I

GETTING STARTED IN TECHNOLOGY

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TECHNOLOGY BASICS

Technology is a word jammed with meanings. And through the years, it's been philosophized more than you might imagine. Martin Heidegger regarded technology not just as a mechanical process, but a "bringing forth," a ". . . mode of revealing. Technology comes to presence in the realm where revealing and un-concealment take place . . . where truth happens" (319).

Wow! Who knew a simple guide to Tech investing could lead us to the nature of truth itself! Well, we're not going to be quite that ambitious for this book, but it is important to realize technology captures our imagination more than most types of industry. Tech is virtually omnipresent in our greatest hopes and deepest fears about civilization. For every rapturous fantasy we have about flying cars and curing diseases, there are dystopic visions of tech run amok like the Terminator or Darth Vader.

The public has a romantic relationship with technology—sometimes as spiritual and potent as religion. The last years of the 1990s are quintessential—we collectively dispensed with the notion of economic cycles altogether and declared a "new economy" on the wings of savior technology. Conversely, even today we shudder to think of the awesome power of nuclear technology, of robotic soldiers and drone planes—forces seemingly too powerful to control, capable of inducing real Armageddon.

In short, technology carries potent emotional impact—and you'll do well to remember that when investing in it. The romantic vision of technology and successful investing in it are two different matters entirely.

MORE THAN GADGETS . . . A MEANS

Still, context about technology as an idea is important before we go further. Ultimately, a technology is a means to fulfill some purpose. So it may not just be chips or phones or other "gadgets." Technology gets to the heart of human progress. A refined or new math equation is a technology—perhaps a new algorithm suddenly allows a trader to capture and profit from some inefficiency never possible on a derivatives trading desk; or an engineer discovers a simpler, more elegant equation to increase the number of transistors on a microchip, expanding processing power and thus what can be achieved by others still. Both are technologies. Processes are technologies, too—after all, what is software but a process, and what do we call Microsoft's Windows software if not a technology?

Brian Arthur describes technology as capturing natural phenomena and putting them to use. This is done—always—by combination. A new technology is a combination of elements that already exist. That makes tech *recursive*—all devices consist of technologies within technologies. A microchip, for instance, functions as a computer's "brain." But you can break down a chip into its transistors and diodes (all separate technologies in themselves). And you can also trace a chip's functionality all the way down to its most basic features until, ultimately, you get to the basic physics of capturing and manipulating electrical current and conductivity. That is, a chip, at its most essential level, is a use of the phenomenon of electricity toward another end.

Maybe the notion that tech is recursive (technologies within technologies and building on each other) and combinatorial seems obvious, but it's especially important to realize when considering advancements in a larger economy. The elements of anything new must preexist before an innovation (new combination) can take place. We couldn't have a jet plane before we first discovered how flight and aerodynamics worked, or how jet propulsion and fossil fuel combustion worked; likewise, there can't be an Intel 4 Pentium chip until you had the 3 version, and so on. So even a product that seems "brand new" didn't come totally from out of the blue. Apple's iPhone seems totally groundbreaking, but in truth, it merely combines existing cell phone, computer, and touchscreen technologies in a unique way.

In some sense, technologies are never finished—they're always in flux. There are always additions, streamlinings, and new innovations possible. And technologies are never perfect. Generally, a technology must be envisioned first (an engineer or inventor needs to first conceive of what's being created) and executed second. Which means our technologies are not only discoveries of the uses of natural phenomena; they are also products of our minds. And we humans don't tend to produce perfection on the first try. Instead, by iteration, we move forward, improving by increments upon what came before. That's not just true conceptually; it's also true pragmatically in any economy, which has fixed costs and existing infrastructures that can often only handle improvements on existing concepts. For instance, today's PC manufacturers can certainly handle incremental improvements on a new Intel chip—they just adjust the motherboard and it fits right in. But if Intel were to suddenly ditch the semiconductor altogether and offer some kind of new, crazy organic microprocessor that computes on water and algae instead of electricity—well, let's just say Dell would have a tough time manufacturing a computer around such a thing right away.

Over time, revolutions can and do take place—there is little doubt the way we make computers today will be wholly different and barely resemble what we do decades from now. The combinations lead to more and better combinations, ad infinitum, and at an accelerating pace. Revolution via small steps.

Which brings up an important point: We tend to think of tech innovation as faster and faster, smaller and smaller. But that's far too narrow—technology is also about increasing interconnection, efficiency, and opening to new possibilities. New technology creates the potential for ever more and newer things—things we haven't even conceived of yet.

On this broad definition, most things are technologies and technology is in just about everything. In fact, an economy is a kind of technology. Money is one of the greatest of all technologies because it allows folks to trade goods and services more efficiently than any other known mechanism. (Anyway, it's a lot better than trying to deal in clay jars of oil or bartering with cattle, as in olden times.) Stocks and bonds and other tradable securities, too, are tremendous technologies—mechanisms that allow for capital to move ever more efficiently to places of greatest need. Even more, GDP is very much dependent on technology, because growth in productivity happens most often via technological advancement and is thus a huge driver of wealth creation.

But let's not get too excited. This book is for making better investments in technology—correctly forecasting the ways innovation and technology transfer into rising stock prices requires a good dose of discipline and sobriety about these exciting concepts. Many of the greatest innovations and ideas don't translate into company profits for a long time, if ever. For instance, liquid crystal display (LCD) technology has been around for decades, but it didn't become economically viable for mass production as computer monitors and TV screens until recent years. Hundreds of startup tech companies—with seemingly can't-miss ideas—have bankrupted over time. How to pick the right companies at the right times? How can investors quantify a company's ability to innovate via real costs like research and development (R&D) expenses?

These are the sorts of questions this guide aims to address. But first, we need to cover the nuts and bolts of the products the world's largest technology companies make and how they work. After all, to make a disciplined stock investment, an investor must understand the underlying business.

TECHNOLOGY 101

While technology is a broad-reaching term, the Technology sector includes firms that make or distribute electronically based products or services. The opportunity for Technology firms is massive. Firms in every sector and country can invest in technology to help improve the products and services they offer or even make business operations more efficient. For example, a Financials firm may invest in new data storage systems to back up client information. Or it could purchase faster servers to process the data and respond to client needs more quickly. Firms may risk falling behind in the global economy if they don't periodically invest in upgrading their technology—which is why businesses are the leading spenders on technology while consumers are a distant second.

And the global Technology sector encompasses a wide range of firms. When folks think about technology, final products most often come to mind, like the ubiquitous personal computer (PC). Over the last few decades, these machines have made an impressive foray into mainstream society. Not only are PCs necessary for virtually every modern business, they also serve the needs of consumers as entertainment devices, databases, access points to the Internet, and more.

But producing the PC can require the input of many firms across the Technology sector, providing a variety of building blocks like chips, components, and software. Each of these building blocks can come from different companies and regions in the world. Some firms specialize in only one area while others focus on many, and some are purely service based. It's a diverse, global sector.

STARTING SMALL: SEMICONDUCTORS

In order to better understand investment opportunities in the Technology sector, it's essential to first know the basics of the underlying technology itself. And a good place to start is with *semiconductors*. As shown in Figure 1.1, these are manufactured early in the Technology supply chain.

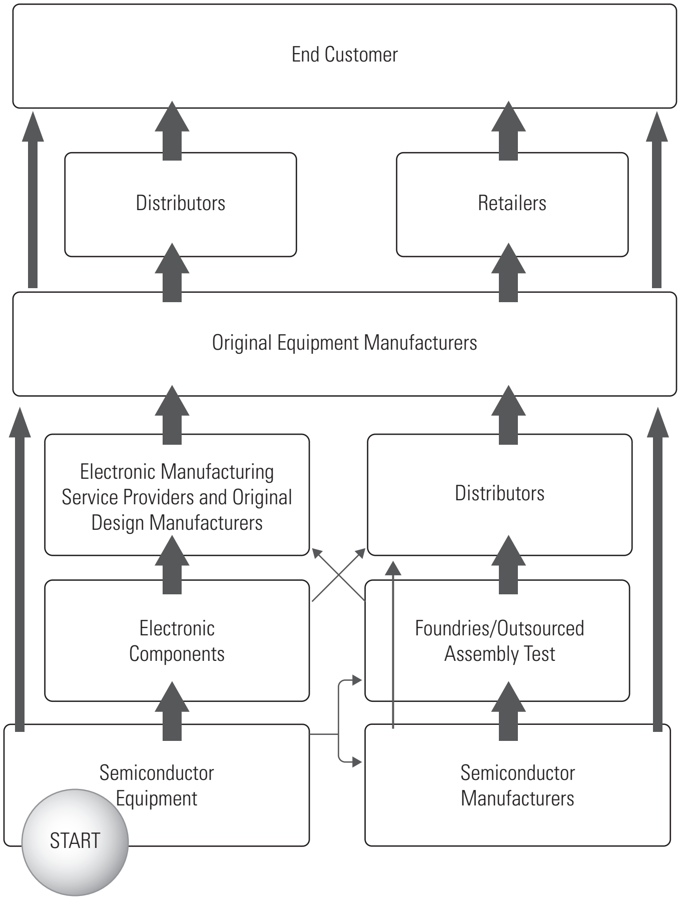

Figure 1.1 Technology Supply Chain

The semiconductor industry is highly complex. In fact, many books can be written on semiconductors and semiconductor equipment alone. Here, we'll provide just a basic outline of the major semiconductor types so in your analysis of the sector you can understand who produces what and why.

But what exactly is a semiconductor? It's a tiny bit of metal that executes orders—sometimes millions of them a second, depending on the complexity of the gadget it's in. There are two basic types—*discrete components* and *integrated circuits* (explained more nearby).

Semiconductors are usually made of silicon—hence "Silicon Valley" in Northern California where many semiconductor firms (designers and manufacturers) are located.

Discrete Components and Integrated Circuits

A *discrete component* contains one active element, like a transistor that simply turns an electrical signal on or off. A *hybrid* can contain more than one active element.

An *integrated circuit* (IC) is a chip imprinted with multiple active elements, like a series of transistors and other electronic or network components that work together to perform various tasks.

Semiconductors, often called *chips*, come in many forms and are one of the first and most important building blocks in manufacturing electronic devices. For example, a PC microprocessor is one type of semiconductor. It acts as the "brain," sending electronic signals that tell PCs to process data.

Types of Semiconductors and End Market Applications

Discrete components are generally less complex—they only contain one active element. A *capacitor* is an example—it is a single component serving no other purpose than storing an electrical charge (which represents the active element). Capacitors are in essence temporary batteries, often found in electronic devices to maintain power in the absence of traditional batteries. Discrete components represent the larger portion of total semiconductor shipments. But because they are simplistic and therefore easier and cheaper to design and manufacture, they sell for a lower price than most other semiconductors.

Integrated Circuits (ICs) are more complex semiconductors with multiple active elements—often an aggregation of many discrete components (hence the term *integrated*). They are sold in smaller volumes, but their higher prices mean ICs make up the lion's share of the semiconductor market. And because they are generally more important to the sector, this section focuses primarily on ICs.

ICs can be broken down into myriad categories, but at the highest level, there are *digital* and *analog* ICs. They are differentiated based on the type of signals processed by the device. A *digital* signal is information coded as discrete sets of numbers (generally binary digits), whereas *analog* is a continuous "real world" signal such as sound, temperature, or voltage. Typical analog semiconductors include power amplifiers and converters. Typical digital semiconductors include microprocessors and memory.

But electronics don't solely use one kind of semiconductor. For example, cell phones have both analog and digital ICs. Speaking into a cell phone creates an analog signal—the voice. The analog IC converts the signal into digital code. This code is processed by a digital IC and sent over the air to the other end of the phone call where it's converted back to an analog signal—the voice heard on the other end.

Analog ICs Analog semiconductors are a smaller portion of the total IC market relative to digital, but producing them remains a lucrative business. These devices are notoriously difficult to engineer, creating high barriers to entry for the industry. This also means analog designs typically have longer life cycles. Extended life cycles reduce chip manufacturers' urgency to upgrade to the latest and best production equipment, thus lowering development costs. These factors together give analog ICs the highest gross margins in the semiconductor industry.

The analog market can be segmented into *standard products* and *application specific standard products* (ASSP). Standard analog ICs can be used in a multitude of end products while ASSPs are designed for one specific end product. Power management chips, amplifiers, and converters are all standard analog ICs. But these can become ASSPs if modified to meet a certain end product's specifications.

Digital ICs The majority of the semiconductor market is made up of digital ICs. They're more precise—able to make highly complex calculations. Unlike analog, producing digital chips is hugely capital intensive. Their shorter life cycles relative to analog chips force manufacturers to invest in cutting-edge production equipment to improve and differentiate their products. For example, memory chip manufactures all compete to produce chips on the smallest scale with the largest storage capacity. In order to constantly improve on these metrics, they must invest in the latest and greatest manufacturing equipment. Most digital chips can be broken down into two categories—*logic* and *memory*—logic being the larger market.

Standard *logic* ICs include what could be the most widely recognized semiconductor: the microprocessor. This is an electronic device's "brain" and is most often found in computational machines like PCs, servers, mainframes, etc. *Microcontrollers* also fall into the standard logic space. (Microcontrollers are similar to microprocessors but are used in devices requiring less computational speed and power.) Automobiles, washing machines, and office equipment use microcontrollers. Outside the standard market, there are myriad logic chips with more specific purposes—like application processors, which are basically less powerful microprocessors found in cell phones.

The two most common types of *memory* ICs are dynamic random access memory (DRAM) and NAND (i.e., "not and") flash. DRAM is commonly found in computers and is a form of *volatile memory*—it does not retain information in the absence of a power source. Conversely, NAND flash is a form of *nonvolatile memory*, which retains information without power. NAND is most often found in consumer electronics like cell phones and MP3 players.

End-Market Applications

Once manufactured, semiconductors are shipped to equipment manufacturers in various end markets. The largest end markets are computers and mobile handsets—representing 40 percent and 20 percent of global semiconductor consumption, respectively.[1] The remaining end markets are divided between consumer electronics, industrial applications, automotive, and other forms of communication equipment.

Until 2000, the Americas represented the largest regional consumer of semiconductors. But beginning in 2001, Asia Pacific (excluding Japan, the world's second largest economy) took the lead and, by 2007, made up 48 percent of global semiconductor sales.[2] This dominance was due to the large concentration of electronic equipment manufacturers in the region. In aggregate, this market has grown from only $342,000 in annual sales to over $255 billion in the last 30 years.[3]

GETTING LARGER: PRODUCTS AND COMPONENTS

After development and shipment, a semiconductor is then built into its corresponding final product. This section details products in the computer hardware, communications equipment, and consumer electronics end markets, as well as major components for each.

Computer Hardware

One of the most widely recognized Technology products is the computer or, more specifically, the PC. To the average person, a PC is often used for work, accessing the Internet, storing and playing media files, or writing college term papers. But a PC is only one of many types of computers.

A computer, simply, is a data-processing machine. It follows sets of coded instructions to perform tasks like saving and retrieving files. Mainframes, workstations, and servers are also computers—each is a type of data-processing machine. Unlike simple calculators, computers can be programmed to perform more than one task. At their core is the microprocessor, which interprets and executes various programs allowing them to function. These devices have also given rise to complex storage systems that centralize data.

Personal Computers (PCs) The vast majority of computers today are PCs, and they come in two common forms: desktops and notebooks. Both have similar features and functionality, with the latter being portable. And notebooks are becoming more popular than ever—global shipments of notebooks outpaced desktops for the first time ever in the third quarter of 2008.[4]

PCs come in many brand "flavors," produced by original equipment manufacturers (OEMs) like Hewlett-Packard, Apple, and Dell. But no matter the packaging, they all are made with the same basic components, including the microprocessor, motherboard, memory, hard disk drive (HDD), and liquid crystal display (LCD). (A more detailed overview of these components and their functions is provided in Chapter 6.)

Peripherals Peripherals are computer hardware depending on the PC to function and usually attached externally (e.g., keyboards, printers, scanners, cameras, microphones, speakers, disk drives).

As separate electronic devices, peripherals typically incorporate semiconductors, circuit boards, and various electronic components and are usually (though not always) produced by the actual PC maker. For example, Hewlett-Packard is a leader in both global PC and printer sales.

Netbooks A *netbook* is a basic version of a notebook. Smaller in size and with fewer components and software, these devices primarily function as Internet portals. Their limited functionality makes them cheaper (and generally lighter and smaller) than traditional notebooks and a big success in emerging markets. Taiwan's ASUSTeK Computer Incorporated was the first mover with its Eee PC. Since its launch, almost all PC manufacturers have released some form of a netbook.

Workstations *Workstations* are more powerful desktop PCs—rather like a server with a monitor. But unlike most servers, they're generally not used as a central hub in network environments. Given their higher relative performance over traditional PCs, they're used for more complex tasks like graphic design and modeling.

Mainframes, Servers & Blade Servers The term "mainframe" has become less prevalent in today's computing world. In fact, mainframes are usually referred to as servers, and only the largest servers are called mainframes.[5] At one point, a single mainframe computer could fill an entire room. But after years of technological advancements, they're now often the size of a refrigerator or smaller.

Servers are vital products in computer hardware, with networking and the client-server model becoming the de facto standard for businesses. As shown in Figure 1.2, the client-server model is a networked environment where individual PCs (the *clients*) are connected to a server. This model allows sharing of information among all networked clients, greater storage capacities (information is saved on servers rather than limited client terminals), easier maintenance, and better security control.

Types of servers vary but all are essentially powerful computers. They're built with many of the same components as personal computers, just more of them and on a larger scale. Some function as application servers, meaning they serve software applications to clients connected to the network. Others function as web servers and

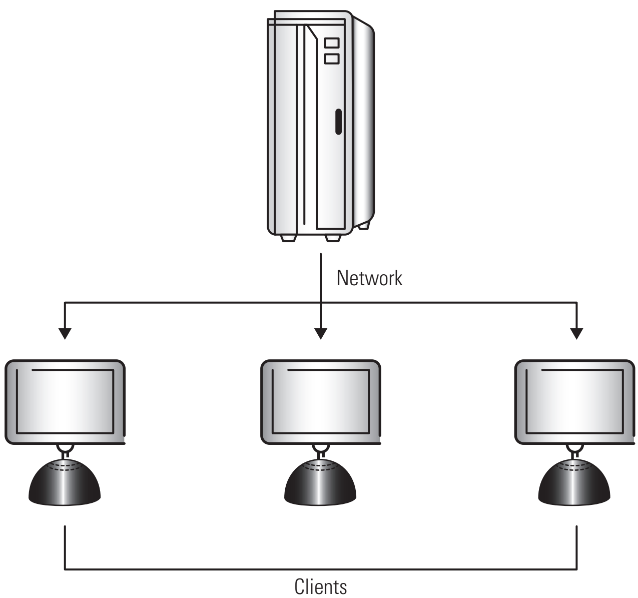

Figure 1.2 Client-Server Architecture

connect clients to the Internet. Because information is viewed on the client terminal, servers do not typically incorporate monitors.

Blade servers are a variation of standard rack-mounted servers. The removable "blades" themselves can be considered computers, with each blade operating independently and made up of different components. Blade servers have been gaining in popularity because of their reduced space requirements, reduced power consumption, and easier physical deployment since new blades can simply be added to an existing chassis.[6]

The Data Center *Data centers*, also known as server farms, are large collections of servers housed in a single environment. They're often built by telecommunications firms and corporations as hubs for network traffic and central computing. Space in these facilities can be leased, leaving management of the data center to a third party. They're classified into four different tiers, as determined by the Telecommunications Industry Association (TIA). Each differs in technology and architecture, with the highest tier generating the least amount of expected downtime in any given year.

A River Runs by It

Data centers can be massive in size. Internet giant Google has built a data center the size of two football fields along the Columbia River in Oregon.[7] The location was chosen partly due to the abundance of hydroelectric power that can feed the facility's significant energy requirements. Data centers accounted for 1.5 percent of total US electricity consumption in 2006.[8]

Enterprise Level Storage Devices and Technologies As of 2008, the size of the digital universe was approximately 281 exabytes, which translates into more binary "1"s and "0"s than estimated stars in the entire universe.[9] All the data need to be stored somewhere, which has led to the rise of large storage systems. *Enterprise level storage devices* are mostly comprised of magnetic disk arrays (HDDs). Depending on capacity requirements, a single system can include thousands of drives.

Communications Equipment

Ever wonder how all those e-mails get from point A to point B? Or how music and video gets downloaded onto cell phones? Communications equipment allows corporations and consumers to form computer networks, connect to the Internet, video conference, or simply chat. While computer hardware performs calculations to generate data, communications equipment allows it to be shared. Products in this market typically fall into three categories: fixed-line infrastructure, wireless infrastructure, and mobile handsets.

Fixed-Line Infrastructure *Fixed-line infrastructure* is often referred to as *wireline* because physical wires connect end users. For example, a landline phone and most Internet connections use a fixed line. This equipment helps route data between two endpoints, and its history goes back to the invention of the telephone.

Products include routers, hubs, switches, and the physical wires themselves running between each. Globally, most fixed-line infrastructure for traditional voice services has already been built out, so growth in this industry is mostly for the Internet. But to understand how these products work, it's good to grasp the underlying technology.

A major milestone was the transition from circuit-based to packet-based switching. Circuit-based switching opens a line that's all yours until you hang up—like driving on the highway in a lane restricted to everyone but you. But that makes traffic worse for those in other lanes. It'd be better if everyone could change lanes according to how fast they're going, and when and where they need to get off the highway.

This massive inefficiency led to *packet-based switching*. Instead of holding open a dedicated line, information is broken up into small "packets" where it can be intermixed with other data and sent along a shared line. Though more efficient, the problem is ensuring all information gets to the right place after it's broken up.

Routing equipment—hubs, switches, routers—makes this happen. They get information from point A to point B on a network, examining the address attached to each data "packet," forwarding it to the appropriate destination, then reassembling it into its original form.

Hubs are simplest—designed only to receive an incoming signal and pass it on to all other points connected to them. They've more or less been replaced by *switches*, which are more intelligent. Switches can receive an incoming signal and send it solely to the desired destination, rather than all destinations connected to the switch. *Routers* are the most complex, capable of receiving signals of any protocol, identifying the underlying address, and rearranging the data to fit the destination's network protocol before finally forwarding it on.

Cisco Systems is the 800-pound gorilla in this market, serving all types of customers. The Telecommunications industry is a significant buyer, but corporations large and small require fixed-line infrastructure, installing many of these devices in data centers to connect company servers and storage devices to the outside "networked" world.

Wireless Infrastructure The wireless market is one of the largest industries in the world, and it's still growing. As of this writing, there are over 3.8 billion wireless connections worldwide, with most subscribers concentrated in Asia Pacific[10]—meaning almost 60 percent of people on earth use a cell phone. This gigantic market is primarily divided into two camps based on underlying technology. *Global System for Mobile* (GSM) communications is the most prevalent technology worldwide—over 80 percent of wireless connections use GSM technology.[11] *Code Division Multiple Access* (CDMA) is the leading alternative.

Both standards send digital voice and data information over wireless networks. Newer versions of these technologies are also being implemented (referred to as "third generation" or 3G). Both 3G standards incorporate CDMA technology with Wideband Code Division Multiple Access (WCDMA) stemming from the GSM camp and

CDMA2000 from the CDMA camp. These third generation networks have higher bandwidth, resulting in faster speeds for downloading data or surfing the Internet.

Both standards are built using the same basic equipment—base transceiver stations and antennas (illustrated in Figure 1.3). Together, they make up the cell site, which sends and receives wireless signals as radio waves. Signals received are then transferred to fixed-line networks before being retransmitted wirelessly at the other end (another cell site).

Wireless networks aren't as cumbersome to build as fixed-lines since they don't involve physically laying cables. However, they're extremely capital intensive. Not only is equipment expensive, carriers also must spend heavily on *spectrum*—the amount of airwaves available to offer their services. In 2008, US carriers Verizon and AT&T combined spent in excess of $15 billion for spectrum![12] The spectrum purchased was in the 700 MHz band, which was freed up from the nationwide switch to digital television.

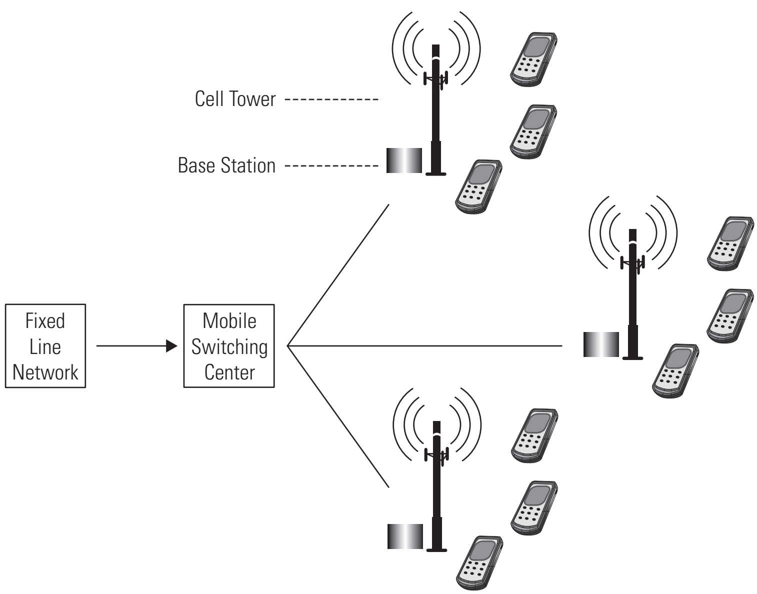

Figure 1.3 Wireless Network Architecture

Telecommunications firms are the primary purchasers of wireless infrastructure equipment. However, they're not exclusive owners of cell sites. In some cases, it can be difficult to establish a new wireless tower due to various environmental and government regulations. In these scenarios, telecommunications firms may lease space on existing towers built by a third party. These third parties typically don't offer wireless services directly, but instead specialize in owning, leasing, and servicing towers.

Mobile Handsets Mobile handsets are now about as ubiquitous as wallets (and in some countries, they are even used as wallets). Globally, over 1.2 billion mobile phones were shipped in 2008.[13] Mobile handsets are the second largest market for semiconductors behind computers.

Outside of the PC, they have become the most central electronic device in everyday life. They now offer rich multimedia functionality with the ability to store and play video and music, connect to the Internet, synchronize e-mail accounts, act as calendars and day planners, even play video games—the most sophisticated are deemed "smartphones." Mobile handset components are also very similar to a PC—a circuit board, microprocessor, keypad, LCD screen, memory, and power source.

A unique characteristic of the handset market is the extensive use of telecommunications carriers. Most mobile phones are sold to end customers by service providers (e.g., Verizon Wireless, AT&T, Sprint). These firms often pay handset manufacturers a set price, which is then usually subsidized for customers in order to attract new business for their service plans.

Consumer Electronics

Consumer electronics can come in thousands of different forms—televisions, digital cameras, DVD players, car stereos, calculators, camcorders, etc. Sometimes, the defining line between Technology and Consumer Discretionary sector firms is blurry. Outside of mobile handset manufacturers, if a firm specializes in purely consumer electronics it will typically be classified as Consumer Discretionary. However, consumer electronics play an important role in the Technology sector. These goods can be sold directly by Technology firms or drive demand for Technology components.

Televisions Televisions are a sizeable portion of the consumer electronics market. Cathode ray tube televisions, or CRTs, have historically been the de facto standard but are increasingly being replaced by flat panel displays like LCDs. In fact, televisions are one of the largest drivers of LCD demand, along with notebook and desktop PC monitors.

Video Game Systems Currently Nintendo's Wii, Microsoft's Xbox 360, and Sony's PlayStation 3 are the dominant video game systems. Over the past few decades, these machines have become increasingly sophisticated and fueled demand for more advanced microprocessors, graphic chips, memory, and other components. Just like cell phones, video game consoles are becoming similar to PCs in components and functionality. All three consoles even include Wi-Fi chips for connecting to the Internet. While not as large as PCs, the market for these devices is still capable of influencing demand for parts and components across the technology supply chain.

MAKING IT ALL WORK: SOFTWARE AND SERVICES

So far, this chapter has detailed hardware components and products. But all this hardware is useless without one critically important element: software. What good is a hard disk drive if a computer doesn't know how to access information stored on it? Without software, a PC is just a very expensive paperweight—it's not possible to access e-mail, connect to the Internet, play a DVD, or type a term paper without software. Software is the instructions, or code, telling the hardware how to function and interact with other hardware and the end user.

Another differentiating feature between hardware and software is the distribution model. Software has no physical building blocks—it's simply code. It doesn't require semiconductors and electronic components to develop (other than the PCs used to write the code). In fact, the vast majority of input costs are R&D. Software can be preinstalled on hardware during the manufacturing process or installed after the hardware's final purchase. Sales range from prepackaged (think Microsoft Office in retail stores), to enterprise-wide licenses or even seat-based licenses (for businesses). Under the licensing model, there are generally fees for updates and maintenance. Some software can also be downloaded directly to hardware via the Internet.

Software comes in myriad forms, but we'll discuss the following:

- Operating systems
- Application software
- Middleware
- Internet software

Operating System

Think of *operating system* (OS) software as similar to the microprocessor. It's the core set of instructions and simply tells hardware how to operate. PCs, servers, workstations, cell phones, and video game systems all have operating systems. The OS can provide system management, communication to hardware and networks, file access, and a user interface (UI).

Microsoft Windows is perhaps the best-known OS—it's nearly ubiquitous across the global PC market. Its defining feature is a unique UI allowing users to perform tasks in separate graphical "windows."

OS software varies by the product it's used in. For example, Unix is a standard most often used in high-powered computers like servers and workstations. Sun Microsystems' Solaris is one of the more popular Unix-based operating systems used today. Linux operating systems, very similar in design to Unix, are found more in servers than traditional PCs. Their unique open source software is free and not patented by any one firm. This enables them to be altered and customized at will.

Application Software

Application software is designed for a specific task. For example, Microsoft's widely used Office suite includes Outlook, Word, Excel, and PowerPoint—all application software. There are applications for security, client relationship management (CRM), and enterprise resource planning (ERP). Apple's iTunes is another application software, allowing users to access and manage music libraries. The possibilities for application software are infinite and depend only on the ability to imagine new tasks to perform.

Middleware

Between the OS and application software lies *middleware*. While a user can see the OS and application software through their corresponding UIs, middleware is behind the scenes. It's responsible for providing interoperability between different software programs. The benefits can most easily be seen in networked environments, which typically consist of hardware running on multiple operating systems. Middleware translates programs from one operating system to fit the format and/or protocol of another. Many operating systems and application programs now come with already built-in middleware.

Internet Software

Search engines represent the largest market within Internet software. The software performs highly complex algorithms to generate lists of websites best matching (according to the search engine's unique criteria) whatever keyword is entered. Google, Yahoo!, and Microsoft are the largest three search engine providers in the US. But Internet software isn't limited only to search as any web-based application can fall into this market. Web browsers, Internet retail, and travel applications all use Internet software.

IT Services

With so many different forms of hardware and software, it can be difficult for businesses to effectively manage IT systems. IT services firms specialize in systems integration, consulting, business process outsourcing, and payment and transaction processing. Other services include custom programming and software development. These businesses are global in scale, with operations in hundreds of countries.

Offered by hardware manufacturers, software providers, and independent firms, these service offerings can help businesses run more efficiently and maintain focus on their core areas of expertise. For example, a bank with no significant IT expertise would be more inclined to hire a third party to process account transactions. This is likely less costly than hiring a large team of IT professionals to develop the software internally.

Chapter Recap

You've now been introduced to some of the fundamental characteristics of the Technology sector. We will build upon many of the concepts presented in this chapter as we progress into later chapters.

- The Technology sector is highly diverse, consisting of a wide gamut of semiconductors, components, products, software, and services.
- Globally, technology plays a vital and necessary role in everyday life. Enterprises, which account for the vast majority of spending, must invest in technology to stay competitive. Consumers also account for a substantial portion of spending, which is more discretionary in nature.
- Semiconductors are the basic building blocks for electronic components and products—computers and mobile handsets represent the largest end markets.
- Hardware can come in many forms, but ultimately software enables it to function.