-to-the-building,” and high-speed wireless networks.

Customer Empowerment

Customers are becoming empowered to demand unique products that satisfy their specific needs

A key trend as the Information Age gets under way is customer empowerment: Customers are becoming empowered to demand from suppliers the unique products or services that satisfy their specific needs. This contrasts sharply with customers' experiences in both the Agricultural Age and the Industrial Age:

- In the Agricultural Age, artisans carried out most manufacturing on a custom or “bespoke” basis. Each product was made to order by a craftsman *after* he and the customer had negotiated specific product details, as well as the price. But while customers were able to have customized products made, they were limited in their choice of vendors. And because artisans could not enjoy economies of scale, they had little surplus funds to invest in research and development.
- In the Industrial Age, by contrast, mechanization and standardization gave rise to uniform manufacturing procedures and the production line, yielding greater efficiencies. These factors, coupled with the advent of early transportation and logistic systems, gave rise to standardized goods and the mass market. More efficient transportation also allowed the latest technological advances to reach a large market.

During the Industrial Age, most customers had very little say about the design and development of the products they were buying, much less about the production or distribution processes. The deficiencies of the transportation and communication infrastructures meant that, if customers wanted to interact with suppliers, it was a troublesome and expensive process. As for what suppliers offered customers, most manufacturers focused on products that they, as suppliers, considered would have the widest appeal to the greatest number of customers. However, in many instances, what manufacturers chose to produce was a function of what was easiest to produce over an assembly line.

The early days of information technology witnessed a similar situation. End users (corporations and consumers) had very little influence over the design, production, or distribution of technology products, and so were forced to accept and use the limited product offerings of tech companies. So for example, into the early 1980s, DOS (“desktop operating system”) was *the only* desktop PC operating system.

The advent of the Information Age has changed this paradigm. At the core of the Information Age is the ubiquitous digitalization of information, leading to a huge increase in the numbers of individuals with immediate and unobstructed access to vast amounts of data. (A key part of this process has been the disintermediation of middlemen, who have traditionally added an extra layer to the purchasing process.) Not only do end users today have access to vast amounts of information, but they are also empowered—by *supply-chain management*, *deregulation*, and *globalization*—to choose among a very broad selection of products and suppliers.

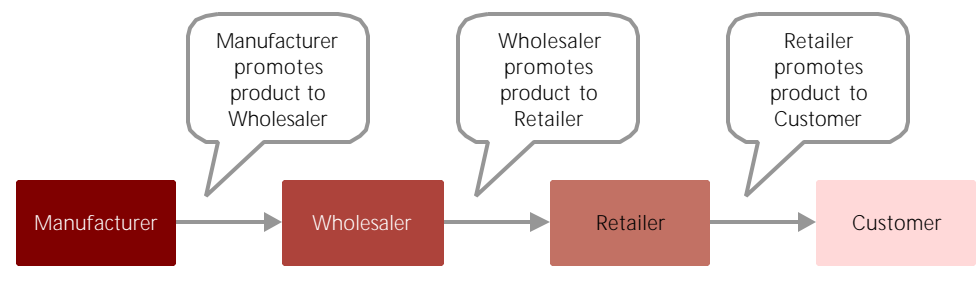
Supply-chain management, deregulation, and globalization are empowering customers

Empowerment Factor #1: Supply Chain Management

As the supply chain has evolved from the “push” model of the Industrial Age to the “pull” model of the late twentieth century, and now to an “interactive pull model” of the Information Age, customers have gradually become empowered.

In the Industrial Age, goods were “pushed” at customers (Chart 8). In other words, customers were offered the goods that suppliers chose to offer, with suppliers promoting products “downstream” to the next link in the marketing chain (i.e., wholesalers and retailers), and encouraging them, in turn, to “push” the products through to customers.

Chart 8: Push Model

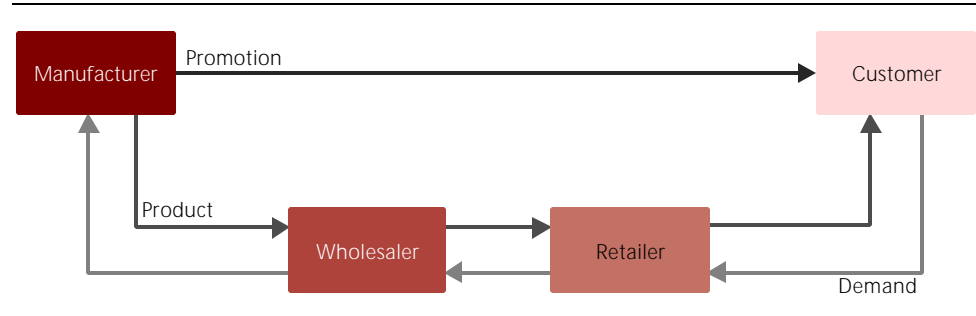


Source: UBS Warburg LLC

The drawbacks of this system were twofold. First, customer choice was limited. Second, there was no mechanism for customer preferences to get back to the suppliers.

With the emergence of the “pull” model in the twentieth century, suppliers created demand for their products by *promoting* the products directly to the customer, and then relying on this demand to pull the products through the marketing channel (Chart 9). Feedback was sent back along the marketing channel (i.e., from customers to retailers to wholesalers to suppliers), so that suppliers could use this information to forecast demand patterns.

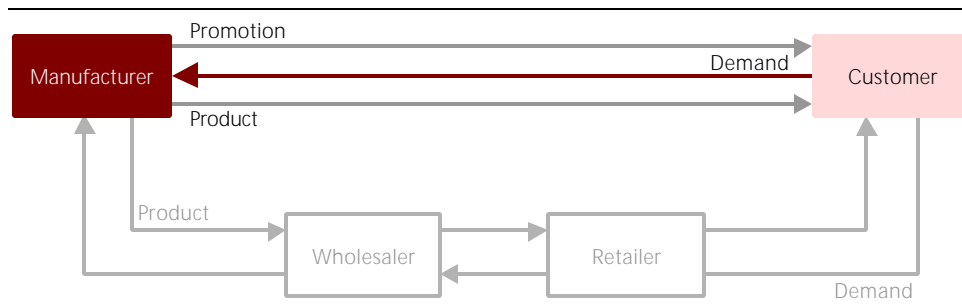
Chart 9: Pull Model



Source: UBS Warburg LLC

Today, direct and interactive communications between suppliers and customers enables customers to express their demand preferences (Chart 10). *Supply chain management then enables that demand to be fulfilled* by allowing products to be custom-made to end-user specifications, and service and technical support programs to be fitted to customer needs. Perhaps the best known example of this model is Dell, which attributes its success in the PC sector to its “direct model.”

Chart 10: Interactive Pull Model



Source: UBS Warburg LLC

Empowerment Factor #2: Deregulation

Deregulation is destroying protected market niches. Three major industry sectors—finance, telecom and utilities—are in the throes of deregulation *on a global basis*. They are being transformed from sleepy bureaucracies to dynamic industries focused on innovation, mergers, and cost cutting. Consequently, deregulation is giving end users much more choice, while forcing service providers to battle for market share.

In the telecom sector, for example, restrictions on foreign ownership of U.S. service providers were lifted in January 1998. Since then three major foreign telecommunications companies—Deutsche Telekom, NTT DoCoMo, Vodafone—have all entered the U.S. market, either through acquisitions or partnerships. Through NTT DoCoMo's relationship with AT&T Wireless, it is likely that, in the near future, U.S. customers will have more wireless data choices, similar to some of the i-mode services offered in Japan today.

The lifting of similar restrictions has resulted in many foreign companies entering into local telecom markets. In Latin America, for example, Spain's Telefónica recently acquired Telefónica de Argentina, Telefónica de Peru, and Telesp (a Brazilian wireline company), and it also owns stakes in CTC (Chile) and CANTV (Venezuela). In Europe, following its acquisition of Germany's Mannesmann, Vodafone now operates in 15 countries, the most extensive European wireless footprint.

Empowerment Factor #3: Globalization

A more capitalistic economy is emerging outside the U.S., thanks to trade liberalization (e.g., NAFTA and China/WTO), the creation of the European Monetary Union, and widespread privatization of state-owned firms. Of course, in many markets, technological advances—such as the Internet—do away with geographic barriers, and accelerate the move towards a truly global competitive landscape.

In addition, many tech segments that used to be dominated by U.S. firms now face intense competition from overseas companies with leading-edge technologies. For example, during the early days of mobile telecommunications, Motorola led the industry, commanding more than 50% of the analog handset market. However, Motorola's overall market share has since fallen to 15%, and is now second to Nokia's number one position. And Japan's Hitachi Data Systems, a small portion of the Hitachi conglomerate, is challenging EMC's technology in the global storage market, much more so than established competitors such as Compaq, Hewlett-Packard, IBM, and Dell.

Who Is the Customer?

Importantly, as customer empowerment gains momentum, the *corporate* customer will become increasingly empowered. This is already true in the handset market, where today a handful of giant telecom operators are the key customers of the handset manufacturers. Thanks to global industry consolidation, that trend is spreading to other sectors. Table 1 illustrates that the customer base of some GiganTechs is highly concentrated among a handful of large customers.

Table 1: GiganTechs' Customer Concentration

Company	# of Customers	% of 2000 Revenue
Celestica	5	69%
Flextronics	10	59% (fiscal 2001 net sales)
Intel	5	42% (net revenue)
Microsoft	1	9%
Texas Instruments	5	28% (semiconductor revenue)

Source: Company Reports

Tremendous corporate concentration has facilitated the emergence of GiganTechs

As global industry consolidation—and concentration—continues, immense corporations will become the key customers of GiganTechs. Indeed it has been the tremendous corporate concentration of the last few years that facilitated the emergence of GiganTechs. For example, the global banks that have been formed in recent years would clearly prefer that just a few companies with end-to-end solutions supply their *global* telecommunications and computing needs, rather than having to deal with dozens of different companies in dozens of different countries. The same holds true for the global auto manufacturers, pharmaceutical companies, etc.

Mass Customization

Empowered customers are demanding the ability to determine specific features of the products and services that they buy. The initial response of suppliers to these demands has been to offer:

- **Build-to-order systems and solutions.** “Build-to-order” involves the manufacturing of *products* from standard, mass-produced components. For example, most car manufacturers allow buyers some latitude when purchasing an automobile, offering optional automatic transmission, leather seats, and a CD player. The drawback of this approach to customers is that choice is limited, and is dependent on the diversity and availability of components.
- **Configure-to-order systems and solutions.** “Configure-to-order” involves the customizing of products through unique *software* specification and integration. This results in a more customized product than build-to-order. For example, the car buyer who chooses the GPS system option could specify which vendor’s system to have installed.

The next step in the process of satisfying the demands of empowered customers is mass customization

Build-to-order and configure-to-order are steps towards satisfying empowered customers’ demands. However, customers today increasingly want an even wider selection of personalized products and an even greater degree of customization. Thus, the next step in this process of satisfying the demands of empowered customers is “mass customization.”

Mass customization involves the development, manufacture and sale of very individualized products on a mass scale. Bringing this to realization involves close collaboration between the buyer and the seller, which is being facilitated by tremendous advances in communications. Today, however, the world is only in the beginning stage of mass customization, with most industries still at build-to-order.

Ability to mass customize for large corporate customers will be key in determining GiganTechs

As corporate customers become empowered, they will increasingly demand mass customization. And given the benefits of economies of scale and global leverage, those suppliers that offer corporate customers mass customization will enjoy much greater profitability than companies that offer mass customization to individual consumers. Indeed, the ability to offer mass customization to large corporate customers will be a key factor in determining which companies succeed as GiganTechs, and which do not. Mass customization in the corporate market will fund the research and development in supply chain management, logistics and process technology that allows for mass customization at the consumer level.

Below we cite three current examples of *steps toward* mass customization in the consumer sector. Note that these are *not* examples of *full* mass customization because, in each case, the end user is still *limited* in the number of choices available to him.

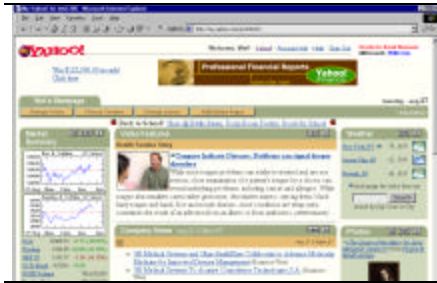
- Consumers shopping for sneakers can “Choose It. Build It. Buy It.” online at the Nike Website through the “Nike iD” program (Chart 11).
- Yahoo’s MyYahoo service offers Net surfers the ability to customize their start page with their own choice of content, such as news, sports, and stock quotes, and applications, such as e-mail and chatrooms (Chart 12).
- In the near future, General Mills will allow individuals to blend 80+ ingredients to create a custom cereal at the mycereal.com Website (Chart 13).

Chart 11: Personalized Sneakers



Source: Company Reports

Chart 12: Personalized Content



Source: Company Reports

Chart 13: Personalized Food

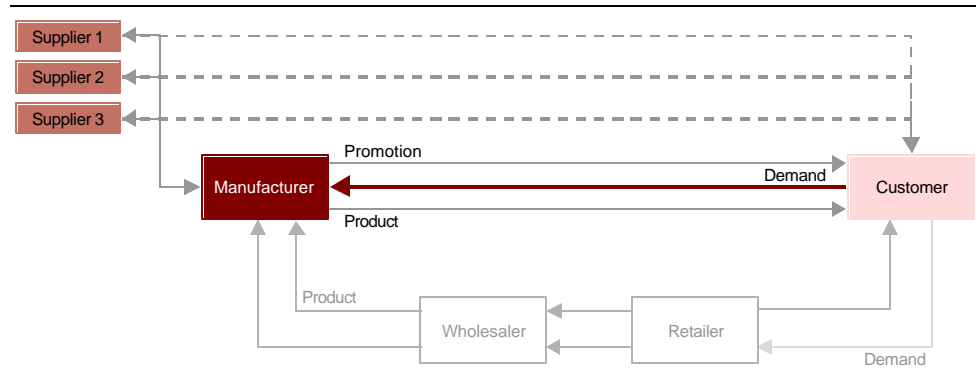


Source: Company Reports

Note here that customer empowerment and the trend toward mass customization have important implications for “consumer branded products.” As the *Financial Times* of August 7, 2001, observed, “Mass marketing has become very hard because people all want to be seen as individuals.” The FT cited a Harvard Business School marketing professor who argues that, if packaged goods companies want to restore growth to their brands, they have to drop the one-size-fits-all, mass marketing approach and find out how they can make their brands more meaningful to different kinds of people. Said the professor, “[Packaged goods companies] tend to want to understand their brands, when what they really need to do is understand consumers’ lives and fit their brands into them.”

Advances in supply-chain management technology have facilitated the trend towards mass customization. As we saw above, supply chain management technology is enabling customers to buy a *completed* product directly from the manufacturer. In addition, as Chart 14 illustrates, better supply-chain management and logistics also enable customers to buy *components of that product* directly from the component manufacturers. For example, within the PC industry this trend has led to the formation of the motherboard industry as a separate segment, and the emergence of companies such as Asustek, a leading manufacturer of motherboards.

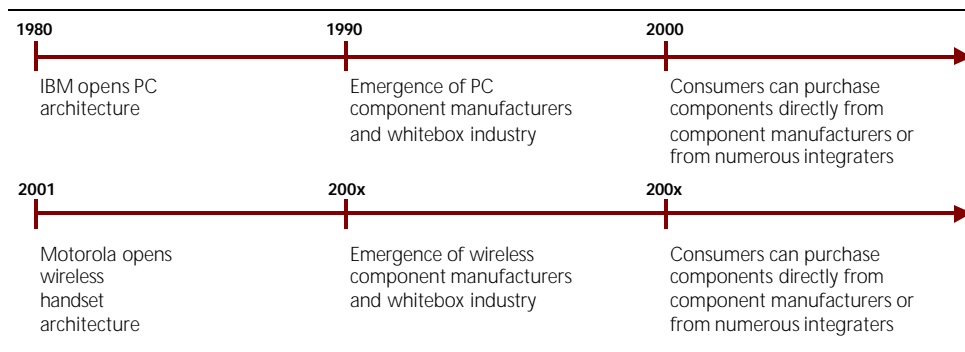
Chart 14: Advanced Interactive Pull Model



Source: UBS Warburg LLC

The ability to buy components directly from the component manufacturer can be traced back to IBM’s decision to open the PC architecture to standard components in 1980 (see Chart 15). It was that move which led to much greater choice for customers and, ultimately, mass customization in the PC sector. Today a similar shift is occurring in the wireless handset industry—in July 2001, Motorola announced that it would open its portfolio of 2.5G and 3G platforms to handset manufacturers globally. This trend toward open architecture is likely to occur in many other industries in the next few years.

Chart 15: Opening Technology Architectures



Source: UBS Warburg LLC

Mass customization is just getting under way, and will advance further as more companies seek to offer greater personalization of their products and services. The progression of mass customization will result in more choice for customers, more involvement by the end-user in design and development, and closer collaboration throughout the supply chain. As mass customization proceeds further, it will also lead to fragmentation as companies seek to differentiate their offerings.

Fragmentation

As mass customization proceeds further, it will lead to fragmentation

Fragmentation is a situation in which many companies offer many competing variations of a technology. As fragmentation occurs, two things typically happen:

- **Rapid development of additional technology.** The company that developed the new technology strives to maintain its lead through further R&D. As end-user demand for the new technology increases, that attracts new entrants who develop their own competing technologies.
- **Battle for domination.** During this period, no single firm/technology has yet gained dominance. This is typically due to end-user confusion about the “best” technology, uncertainty about future product support, and the lack of interoperability and compatibility between technologies.

Gradually, however, the non-viable technologies and unsupported platforms begin to wane, while the surviving technologies start to gain critical mass. Consolidation typically leads to a renewed period of growth for the winning technology.

Below we give three examples that illustrate three different types of fragmentation, two of which were followed by consolidation, and one of which is likely heading towards consolidation.

- **Music—Convergence onto a single technology.** In the music sector, the cassette and vinyl disc have been virtually eliminated by the compact disc, whose key advantage is that it is compatible over multiple platforms ranging from the home stereo to the office PC.
- **Networking—Almost complete convergence onto a single technology.** In the networking sector, while Token Ring and ATM still have some share of the market, the sector is completely dominated by Ethernet.
- **Unix—Unsustainable fragmentation.** No single firm gained dominance of the highly fragmented UNIX market, which gave Microsoft an opportunity to consolidate market share onto its competing Windows technology.

Music: Convergence onto a Single Technology

Over the past 100 years, technologies for capturing and distributing sound have evolved from Edison’s tin foil cylinders of the late 19th century, to cylindrical and flat recording mediums of the early 20th century, and the adoption of flat disc 78 rpm records as the standard for the first four decades of the 20th century.

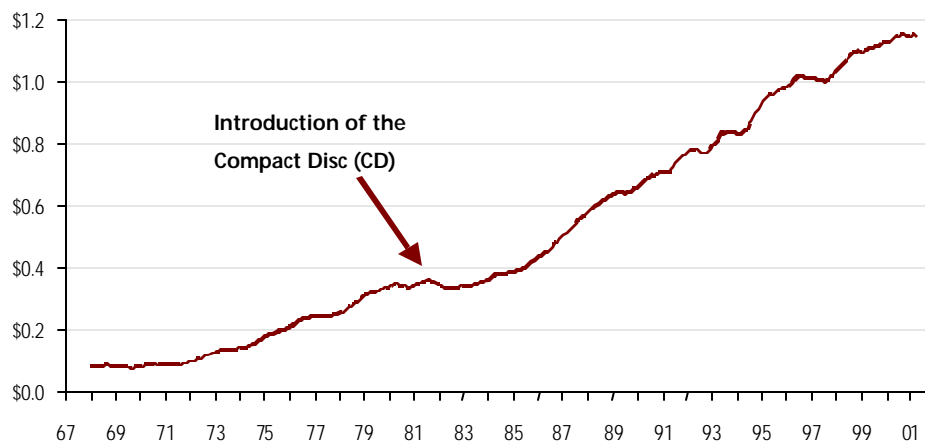
Importantly, as these technologies developed, music “penetrated” deeper into people’s everyday lives.

- First, music was introduced into the home, as the phonograph entered the living room in the early 20th century. By the 1950s, record players playing 33 rpm and 45 rpm records had become the standard for recorded music.
- The 8-track cartridge became popular in automobiles in the mid-1960s, given its simplicity of use and direct track access.
- The combination of Philips’ compact cassette and the Sony Walkman meant that consumers in the 1970s could listen to music anywhere.

Music sales experienced explosive growth after the industry converged on the CD standard

In the early 1980s, the music market was to be fragmented still further, *and in a significant way*. In 1982, the compact disc (CD) was introduced into the U.S. market. Music sales were relatively flat in the few years after the introduction of the CD (see Chart 16), but the new technology gradually won acceptance as the industry “standard.” By 1988, CD sales had eclipsed record sales, and the vinyl record began to disappear from music stores. Chart 16 illustrates that music sales experienced a period of explosive growth after the industry converged on the CD standard.

Chart 16: U.S. Music Store Sales (\$B, monthly)



Source: UBS Warburg LLC

Networking: Emergence of Ethernet Domination

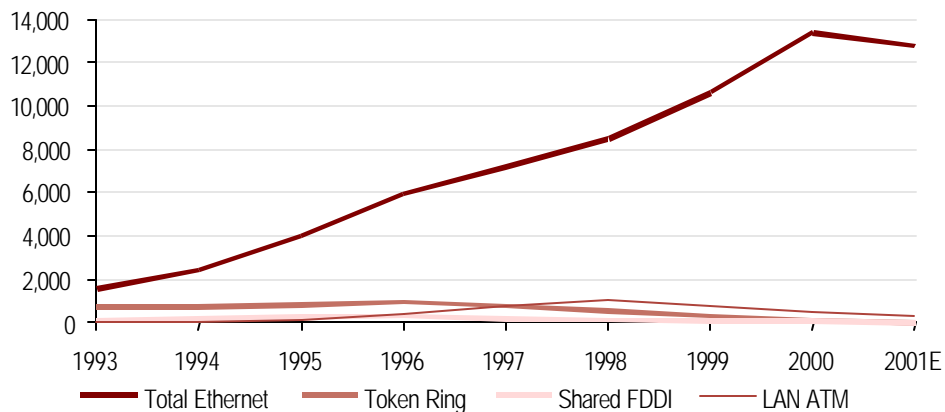
During the 1990s, as enterprise local area networks (LANs) became mission critical components of everyday business, enterprises faced a number of choices for networking their business. The most significant choices were various forms of Ethernet, Token Ring, FDDI, and ATM³. While ATM and FDDI did not have a chance to gain any significant market share in the LAN backbone market due to its cost and complexity, Token Ring and Ethernet competed for dominance for some time.

As it became clear that Ethernet would win, vendors flocked towards Ethernet

In the mid-1990s, Ethernet started to garner more vendor support due mainly to its lower cost, fault tolerance, and ease of troubleshooting advantages. As it became increasingly clear that Ethernet would win the battle, vendors flocked towards Ethernet, and Token Ring shipments waned (Chart 17). By 1999, according to industry research group Dell’Oro, “Ethernet accounted for 98% of the ports shipped and 90% of the revenues within the LAN.” Today, the various forms of Ethernet ship hundreds of thousands of ports annually.

³ Ethernet, Token Ring, FDDI, and ATM differ primarily in the way that they pass information among computers attached to the network.

Chart 17: Worldwide LAN Market, Manufacturer Revenue (\$US Millions)



Source: Dell'Oro Group

Unix Fragmentation: New Opportunities

UNIX, an operating system (OS) for workstations and servers, was created in 1969 at Bell Labs. The key advantage of UNIX over its predecessor, MULTICS, was that UNIX was simpler to use: it was the first OS written in the C language, and so was much easier to program in than earlier, low-level, assembler languages.

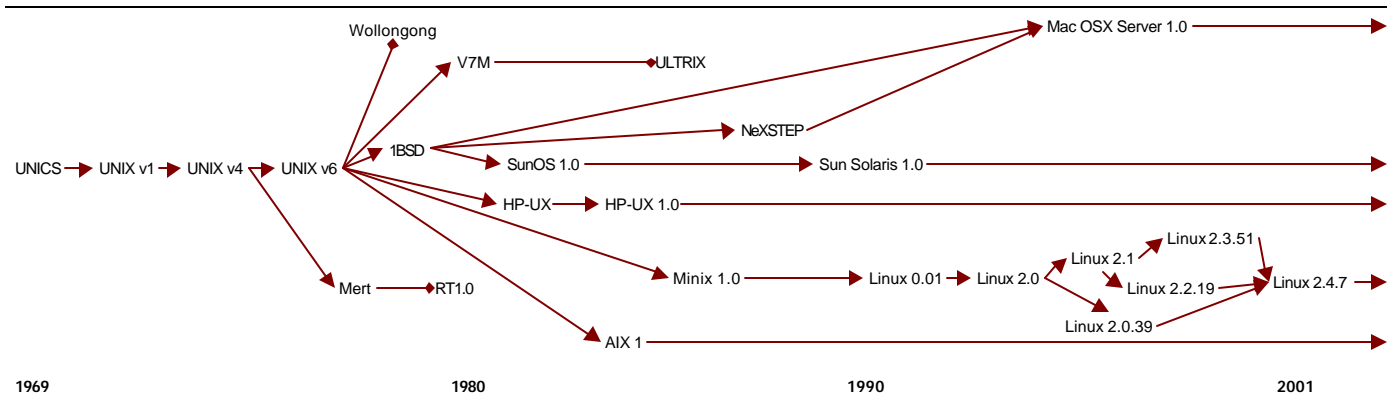
As improved versions of the OS were created in the 1970s, word spread quickly through the academic community. Then, as students familiar with UNIX were hired into the commercial world as programmers in the late 1970s/early 1980s, they introduced UNIX into the business environment. Soon a new business opportunity emerged in writing programs to run on UNIX for commercial use.

These new business opportunities led a number of vendors—including AT&T, Sun Microsystems, Silicon Graphics, Hewlett-Packard, and IBM—to create their own versions of UNIX to sell with their own proprietary hardware. During the 1980s, UNIX proliferated to a point where almost every hardware manufacturer had its own version of UNIX, and the UNIX market fragmented (Chart 18). The end result is that, today, there are a number of different versions of UNIX including Solaris from Sun Microsystems, HP-UX from Hewlett-Packard, AIX from IBM, and Tru64 UNIX from Compaq. Not all of these versions are necessarily fully compatible. However, with no single entity taking a dominant role guiding UNIX, that vacuum created a window of opportunity for Microsoft to enter the server market with NT.

UNIX proliferated to where almost every hardware manufacturer had its own versions of UNIX

UNIX fragmentation created a window of opportunity for Microsoft to enter the server market with NT

Chart 18: Partial UNIX Evolution



Source: UBS Warburg LLC and Company Reports

IBM's support is spurring technological breakthroughs and deeper Linux penetration

The emergence of a truly converged UNIX—and a serious competitor to NT—may be on the horizon with Linux. Linux is the culmination of thousands of developers working on a single OS for several years. And in the same way that UNIX was introduced to corporations by newly hired programmers, Linux, which has significant support in universities, is being brought into the business world by new hires.

A key reason why Linux has gained momentum is that hardware vendors do not have the resources to support a multitude of operating systems. Rather, they would prefer to focus resources on one or two dominant distributions. Therefore, today IBM's support of Linux is increasing Linux's competitive threat to Windows on the server. Although IBM is not controlling Linux, the amount of support that IBM is providing is spurring technological breakthroughs and deeper Linux penetration.

What made Windows successful was that it was Microsoft dominated and controlled. In the future, in order to mass customize, we will need something midway between the complete control of Microsoft and the historical total lack of central control over UNIX. Linux today has the key attributes of being both open source and having the guiding hand of IBM and others.

Tech Fragmentation Today

Key tech sectors are currently highly fragmented

As Table 2 illustrates, key tech sectors are currently highly fragmented:

- **Semiconductors**—Over the years, there has been a move from integrated device manufacturers (IDMs) to a disaggregation of the semiconductor value chain.
- **Networking**—Networks have grown from small local area networks (LANs) to vast wide area networks (WANs), metropolitan area networks (MANs), and are now encompassing personal area networks (PANs).
- **Hardware**—The number of devices has proliferated, and there is significant operating system fragmentation across and within platforms.
- **Enterprise Operations**—While the original mainframe offered all of the required computing services, today there is a host of operating systems, applications, and services to choose from.

- **Storage**—Storage has evolved from saving on a floppy disk to saving on a distributed network.
- **Connectivity**—Historically, customers had one telecom monopoly to provide their services, but today there are a multitude of providers offering services through a variety of different media and technologies.

As we discuss below, this fragmentation will lead to consolidation and ultimately the emergence of GiganTechs.

Table 2: Current Technology Fragmentation

Sector	Market Fragmentation	Tech Fragmentation
Semiconductors	<ul style="list-style-type: none"> • Fabless Design Houses, Integrated Device Manufacturers, Foundries 	<ul style="list-style-type: none"> • Process Technology: CMOS, Gallium Arsenide, Silicon Germanium, etc...
Networking	<ul style="list-style-type: none"> • Wide Area Network, Metropolitan Area Network, Local Area Network, Personal Area Network 	<ul style="list-style-type: none"> • SONET, ATM, Ethernet, Frame Relay, 802.11, Bluetooth
Hardware	<ul style="list-style-type: none"> • PC, Mobile Phones, PDAs, Pagers 	<ul style="list-style-type: none"> • OS fragmentation across all platforms and within each platform
Enterprise Operations	<ul style="list-style-type: none"> • Operating System • Application Software • Enterprise Software • IT Services 	<ul style="list-style-type: none"> • Operating System: UNIX, Windows • Application Software: XML, PDF, MPEG, etc... • Enterprise Software: ERP, SCM, CRM, etc... • IT Services: Web Services
Storage	<ul style="list-style-type: none"> • Storage Area Network, Network Attached Storage 	<ul style="list-style-type: none"> • Fiber Channel, iSCSI, Infiniband, Ethernet, etc...
Connectivity	<ul style="list-style-type: none"> • Telecom Operator, ISP, Wireless Operator, Cable • Wireless Operators: Global, Regional, Local 	<ul style="list-style-type: none"> • Cable, Copper, Fiber, Wireless • Wireless Networks: GSM, CDMA, TDMA, AMPS, PDC, etc...

Source: UBS Warburg LLC

Technology Penetration

Initially, fragmentation is virtuous because it leads to deeper tech penetration

One key implication of fragmentation is incompatibility. However, another implication is *deeper tech penetration*. As technology becomes more fragmented, there is, by definition, more technology for customers to choose from. And as technology evolves via fragmentation and becomes easier to use, it penetrates deeper into (i) physical products, (ii) the DNE, and (iii) society.

Penetration into Physical Products

As in the early days of the PC, the mechanical functionality in cars is increasingly being replaced by electronics—semiconductor integrated circuits (ICs). In addition, cars are becoming crammed with ICs for:

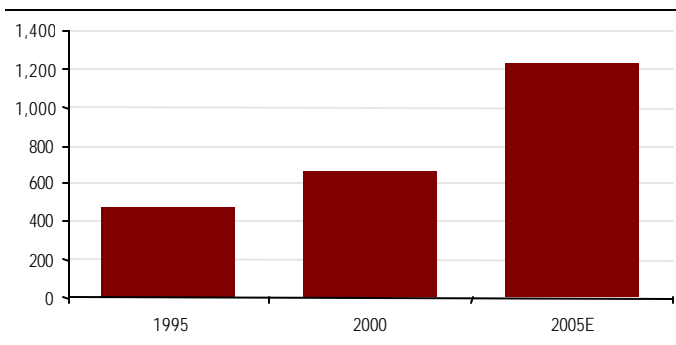
- Engine management systems;
- Surveillance, anti-theft, and security services on call;
- Advanced navigation and GPS;
- Mobile communications and Internet access;
- Advanced entertainment systems;
- Radar proximity warning system; and
- Traffic-control and information systems.

Electronics is where a carmaker adds value to a vehicle today

Indeed, the *Financial Times* recently (August 4, 2001) noted that, “If there was a button or knob to control every system in the new [BMW] 7-Series, there would need to be 700 of them. *Electronics, magically simplifying this, is where a carmaker adds value to a vehicle today.*” [Our italics.]

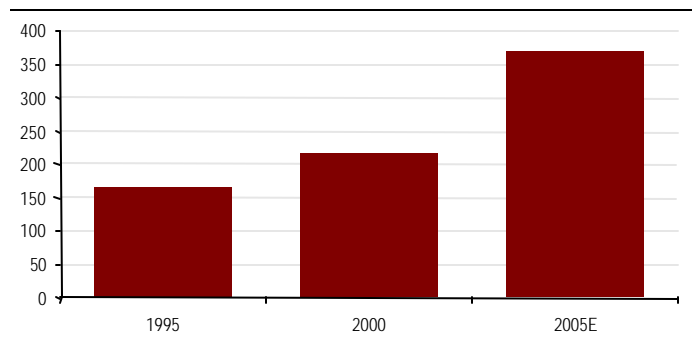
Total worldwide automotive vehicle production is forecast to increase from 48 million vehicles in 1995 to 61 million vehicles in 2005, a compound annual growth rate (CAGR) of 2%. However in the same time period, the automotive electronics chip count will increase from 477 to 1,231 per car on average (Chart 19), a CAGR of 10%, while the dollar value of automotive electronics semiconductor content will grow from \$167 to \$370 per car on average (Chart 20), a CAGR of 8%. So the IC market for automobiles will grow about four times faster than the automobile industry itself.

Chart 19: Automotive Electronics Chip Count (per car, on average)



Source: Semico Research

Chart 20: Automotive Electronics Semiconductor Content (per car, on average, US\$)



Source: Semico Research

Most of the technologies currently in cars are proprietary, with their own embedded processors and man-machine interfaces. But since there is a growing need to have architectures that facilitate interaction, standards have recently been introduced—although not yet agreed upon—for communications and multimedia platforms. Some companies (i.e., Intel and Microsoft) have argued strongly that in order to increase interaction between applications both inside and outside the car, it is important for in-car technologies to move to PC-type architecture and operating systems.

Processing for natural language speech recognition is critical for new auto applications

Currently the dominant processor architecture in cars is the Hitachi SH processor, although Intel has been pushing heavily for the Pentium architecture to be used. In addition, ARM and NEC both have architectures that are competing in this space. It remains to be seen which architecture will win. However, one key factor that will likely be an important determinant of the winning architecture will be the ability to process natural language speech. As we noted above, there are increased requirements in terms of processing, memory, and storage for the natural language speech recognition applications that will replace today’s limited voice-command technologies.

Penetration into the DNE

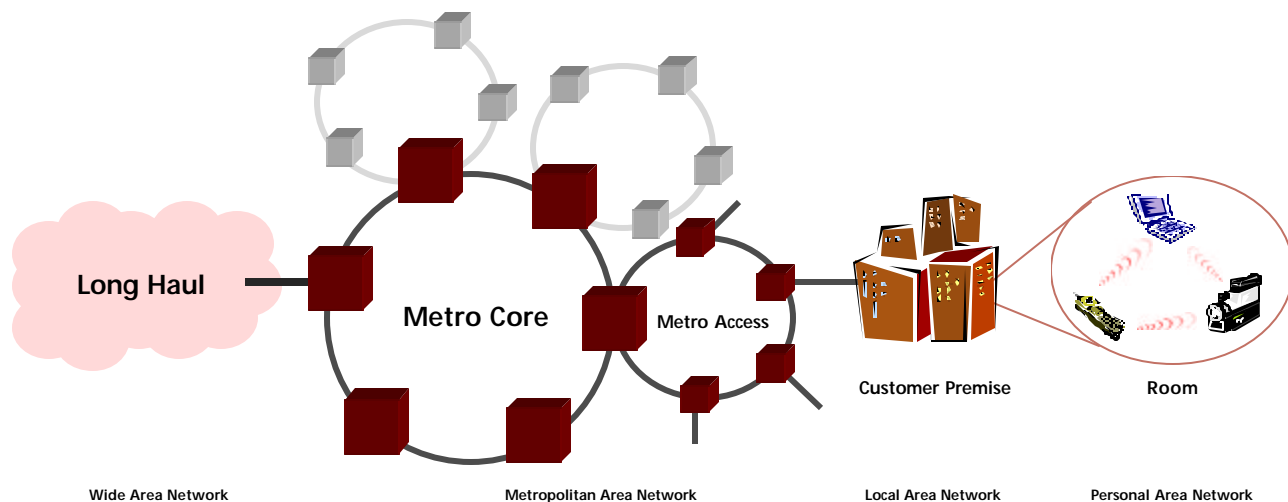
The networks of the world are increasingly becoming interconnected and interoperable. This trend will continue with the build-out of the DNE, as the wide area network (WAN), metropolitan area network (MAN), local area network (LAN), and personal area network (PAN) blur into a seamless entity (Table 3, Chart 21).

Table 3: WAN, MAN, LAN, and PAN

Network	Network Size	Network Span
Wide Area Network	100 km – 10,000 km	Country, Continent
Metropolitan Area Network	5 km – 100 km	City
Local Area Network	10 m – 5 km	Room, Building, Campus
Personal Area Network	1 cm - 10 m	Person, Room

Source: UBS Warburg LLC

Chart 21: WAN, MAN, LAN, and PAN



Source: UBS Warburg LLC

The WAN and LAN have been built out significantly in the past decade. Large telecommunications carriers have spent billions of dollars laying fiber across the globe to build out the WAN. And enterprise adoption of evolving Ethernet networking technologies has contributed to the creation of high-speed LANs.

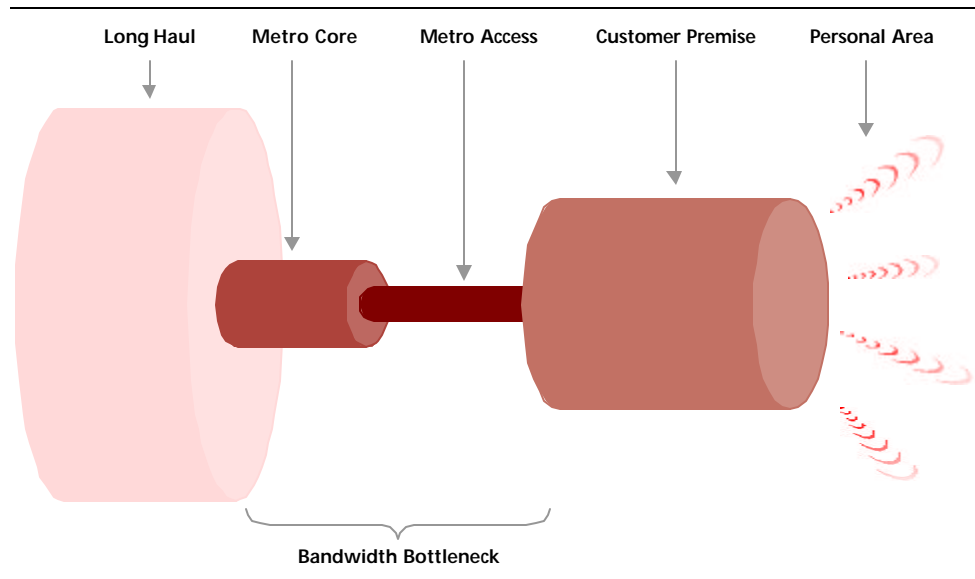
In the past few years the MAN has started to be built out. The introduction of DSL and cable modems in residential access markets has contributed to the first steps towards broadband connectivity. Enterprise access is being developed through advanced optical technologies which offer very high speed connectivity to those enterprises with access to fiber in the MAN. However, as the MAN is being built out, the fragmentation among standards and protocols is becoming more pronounced. As we noted in *“The Metro Market Wars”* (May 22, 2001),

MAN fragmentation among standards and protocols is becoming more pronounced

“With the alphabet soup of standards and protocols awash in the MAN market, equipment vendors need to support multiple protocols. Customers have, and will continue to use, many different legacy systems. Carriers continue to provide X.25, Frame Relay, SONET, ATM, MPLS, GigE, and others in a very heterogeneous networking environment.”

However, the current DNE infrastructure is not able to provide the bandwidth necessary for today, much less the traffic growth of coming years. As Chart 22 illustrates, the metro core and metro access markets are the sources of greatest congestion. Consequently, there is a significant opportunity for service providers to offer their customers connectivity, which is spurring the current build-out of the metro area network.

Chart 22: Bandwidth Bottleneck



Source: UBS Warburg LLC

The PAN will begin to be built out in the next few years. Bluetooth and wireless LAN technologies will spur the proliferation of personal area networks. Again, in the wireless LAN market, there is fragmentation among competing technologies such as 802.11a, 802.11b, 802.11g, and HiperLan2. These technologies are currently being introduced in certain markets. For example, synchronization between a PDA and a notebook computer is possible today via Bluetooth. In the near future, PANs will allow for information to be transferred wirelessly and seamlessly between all devices within close physical proximity.

Penetration into Society

Once a technology becomes socially acceptable, adoption and penetration rates increase

As technology weaves its way into the fabric of society and becomes socially acceptable, it can change social norms. For example, ten years ago, who would have thought of sitting on a train and using a mobile phone to order a take-out dinner to be picked up at the destination? And once a technology becomes socially acceptable, adoption and penetration rates increase. Several years ago, when people started using personal e-mail, they began to give their e-mail address as a contact point for their friends. This in turn encouraged their friends to get their own e-mail accounts.

Consolidation

Deeper tech penetration will further advance the development of the DNE. However, as high-tech companies build out their portfolios, they are faced with several challenges:

- technology is becoming more complex;
- the pace of technological change is accelerating;
- technology is penetrating into every facet of corporate enterprises and is becoming mission critical; and
- technology increasingly needs to be compatible and interoperable.

Given these challenges, high-tech research and development is requiring more resources such as advanced facilities, highly skilled talent, and legal support for the protection of intellectual property. These requirements illustrate the need for access to capital and scale.

Companies that first gain critical mass in the DNE will be able to establish the dominant technology

The companies that first gain critical mass in a portion of the DNE will be in a strong position to establish the dominant technology in that sector. And once customers on a wide scale have adopted those dominant technologies, market share should quickly consolidate in the hands of the leaders, as the fragmented sub-segments converge onto their technologies.

Of course, consolidation and concentration of market share in the hands of a few players have occurred throughout the history of the tech industry. So what's different this time? What's different is that, because of the trends of customer empowerment and mass customization, today there is *even greater fragmentation* in the tech sector. Therefore, by definition, there will have to be *even greater consolidation*. Ultimately, this means that even more market share will be concentrated in the hands of a few companies—the GiganTechs. Below we discuss the likely patterns of consolidation in the six key sectors of the DNE identified in Table 2.

Intel and Texas Instruments dominate the lion's share of the IDM market

Semiconductor Consolidation: Flight to the Foundry

Previously the semiconductor industry had a multi-tier structure with a handful of “tier 1” integrated device manufacturers (IDMs—vertically integrated chip companies that do their own manufacturing), such as **Intel** and **Texas Instruments**, dominating the lion's share of the market. These two companies have consolidated their position in recent years, and we view them as the clear IDM GiganTechs in the semiconductor industry. Numerous smaller IDMs continue to fight for the remaining market share.

However, in the past several years, we have also witnessed the emergence of dedicated foundries. A foundry is a contract manufacturer of semiconductors that builds customers' chips to order. As a result of the foundry model, there has emerged a growing distinction between the two key processes in the semiconductor industry:

- *Design*: There are companies solely focused on the design of semiconductors. These companies are called “fabless” design houses.

- *Manufacture:* The core competence for foundries is process technology for manufacturing of semiconductors. Foundries allow fabless design houses to outsource their manufacturing.

The foundry model disaggregates the once vertically integrated semiconductor value chain. In eliminating the high barriers to entry for the semiconductor industry, the foundry model allows for many design innovations that are necessary to meet the demands of empowered customers.

Bluetooth provides a good example of how fabless design companies are able to have innovative designs manufactured without incurring huge fixed startup costs. The foundry model and concomitant process technology innovations are allowing fabless integrated circuit (IC) design companies such as Alcatel, Broadcom, Cambridge Silicon Radio, Transilica, and Zeevo to focus on their core competencies in design to deliver Bluetooth solutions.

As mass customization drives the semiconductor industry to create distinct solutions at the affordable prices that allow for deeper technology penetration, “process innovation leadership” and “process cost leadership” both become critical. There are two camps that are driving process innovation leadership and process cost leadership: **Taiwan Semiconductor**, and the WorldLogic Process Alliance comprising UMC, IBM, and Infineon. The Taiwan Semiconductor 0.18-micron RF (radio frequency) CMOS (complementary metal-oxide semiconductor) fabrication process is an example of process innovation leadership that enables Bluetooth chips to be made by foundries. The CyberShuttle program, originally known as Multi-Project Wafer, is an example of process cost leadership, as it empowers IC designers to leverage leading-edge process technology without committing to large volume wafer starts.

Today, the foundry industry is moving from a growth market to a mature market where the industry is becoming more crowded and competition is intensifying. Increased competition will lead to more price competition and lower margins overall in an industry that is capital intensive and depends on a high return on sales. Differentiation among foundries first and foremost will focus on process innovation leadership and process cost leadership. In this hyper-competitive market, there will be a flight to quality, and orders will likely migrate to entrenched incumbents, i.e., GiganTechs such as **Taiwan Semiconductor**.

Intel and **Texas Instruments** maintain their dominant positions as IDM GiganTechs primarily through leading-edge technologies, mass-market economics and marketing prowess (including strategic alliances). For example, with the advent of **Intel’s** Itanium microprocessor, and Itanium’s next generation microprocessor—code-named McKinley—Intel should further consolidate its position in the enterprise multi-processor server industry. Itanium will be cost-competitive versus other 64-bit microprocessors, and will allow Intel to leverage mass-market economics as it enters the 64-bit microprocessor market, to the probable detriment of existing competitors in that market. As for strategic alliances, McKinley will have the support of Microsoft’s Windows, as well as other 64-bit software: HP-UX Unix, Linux, Novell’s Modesto, etc.

Orders will migrate to entrenched incumbents such as Taiwan Semiconductor

Texas Instruments' OMAP (open multimedia application platform) is a leading software development protocol platform for 2.5G and 3G wireless devices (that runs on the TI TMS320 DSP family). The first generation OMAP architecture includes a high level of system integration (i.e., the chip is small and has low power consumption), and a rich peripheral set (e.g., support of Bluetooth, USB, etc.) that will run multimedia applications like streaming video, video conferencing, and high-fidelity audio. Given that the OMAP architecture has been selected by major OEMs such as Ericsson, Nokia, Sendo, and Sony, it is poised to become one of the leading standards for next-generation wireless devices.

Applied Materials has critical mass and global infrastructure

Today, semiconductor companies are in the process of shifting their manufacturing from aluminum to copper technologies, migrating circuit lines from 0.18 micron to 0.15 and 0.13 micron, and changing silicon wafer production sizes from 8 to 12 inches. As they make these transitions, research and development becomes increasingly expensive for semiconductor capital equipment manufacturers. **Applied Materials**, the widely acknowledged GiganTech of the capital equipment sector, has the critical mass and global infrastructure to fund the research and development needed to develop a broad production solution.

Networking: Connecting from the WAN to the PAN

As discussed above, the networks of the world are increasingly becoming interconnected and interoperable. This trend will continue with the build-out of the DNE, as the wide area network (WAN), metropolitan area network (MAN), local area network (LAN), and personal area network (PAN) blur into a seamless entity. The challenge for companies enabling these networks is allowing the devices on the edges of the networks to communicate.

- The long-haul WAN will continue to be developed with fiber. This will allow for the continued advancement of dense wavelength division multiplexing (DWDM) systems, which will allow protocol-independent traffic (i.e., video, voice, data, etc.) to travel across the WAN. These new multiplexing technologies will be combined with the increasing capacity of optical fibers, and the emergence of all optical systems.
- The LAN will grow in both business and residential settings. Users will continue to utilize Ethernet in wired and wireless configurations. As fiber is brought closer to the home, individuals will begin to adopt home networking to connect computers and appliances to the DNE. As usage increases and traffic grows, the issue of interoperability and standards will become increasingly important.
- While the MAN may be the bandwidth bottleneck of 2001 (i.e., the bottleneck is currently between the customer premise and the long-haul—Chart 22), it is also the area of greatest growth. As the MAN is built out with advanced fiber, it will slowly begin to resemble a combination of the WAN (with DWDM technologies) and the LAN (with Ethernet technologies).
- The network that is mostly in its infancy today is the PAN. The personal area networks will develop with the adoption of wireless technologies such as Bluetooth. This will enable the various connected devices on each individual (i.e. digitally networked clothes, watches, jewelry, etc.) to communicate with the DNE at all times.

It is critical for networking companies to provide an end-to-end solution

Each of the networks above will not develop independently; rather they will evolve together to form the physical infrastructure for connecting the DNE. The protocols and technologies chosen for upgrading any one of the networking segments will be highly dependent on upgrades in the other three network infrastructures. This is why it is critical for networking companies to be able to provide an end-to-end or technology-agnostic solution.

Cisco will likely continue to dominate the networking market

There will only be a few companies that will be able to equip networks spanning much of the WAN, MAN, LAN, and PAN. **Cisco**, as the GiganTech in networking, will likely continue to dominate the networking market, because it has the broadest depth of technologies from the WAN through the PAN. And where there are gaps in Cisco's portfolio, the company has tremendous financial resources to fill the gaps through acquisitions or research and development.

Hardware: Intelligent Devices in the DNE

Connecting to the DNE will be a multitude of intelligent devices: PCs, handsets, PDAs, cars, etc. Again, interoperability and compatibility will be necessary if these devices are to communicate with each other across the DNE. This, in turn, means that standards will have to be established to permit seamless communication between hardware devices. Standardizing the actual hardware is not enough to ensure interoperability—the software and the communications platforms also need to be compatible.

However, as we mentioned above, PVA technologies such as George will be far too complex, and will require too much processing, memory, and storage, to operate within a device such as a mobile phone. So the actual processing and intelligence for PVAs such as George will reside mainly on servers or mainframe computers located in a mobile operator's data center. In this regard, there are three key trends of the future that have important implications for hardware in the DNE:

Recentralization, Open Architecture, and Proliferation will drive hardware in the DNE

- **Recentralization.** As the DNE is developed, processing and intelligence will be recentralized (i.e., consolidated) away from client devices and onto servers.
- **Open Architecture.** In order to ensure interoperability and compatibility, the hardware and the software of the DNE will be based on "open" architectures including Linux, XML, SOAP, etc.
- **Proliferation.** While recentralization means that processing and intelligence will go back to the core, proliferation means that enough technology will penetrate into all devices, so that those devices will be able to communicate seamlessly across the DNE.

GiganTechs that should thrive in this environment are:

- **IBM**, which dominates the mainframe market with a 97% market share. Recently, IBM has made a technological breakthrough that enables mainframes to take on PC server farms. Instead of having a PC server farm run thousands of Linux PC servers at once, IBM's partitioning of mainframes to run Linux Virtual Machines allows a single mainframe to accomplish the same task. IBM is also delivering similar partitioning and superior performance on its new high-end Regatta Unix servers.

- **Nokia**, which already has the largest global market share (35%) in mobile handsets, and is one of the world's most recognized brands, being ranked number five in the 2001 Interbrand survey. And in the Brand Keys survey of consumer expectations, Nokia ranked among the top three brands that most consistently met consumer expectations.
- **Sony**, which is already designing more technology into its devices—Playstation video games, TVs, digital video recorders, stereos, etc.—allowing those devices to interconnect and share information and content.
- As leading electronic manufacturing service (EMS) companies, **Celestica** and **Flextronics** are key beneficiaries of the two themes of “open architecture” and “proliferation.” The manufacturing efficiencies and lower costs that **Flextronics** has to offer will facilitate technological proliferation, which also benefits Flextronics as the most vertically integrated EMS. As technology increasingly moves towards open architectures, the superior design capabilities of **Celestica** will allow their customers to differentiate their products.

Enterprise Operations: Global End-to-End Solutions

The enterprise operations sectors provide the intellectual infrastructure that enables companies to operate on a daily basis. This infrastructure consists of software (including operating systems and applications) and services. Large companies are increasingly demanding end-to-end solutions from software and service providers. Therefore the ability for software and service companies to provide “scope,” or end-to-end solutions, is critical. In addition, having a single open platform—including operating systems and services—enhances the value of scope. Having intellectual property also makes that platform defensible.

Scope, or end-to-end solutions, is critical in providing software and services

There are a small number of companies that will be able to compete across all software and service segments, and a number of smaller companies that will be able to leverage their core competence in niche areas.

The GiganTechs in these markets should be **Microsoft** and **IBM**. Microsoft is a leader in software, and is using this leading position to migrate its customer base to a recurring revenue “software as service” model. (Future versions of MS Office will reside on a central server and will be “pay as you go.”) On the other hand, **IBM** is using its leadership position in services to increase penetration of its technology by surrounding the hardware with software and services.

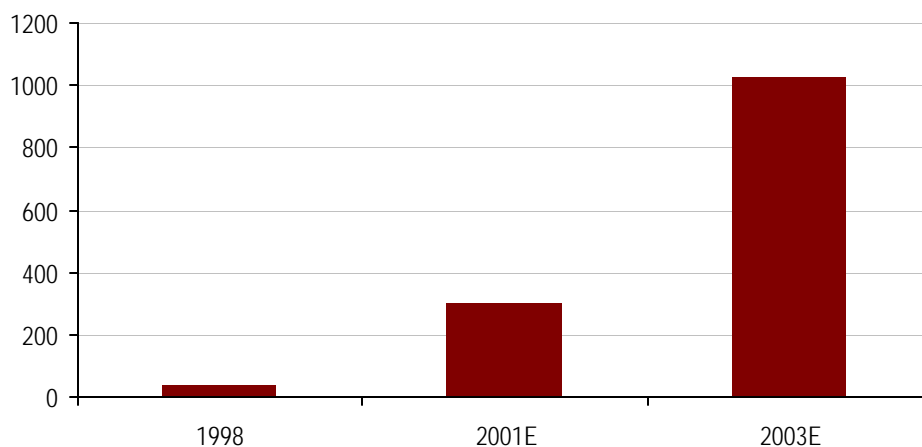
These two GiganTechs will likely be the most dominant firms in the enterprise operations sector. The sub-segments that IBM and Microsoft do not focus on as core competencies will be open for niche players to dominate.

As the DNE gets built out, storage needs are going to escalate

Storage: Time to Terabyte

As the DNE gets built out, every user, corporate or consumer alike, is going to need more and more storage. With technology penetrating deeper into our lives, intelligent devices beginning to communicate among themselves (e.g., vending machines sending out refilling alerts to inventory control systems in warehouses), and end users becoming the creators (not just consumers) of content (e.g., video mail), storage needs are going to escalate. Indeed, in evaluating storage requirements enterprises are now beginning to think in terms of terabytes. Chart 23 shows the median corporate storage capacity in terabytes based on a sample of the 2,000 largest global companies in the fall of 2000. Large companies' storage needs are expected to triple from 300 terabytes in 2001 to 1024 terabytes in 2003.

Chart 23: Median Corporate Storage Capacity (terabytes)



Source: Storage Networking Industry Association

A key factor driving storage needs is that given customer empowerment, data delivery and presentation is also being mass customized. End users are demanding whatever information they want, whenever they want it, wherever they want it, and in whatever format they want it. An example of this is receiving personalized stock quotes on a mobile phone, a PDA, a desktop computer, or at home on an HDTV system. The stock quotes will need to be moved quickly between storage (where the data resides) and servers (where applications run). Furthermore, in the DNE of the future, transactions (such as e-commerce, m-commerce, or interactive CRM) will likely be conducted over several heterogeneous systems and through a variety of different formats—data, voice, video. This will entail even greater storage needs.

The same issues of interoperability and compatibility across multiple systems will drive the need for open storage platforms and open storage Application Program Interfaces (APIs). Ultimately, to provide ubiquitous access to storage it is likely that traffic will converge on a single protocol over IP networks regardless of the physical medium. In order for this convergence to happen, **Cisco** is working with **IBM** to formulate and propose the iSCSI protocol, or SCSI (small computer systems interface) over IP. Today, there are over 250 companies actively driving iSCSI towards draft-standard status in the IETF (Internet Engineering Task Force).

In order to access the DNE, society will need to be “reconnected”

Connectivity: *Reconnecting to the DNE*

As mentioned above, in order to be attached to, and leverage the capabilities of, the DNE, it will be necessary for society to be “reconnected” (wired or wirelessly). Service providers will need to offer new forms of access to customers, such as “fiber-to-the-home,” “fiber-to-the-building,” and high-speed wireless networks.

For companies to succeed as they reconnect customers to the DNE, it will be necessary for them to dominate in three key areas:

- **Coverage**—Service providers must have the physical infrastructure reaching from the long-haul to the last mile.
- **Value-added Services**—Offering real-time interactive video, voice, data, content, and application services to corporate and residential customers.
- **Quality of Services**—Ability to guarantee transmission of the services in service level agreements (SLAs) through service level management. This requires the ability to integrate new technologies into existing infrastructures.

Controlling these three key areas ensures that a service provider will control the connectivity value chain from the physical infrastructure to the delivery of value-added services over that infrastructure.

Reconnecting the world will require abundant capital and global scale

As the world is *reconnected*, this huge undertaking will require abundant amounts of *time* and *capital*. Clearly, relatively young and poorly funded companies (such as CLECs) are not in a position to undertake such huge projects. Neither are established companies that are losing market share in key parts of their business (e.g., many of the U.S. long distance companies). Those firms that can undertake such projects are well established, cash-flow positive companies *that can reap economies of scale on a global basis*. (And, as we noted above, global scale is now possible thanks to deregulation in the communications sector.)

In the fixed line access market, GiganTechs will likely include:

- **AOL Time Warner**, which can use its own broadband network to distribute its own proprietary applications and content such as downloaded music, interactive television applications, streaming news, online shopping, and video on demand.
- **Qwest**, which has an extensive next-generation long haul network. The company is able to cater to large enterprise customers given its full suite of IP/data products, and it also has a local customer base following the US West acquisition.

GiganTechs in the wireless access market should include:

- **China Mobile**, which has the deepest penetration into the largest wireless addressable market in the world.
- **NTT DoCoMo**, the only company in the world that dominates the wireless value chain (i.e., from handsets to infrastructure to content) in a major market.
- **Vodafone**, which has the largest wireless footprint in Europe, and the largest wireless global penetration through alliances with Verizon, Japan Telecom, and China Mobile.

Finally, note that, while these companies are likely to dominate the *global* access market, government regulation will likely ensure that there are a number of *local* companies with strong *regional* franchises.

GiganTechs

Once a company has emerged as a GiganTech, it is critical that the GiganTech focus on consolidating its position. This can be done in three ways:

- strategic alliances;
- moving into adjacent technology markets; and
- moving deeper into existing markets through the pursuit of mass customization.

Strategic Alliances

GiganTechs can use strategic alliances to strengthen their position

The goal of high-tech strategic alliances generally is to foster interoperability and compatibility through standards. Standardization leads to compatibility among designs which allows for more development by third parties, and therefore deeper technology penetration. The advantages of strategic alliances for GiganTechs are:

- leading the standardization process, which should ensure a future for their new technologies;
- expanding into cross-border and cross-sector business opportunities; and
- influencing the composition of the alliance itself, and the future of the alliance members.

Examples of GiganTechs currently leveraging strategic alliances:

- **Cross-Border Alliance: Vodafone and China Mobile** recently formed an alliance to create a global mobile platform. This alliance will move China Mobile one step closer to becoming a global wireless multimedia service provider. And the alliance gives Vodafone access to the huge and rapidly growing Chinese mobile market.
- **Cross-Sector Alliance: Intel and Cisco** have joined together in an alliance to promote each other's Gigabit networking kit, providing extended technical support and discounted hardware deals. The marketing partnership will integrate Cisco's Gigabit Ethernet switches, Gigabit interface converter, and line card with Intel's adapters. The advantage of this alliance is that the companies are able to leverage each other's unique customer base, while the customers are able to enjoy lower costs and greater support.
- **Cross-Border and Cross-Sector Alliances:** This year **IBM** signed new agreements with major software players including SAP, JD Edwards, and SAS Institute as well as 42 niche market leaders. These alliances are generating market share and revenue—over \$1 billion year-to-date. The alliances generated \$750 million in revenue to IBM in 2000, the initiative's first full year.

In the area of strategic alliances, once again, scale matters. This is because GiganTechs have more resources than smaller companies and are therefore able to be involved in more strategic alliances and at a much deeper level.

GiganTechs can leverage their dominant position into adjacent markets

Moving into Adjacent Markets

As the consolidation process outlined above takes place, it not only changes the balance of power among existing competitors, it also opens up opportunities for GiganTechs to move into adjacent markets, and try to become dominant in those sectors.

Intel is currently moving into the communications markets in several ways:

- **Fixed Communications:** Intel is promoting a development platform for computer telephony called the Intel Converged Communications Platform (ICCP). This is targeted at the Computer-Telephony-Integration market.
- **Wireless Communications:** Intel has also entered the handheld mobile processor market with its XScale microarchitecture.
- **Fixed and Wireless Communications:** Intel has entered the voice-processor chip market, and voice-over-packet chip markets. These chips translate the human voice into digitized information that can be transmitted over digital networks.
- **Memory for Communications:** Intel is the leading player in the market for flash memory used by mobile phone manufacturers.

Moving Deeper into Markets

Just because a company has emerged as a GiganTech, there is no guarantee that it will remain a GiganTech. To the contrary, as the pace of technological change accelerates, threats will continuously emerge to challenge a company's dominant position. The greatest threat is through commoditization. The reason for this is that as the process outlined above unfolds, and as technologies become standardized, barriers to entry are lowered. So for example, as the PC monitor industry moved to a standardized product, it became tougher for companies to differentiate themselves and maintain profitability.

The best response to the threat of commoditization is mass customization

The best response to this threat is mass customization. As we discussed above, mass customization involves the development, manufacture, and sale of very individualized products on a mass scale. Mass customization creates barriers to entry because as the product or service gets more customized, it is harder for a new entrant to replicate.

September 4, 2006

I take a last question from the Tokyo audience about “how GiganTechs will continue to benefit now that the DNE is largely built out.” George reminds me that the car to pick me up for the airport is already waiting at the exit behind the speakers’ box. As my concluding comment to the Tokyo audience, I note that my speech about the emergence of GiganTechs has been both a historical analysis and a perspective of what is yet to come. In other words, customers back in 2001 were just tasting customer empowerment and only beginning to see the potential of mass customization. By contrast, today in 2006, we are able to savor and leverage both customer empowerment and mass customization, given the DNE build-out of recent years and advances in human user interfaces. The major constraints holding back the new Information Age have finally been removed.

Table 4: GiganTechs

Company Name	Ticker	UBSW Recommendation	Price as of 08/30/01	UBSW Analyst	Analyst e-mail
AOL Time Warner ¹⁴	AOL.N	Strong Buy	US\$36.00	Christopher P. Dixon	christopher.dixon@ubsw.com
Applied Materials Inc. ¹	AMAT.O	Hold	US\$43.10	Byron N. Walker	byron.walker@ubsw.com
Celestica, Inc. ¹⁴	CLS.N	Not Rated	US\$36.62		
China Mobile (HK) Ltd ²	0941.HK	Hold	HK\$25.00	Dylan Tinker	dylan.tinker@ubsw.com
Cisco Systems Inc. ^{1, 14}	CSCO.O	Buy	US\$16.01	Nikos Theodosopoulos	nikos.theodosopoulos@ubsw.com
Flextronics International ^{1, 14}	FLEX.O	Not Rated	US\$22.27		
IBM Corp. ^{2, 14}	IBM.N	Strong Buy	US\$100.36	Don Young	don.young@ubsw.com
Intel Corp. ¹	INTC.O	Not Rated	US\$27.13		
Microsoft Corp. ¹	MSFT.O	Strong Buy	US\$56.94	Don Young	don.young@ubsw.com
Nokia	NOK1V.HE	Buy	€16.35	Jeffrey A. Schlesinger	jeffrey.schlesinger@ubsw.com
NTT DoCoMo	9437.T	Buy	¥1,450,000.00	Kate Lye	kate.lye@ubsw.com
Qwest Communications	Q.N	Not Rated	US\$20.65		
Sony	6758.T	Hold	¥5,590.00	Masahiro Ono	masahiro.ono@ubsw.com
Taiwan Semiconductor ²	2330.TW	Buy	NT\$63.00	William Dong	william.dong@ubsw.com
Texas Instruments Inc.	TXN.N	Not Rated	US\$32.99		
Vodafone Group ¹²²	VOD.L	Strong Buy	135.00p	Daniel Stillit	daniel.stillit@ubsw.com

Source: UBS Warburg LLC

Prices of companies mentioned as of August 30, 2001:

Alcatel	145	CGEP.PA	€7.18
Asustek Computer Inc.		2357.TW	NT\$105.50
AT&T Wireless Group Inc.	2	AWE	US\$14.89
Broadcom Corp	1	BRCM	US\$30.96
CANTV		TDVd.CR	Bs2,225.00
Compaq Computer		CPQ	US\$12.69
CTC A		CTCa.SN	CLP2,110.00
Dell Computer Corp	1	DELL	US\$21.13
Deutsche Telekom	2	DTEGn.F	€6.94
General Mills Inc.	2	GIS	US\$44.02
Hewlett-Packard		HWP	US\$23.40
Hitachi		6501.T	¥1,108.00
Japan Telecom	122	9434.T	¥373,000.00
Motorola Inc.	2	MOT	US\$17.20
Nike Inc. CI B		NKE	US\$49.51
Philips Electronics		PHG.AS	€9.46
SAP		SAPG.F	€49.00
Sun Microsystems	1	SUNW	US\$11.07
Telefonica		TEF.MC	€2.70
Verizon Communications	2,57	VZ	US\$50.23
Yahoo! Inc	1	YHOO	US\$11.32

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57. UBS Warburg LLC is acting as co-manager in underwriting securities of Verizon Wireless.

122. UBS Warburg Ltd is advising Vodafone with regard to the restructuring of J-Phone Group wireless units.

145. UBS Warburg Ltd acted as co-lead in the initial public offering of Nexans shares.



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