INFORMATION INFRASTRUCTURES AND
GOVERNMENTAL POLICY IMPLICATIONS

by

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Introduction

The term "telecommunications" literally translates to "communications over distances", but usually refers to the application of science and technology to construct electronic channels that make communications possible over any span of distances. For centuries throughout the world, the only methods of communicating information over long distances were either the physical transportation of the written word, visual symbols (such as lanterns or semaphores), verbal storytelling of bards and poets, or, of course, everyday conversation. Travelers going from city to city were the only communications links that isolated regions had.

Over land, stagecoaches and other public and private carriers commissioned to carry post letters and newspapers were the first organized, large scale means of transmitting information over long distances in the United States. The only other way for mass movement of communications was the shipping industry; letters and newspapers shared quarters with passengers and cargo, both domestically and internationally. Before the invention of the telegraph, improving transportation methods were virtually the only changes in the disbursement of information.

The invention of the telegraph and its ancillary discoveries of electromagnetism caused a revolution in the way information would be communicated in the U.S. (and the world) after 1844. The concept of telecommunications had been created with the invention, and new aspects of communication came into being because of the telegraph.

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Interactivity, immediacy, and connectivity exemplified the role that electromagnetic devices such as the telegraph would play in the history of telecommunications. Telecommunications development has since furthered these basic, but powerful, characteristics.

Interactivity, or the two-way flow of information, is important in communications in order to increase understanding between the communicating parties. For example, the communication of information is very conductive to the learning of other cultures, and a community can enhance itself by implementing ideas from others'. However, too much or the wrong usage of information can be detrimental. For example, if a culture could receive information from another, but couldn't communicate back, it might easily assimilate many of the ideas of a more powerful culture and essentially lose its own identity. Information could be misinterpreted and subsequently cause problems if there are no means for query and feedback. It follows that interactivity is important for communication to be most effective and beneficial.

Immediacy and connectivity are other important components to communicating information. Xenophon wrote of the significance of fast messengers in maintaining the integrity of the Persian Empire. Not only has society in general come to expect faster and faster transmit and response times in its communications, but immediacy of information is continually a large issue in business. Sales and financial decisions are heavily based on the timeliness of information. As an example of the importance of connectivity, "just-

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3Inose, 4.
"in-time" purchasing and inventory systems in retail stores are very often connected to manufacturing systems in their suppliers' factories to optimize the stocking of products in the stores. Connectivity between these entities and immediacy of the inventory and sales information are both necessary for such a system to function.

The United States government's involvement in telegraph and telephone development has been largely regulatory. Only during W.W.I did the federal government become directly involved in telecommunications. However, the federal government has never lost sight of how indispensable an instantaneous and universal communications network is. In fact, the contention that it could fit under the Constitution's provision giving power to the federal government to establish postal roads and offices has more than once been expounded by some officials in government.

Technology has continually changed the communication of information as demands and expectations of immediacy, interactivity, usability, and cost-effectiveness have continually increased. Telecommunications have grown from a painstakingly coded form of voice communication to combined voice, full motion video, and data transmission systems. Historical trends in technology, government policy, and individual vision have all shaped the current environment of telecommunications.

This paper details the key developments of these trends in the communications industry that advanced basic telegraphy to the beginnings of an information superhighway. The first major portion
of the paper outlines the history and basic concepts of telecommunications infrastructure and is devoted entirely to the Bell System and AT&T after the advent of the telegraph. This distinction is appropriately done because its regulated monopolistic structure has allowed it to dominate the industry from the invention of the telephone by its founders in 1876 up until the 1980s. Governmental policies that begin to question the industry as a whole, as well as the Bell System's dominance of, are discussed towards the end of this section, as newer technologies in the transmission of information cause an impetus for true competition.

The remaining sections of this paper discuss the history and application of the most recent advances of telecommunications. The development of radio in the early twentieth century freed electrical engineers and inventors from the distance and cost constraints of copper wire, while swift advances in computers, satellites, cellular radiotelephony, and fiber optics continue to stretch the limits of existing telecommunications technology today. Competition in the industry and its use of newer technologies to transmit any kind of information to and from anywhere are the building blocks of the information superhighway that is already partially here.
The Beginning of Telecommunications

The history of telecommunications in the U.S. can be separated into periods relating to the changes in speed, efficiency, volume, usability and cost of various systems and devices. These eras can be identified by the implementation of new telecommunications technologies and their impacts on society. Because private interests constructed this infrastructure for profit, sheer invention of scientists and tinkerers has been focused to continuously implement improvements in response to consumer demand. As an analogy, the expansion of the steamboat in the 1810s and the railroads in the middle part of the century provided people with heightened expectations of faster service to more people from the postal system. This became true with developments in telecommunications, but for different reasons. Improvements in transportation had driven consumer demand for sending more mail since it would have a better chance of arriving to its destination, but consumer demand drove the improvements in telecommunications.

The harnessing of electricity into a telegraph machine in 1838 to send messages near the speed of light marked the beginning of the telecommunications age. The flow of information was directly related to the geographical spacing of the population before the telegraph, but for communications purposes it now did not matter that cities were hundreds of miles away.4 One of the subtle but significant signs that communications' dependence on transportation modes was ending was the abandonment of the fabled "Pony

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4Pred. 12.
Express". A private enterprise started out of the necessity of some form of high-speed information exchange to the West, this enterprising and courageous group of men battled severe elements of the seasons, terrain, and profiteering bandits, strictly in the business of conveying information fast. The freight firm of Russel, Meyers, and Waddle started the line from St. Joseph, MO to Sacramento, CA in April of 1860. However, in one of the most significant technological turning points in history, the invention of the telegraph reduced this exotic information link to nothing more than a single strand of copper. The express ponies were retired in August of 1861, concurrent with the completion of the first transcontinental telegraph line by Western Union.5

It is interesting to note that communications lines in the nineteenth century and even today have some correlation to transportation. Right-of-ways that were originally built for transportation would later be used by telecommunications infrastructures. Telegraph companies such as Western Union placed poles along railroad track just as telephone cable would be placed underneath city streets decades later.

Some correlations regarding federal and state governmental involvement can also be drawn between railroad and telecommunications infrastructure development in the nineteenth century. The questions of an appropriate level of government involvement were based on varying understandings (throughout various administrations and courts) of whether and how federal or state government is responsible for providing a service in the public

5Encyclopedia Americana. (Grolier, 1993), 398.
interest. The federal government, for example, exempted itself from
the capitalization of new infrastructure by prohibiting itself from
owning stock in railroads and canals in 1828.6 States used varying
forms of public-private partnerships in railroads until later when
they mostly found their burden to be too expensive and that private
enterprise could more effectively serve the public interest. By the
start of railroad regulation in 1887, both federal and state levels of
government had realized that providing services doesn't necessarily
mean that they need to produce them. "Regulation, instead of
production or ownership, would be adequate to assure the provision
of needed services."7 This regulatory approach, with a mostly
laissez-faire attitude, was used by the federal government in the
development of telecommunications until the 1910s.

Two men called Cook and Wheatstone were the first to make an
electric telegraph in London in 1838. Samuel Morse worked to refine
their ideas and developed a code for transmitting messages in the
U.S. The first significant line, installed between Baltimore and
Washington, was used to send messages starting on May 24, 1844.
The Western Union company was formed by the consolidation of
many small companies in 1856 by Hiram Sibley, which eventually
set up offices and telegraph lines across the country. Now, a "wire"
could be sent across the country within minutes, ushering in a new
demand for immediacy in communications. Printing machine
telegraphs (teletypewriters) couldn't be invented until a means of

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6Ann Keating, "Public-Private Partnerships in Public Works: A
Bibliographic Essay," in Public-Private Partnerships: Privatization
in Historical Perspective, Vol. 16 (Chicago: Public Works
Historical Society, 1989), 85.
7Keating, 84-85.
synchronizing the sending and receiving units were developed. A new method developed in the U.S. in 1907 by Charles Krum added start and stop flags to the actual code. This idea was picked up by the Siemens Company of Germany and eventually became the standard.
The Bell System

The telephone's invention in 1876 defined yet another new era, unprecedented in its immediacy and ease of use. In 1876 a teacher of the deaf, Alexander Bell, contacted another tinkerer of electrical devices, Watson to help him construct a harmonic telegraph. That is, one telegraph device that would send multiple messages over one wire. They also endeavored to start an offshoot of this, the facsimile machine. They probably would have eventually created a machine such as that if they wouldn't have accidentally discovered that sounds could be sent over the wire. After this discovery and some succeeding experiments in electromagnetism thereafter, a patent was granted on March 3, 1876. It should be noted here that the first complete sentence over this new medium was completely missing any element of premeditated rhetoric; Bell expressed a simple need for Watson's presence, a symbol that later on this device would mean easy access for everyone. Bell believed in the creation of a total, universal system with universal access, and solidified his philosophy by funding these early efforts with lectures given to the general public and investors on "creating and selling a total service system, rather than retailing isolated instruments." Of course, in this climate of extremely conservative capitalists, his ideas were met with discouragement from investors, but from academic lectures his invention and ideas were well received by the public. Meanwhile, Bell had been helping Mr. Gardiner Hubbard's daughter Mabel with

his techniques for the deaf. Mr. Hubbard, a wealthy attorney who practiced before the Supreme Court, became interested in Bell's initial work with telephony.

Hubbard started to work closely with Bell and Watson. In the fall of 1876, he tried to sell all of the patents to Western Union for $100,000 because his fortunes were exhausted. They were declined. Around this time, Bell married Hubbard's daughter; after their 15 month honeymoon to England, Bell returned only to resign from his technical and managerial involvement.

The Bell Telephone Company
Theodore Vail (1877 - 1884)

Hubbard and Watson eagerly applied themselves to commercial development. Watson easily and almost intuitively made inventions necessary to the telephone's development while Hubbard organized the Bell Telephone Company in July, 1877. Western Union, after recognizing the extent of its error, started making telephones by blatantly ignoring Bell's patents and Thomas Edison had, by 1878, made a carbon transmitter (supposedly bought by Western Union). In spite of the patent infringements on his company, Watson set out to improve this microphone and utilize it with the Bell Company's licensees. Also in this year was the installation of the first switchboard in Hartford, CT.

During one of Watson's trips around the country to facilitate the diffusion of the telephone, he interviewed one of Mr. Hubbard's acquaintances in St. Louis. Mr. Theodore Vail, at that time working for the Post Office Railway Operations, turned out to be the single greatest hiring decision ever made for the company. As the first
general manager, he started with an emphasis on the continual improvement effort.9

While in London in 1875, Bell prophetically wrote of the future of the telephone to more potential investors in an effort to start the expansion of telephony. Most of these ideas are familiar as the fundamentals to the system we know today: central offices, overhead and underground cables, switchboards, sale of service rather than the instruments themselves, prohibition against resale of services, and phones available to all in home and work. However, the hard-headed recipients of his report tore it up immediately. Bell’s trip to London also provided one of the new-born industry’s first lessons in keeping up with demand and customer desires occurred when Bell demonstrated the telephone to Queen Victoria. She wanted one, of course, but he felt he needed to carve a new one out of ivory. However, he took so long that she lost interest.10

In Britain the phone was called the voice telegraph. The nomenclature here is important since the telegraph was a nationalized, government-run service as part of the post office. Labeled as a telegraph, this automatically put the telephone into the nationalized service. This also held true for most other countries that put the telephone into use. However, the American private, capitalist economy provided for the diffusion of the telephone to the large market. This is also important to note, as countries with the most phones per capita are those whose systems are not state run.

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9Boettiger, 96-97.
10Boettiger, 97.
At this point in time (1878) there were about three major constraints remaining to the deployment of extensive telephone service. Patent battles on the basic technologies of the telephone were proving to be brutal; outright piracy and copying fueled the legal warfare. Only by 1888 were most of the major patent cases won, due mainly to Bell's expert witness, excellent notes, and unwavering composure.

Meanwhile, Theodore Vail had brought tremendous skill and forbearance as General Manager to the Bell Telephone Company. He wrote reports and even letters to the stockholders in his first person style, taking personal responsibility for everything that happened. It was said that he used "Napoleonic" authority to make things happen.11 Unlike other capitalists of the day, who only wanted money strictly for the accumulation of wealth, Vail saw money as a "resource for a way to advance the system."12 Much like Bell, Vail had a vision of how a system should reach and access all potential customers.

Needing cash in the early years, Vail had given Bell Company patent franchises to local businessmen in return for their stock. To do this, the Bell Telephone Company, now in the form of a corporation, formed the New England Telephone Company, to sell these licenses. However, this could only be a temporary source of funds, as the basic patents would expire in 1893-94. Because he wanted the telephone to benefit all customers, leaving local units to evolve in a haphazard fashion would not ultimately give the people

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11Boettinger, 99.
12Boettinger, 101.
what they needed. The Bell Telephone Company was therefore renamed the National Bell Telephone Company in 1879 to facilitate licensing throughout the country. As a direct result of this process, in hundreds of cities, the local telephone companies were being named "Bell Company of ...".

Bell's inventive fervor could be found in the company as well as himself: the first switchboard exchange in Hartford, CT was now in use and Bell had pioneered the first concepts of what today is fiber optics. In 1878, while in London, Bell noticed that selenium could change its resistance to electricity according to the amount of light hitting it. After returning to the U.S., he patented a way to transmit speech using light. It worked, but practical application couldn't occur until the development of the laser beam and another discovery that light could travel through curved glass.  

In 1880, Western Union contracted to sell telephones to National Bell. This entity was formed as American Bell, combining the operations of National Bell and the manufacturing operations of Western Union. This stayed as the parent company of the system until 1899. Two years later (1882) Vail would acquire Western Electric to utilize its manufacturing facilities, effectively combining them with Watson's band of inventors. Watson himself retired in 1881.

Thinking far much more like a business man than a scientist, Thomas Edison was rather outspoken in this time period in regard to bringing out products for the market. He stated that "pure science is foolishness...how well they [inventors] performed their work was

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13 Boettinger, 144.
determined by whether the product was a commercial success." and that people who made things for other people to use made the greatest contributions. Even though pure science is fundamental to new technologies, the principle that commercial application of such progress is necessary for the company's survival and growth is concurrently valid. This is as true in present day as it was then. Vail knew that research must continue, or the complex structure of the system could not expand and function. Only with a company truly dedicated to research and development could the technological long-distance barrier of communication beyond Denver, Colorado in 1881 become a reality.

Vail's vision of the system required a dependable source for all equipment used. Watson's shop was, of course, becoming too small to produce for this kind of demand at this point in time. Since Western Union had formed a company to make telephone parts, American Bell Telephone Co. in 1881 purchased a majority interest in it and had this operation's name changed to Western Electric. Following the transfer of patents, Western Electric provided all of the Bell Companies' equipment. With this arrangement, Western Electric could work closely with the engineering and technological developments of the parent company. Because of this, Western Electric has been (up until the late 1970s) the hardware part of the Bell System: purchasing, manufacturing, and maintenance of its components.

14 Boetttinger, 103.
AT&T
Theodore Vail (1885 - 1889)

In 1885, Vail's dream of a universal system to call anyone, anywhere was finally becoming publicly accepted as the goal.

American Telephone & Telegraph was created in New York by Vail as the solution to this dream, a supreme parent company as the string that would tie all of the little companies together to make the system work. The charter of AT&T expounded his boundless dream as well as his unhindered planning for the long-term: 

...the lines of this association...will connect one or more points in each and every city, town or place, in the State of New York with one or more points in each and every other city, town or place in said state, and in the rest of the United States, Canada, and Mexico, and also by cable and other appropriate means with the rest of the known world as may hereafter becomes necessary or desirable in conducting the business of the association.

Now Vail was president of AT&T, president of New York City's Metropolitan Telephone & Telegraph, and General Manager of American Bell, making them work together. Because of the corporate capital structures of Massachusetts, American Bell couldn't expand past $10 million in capital, so AT&T absorbed its functions in 1899, thereby pushing its combined assets to $120 million. This structure has remained the same to present day.

Vail's idealistic system didn't sit well with his Boston financiers, who viewed the enterprise as being strictly for financial gain. They envisioned nothing more than short-term profits, while Vail wanted every dollar to be put back into the system. Vail resigned in 1887, under protest to the compromises to his ideas.

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15Boettinger, 102.
Instead of paying out high dividends, he recommended pouring the money back into the company. Theirs being the conventional business wisdom of the day (short term vs. long term), Vail's ideas came across as "radical and dangerous." His ideas were later proven to be from the future.16

AT&T
John Hudson (1887 - 1900)

Vail's successor, John Hudson, had a background and a style that were almost negatives of Vail's. Vail was a self-educated, energetic young man of the heartland; from the frontier towns and a large cross-section of people. Hudson was a lawyer and a scholar who considered inventors as extravagant and as low-lives. Under such leadership, the system barely survived in this structure until Vail returned 20 years later.

In 1893, the original patents expired and Vail's vision would have to wait. Now, with a little cash, anyone could put together a company overnight and have their own local telephone service. Since the cost of having a phone in their time period was still very expensive, many speculators hoped to capitalize on trying to reach a high expansion rate by cutting prices below their costs. Many of these efforts failed, however, as many of the 6,000 new independent companies went broke. Vail's vision of a unified, accessible system was on hold, as the patchwork industry did nothing to make the national communications system look like anything more than a smattering of individual clouds in a big blue sky.

16Boettinger, 102.
AT&T
Fred Fish (1900 - 1907)

In Vail's absence, the Bell Company had hired Fred Fish, a patent lawyer, to head up the company after Hudson. Fish, undriven to advance the company, did little for the American Bell Company, other than fill the capital markets with securities; in this he did a good job in restoring some much needed financial growth.

Nevertheless, the company needed to restore its original vision of a comprehensive communications system in order to expand; the company had lost its direction. The bankers were beginning to realize that this, as well as more support from customers and stockholders, was immediately necessary.

AT&T
Theodore Vail (1907 - 1919)

Vail's experience in building power systems and railways in South America contributed greatly to his managerial talent so he could materialize his system. Only by his conviction in what he was doing was to facilitate the natural course of the progression of telecommunications, did he manage to create such a demand for telephone stock upon his return.

It didn't take much time for Vail to return to his style of taking the reins of the company with an iron fist. Refusing to conceal anything in the company, he was sometimes accused of being too open with his managers and the federal government. Vail's was one of the first major corporations to do in the first 10 years of the 20th century what some companies are just starting to do today. The two programs of cost reduction and image building were probably his
favorites. He also set up a real pension plan, improved employee conditions, and insisted in accurate accounting and financial reporting systems. All of these programs to ensure the integrity of the company were reflected in a great quote from Vail himself, "Take the public into confidence and you win the confidence of the public."

If Vail had not been so forceful of a presence, the early company may very well have become directionless like Western Union. Its market presence would have become lost a burgeoning industry. In 1909, Vail saw the Western Union Company on the verge of collapse and decided to acquire it. In doing so, the whole operation was revamped; offices were remodeled, customer-oriented services developed, and business took off. The federal government thought that this merger did such a good job of connecting all of the people, that it declared the consolidation illegal under the anti-trust laws.

Admist investor and board uncertainty about the financial risk, Vail pushed ahead with his supreme plans of communicating with the Pacific coast and wireless transmission with Europe. They both occurred in 1915.

Upon Britain's seizure of the telephone system in that country at the onset of W.W.I, the U.S. became the only country with a privatized phone system. This caused government officials and the public wondering if the government here should follow suit. The question would materialize in House committee meetings upon the appointment of Albert Burleson as Postmaster General under President Wilson. He perceived letter-carrying and the use of the of voice or signals over wires to be essentially the same thing: the
transmission of information. Since the Constitution gives the federal government the power to create post offices and postal roads, he equated those things with switching stations and telephone and telegraph wire. Taken from this extremely limited viewpoint, it was an logical assumption; only in the 1980s did the differences begin to blur significantly with the use of the facsimile machine and electronic mail. However, socialism, as seen in all of the other countries, didn't prove to provide the catalysts necessary to provide continuing technological advances, reasonable rates, efficiency, and quality of service. Vail, other business leaders, and certain government officials believed this and had to defend AT&T and the Bell System for the first time against the government in 1913. This "minor" skirmish resulted in the "Kingsbury Commitment": AT&T formally acknowledges its inability to monopolize all forms of telecommunications and also requires all other independent companies to connect into the Bell System.

The war had strengthened feelings that the government should be in control of the system for complete security. In July of 1918, a joint resolution of Congress allowed the President of the United States to take over the telephone and telegraph system, and on July 29, 1918, President Wilson took over all systems. W.W.I provided a test for the abilities of the infantile telecommunications industry, as Vail promised it could handle all the Defense needs, domestically and abroad. The government expressed its regard for the high standards of the company as it took over the entire industry. The takeover was complete by October, the system remaining managed and run by

17Boettinger, 170.
the companies that were taken over. Nevertheless, even with the companies operating the systems, policies quickly changed and Vail's parable became a self-fulfilled prophecy: "all monopolies should be regulated. Government ownership would be an unregulated monopoly." An example of which was the connection charge. Before the takeover, the regulators had denied AT&T and the other companies charging the consumers for this one-time hookup charge; within one month of the takeover, the charge was initiated by the postmaster general. This blatant contradiction is still allowed today.

Soon, the government found that it couldn't control the telephone system without drastically increasing rates. Previously, it had blasted the industry with accusations that they were charging high rates to be able to pay out high dividends. Now, it was discovering that it needed to charge even higher rates just to maintain operations. About one year from its inception, Congress recognized the inadequacies of this arrangement and passed a bill giving control back to private interests. From the experience, AT&T gained nothing but a political advantage that underscored for years to come its position that private interests is best for serving the communications needs of the public. It was returned to Vail's (and the tiny independent companies') control before his death in April, 1920.

Vail saw that "public consent" was necessary for such a dominant industry, as well as price protection from the government. "Continual improvement in quality, access, speed, and efficiency"

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were paramount. Only one year earlier had he became Chairman of the Board and picked someone to succeed him as President and carry out his philosophy, his last great act.

**AT&T**
*Harry Thayer (1919 - 1924)*

Harry Thayer, Vail's friend, established the blue-chip benchmark $9 dividend in 1921. He continued the buyout and consolidation of local phone companies into large, regional ones as the Graham Act formally excluded telephone systems from the Sherman Antitrust Act in 1921. AT&T was free to buy up competing companies in two-system cities. Now, the government's official position was that competing companies were relics from a prior era and that "telephony was a natural monopoly subject to regulation."

In 1925, all of the company's research and development work was to be carried out by the newly formed Bell Laboratories, owned 50% by Western Electric and 50% by AT&T. Bell Labs is lauded as one of the world's best laboratories and is continually looked to as why capital investment in research is necessary for enterprise. Due to its intensive research, vacuum tubes were being used in offshore communications, radio broadcasting firsts, hi-fi stereo, and picture transmission by newspapers over the wires had occurred by the end of 1925. Throughout the 1920s, AT&T felt that radio broadcasting was a natural extension of telephony, and that it was necessary to remain in the field. After all, AT&T was sending transcontinental calls using radio before 1920. Holding patents on certain early

19Boettiger, 170.
equipment and having control over all of the phone lines that connected stations and used to shuffle programs back and forth, AT&T was accused of trying to monopolize the radio industry as well.

**AT&T**

*Walter Gifford (1925 - 1948)*

Thayer's successor, Walter Gifford, made some changes by divesting portions of the company that were taking away from the basic telephone service. The company's radio interest and patents were sold to NBC, as well as its firsts in sound motion pictures and hi-fi phonographs to other companies.

In the first couple decades of Gifford's service, the Bell Laboratories produced a number of inventions that would become indispensable in the world of electronics. Long distance television transmission in 1927, color TV a few years later, coaxial cable (for carrying many long-distance calls in a thin cable), the teletype in 1931, the first public use of RADAR, and an altimeter for airplanes are just some examples. All the while, improvements in switching were keeping up with the exploding demand. A sign of the telephone's importance could be seen on President Hoover's desk for the first time in 1929. The company seemed invincible as it weathered the depression under full sail.

The rapid expansion of the AT&T companies and the wild success of the Bell System soon caught up with itself, however, as the first job of the newly created FCC (1934) was to thoroughly and publicly investigate the Bell System. Gifford and his executives beared the burden of proof to the agency that the "natural monopoly" was necessary for the unified system of communication to
work and that the fact that the economic philosophies of a true market system were defied was justified to the extent of the unique type of service that it provided.\footnote{Boettinger, 174.} In fact, the importance of such a system was underscored in the government's postponement of the anti-trust suit until the end of W.W.II.

The extra demand of wartime communications under conditions of shortages of men and materials was met by the system's ability. By the end of W.W.II, the Bell System had over 1,200 major defense projects, including one half of all of the radars produced, microwave transmission, and weapons' fire-control systems. Bell Labs also finished the development of procedural inventions of statistical and quality controls that are now used throughout the world in all forms of manufacturing.\footnote{Boettinger, 196.}

Industry bounded, as the war provided a needed boost to the Depression economy. Pent-up demand for the telephone exploded. The availability of coaxial cable rapidly fueled network television growth, while direct long-distance phone calling became available in 1948. At the terminus of the war, the telephone microwave transmission techniques could once again be used, with a major transcontinental system being used by 1951. This system can be seen in the form of the tall towers with gigantic antennae that loom over the countryside. Long Lines became the department that controls interstate and international communications. Also ending Gifford's term and beginning Leroy Wilson's was perhaps the
greatest contribution to electronics, the invention of the transistor by Bell Labs.

**AT&T**

*Leroy Wilson (1948 - 1951)*

Under Wilson's command until 1951, basic service was solidified, giving the nation a reliable, quality communications backbone, with appendages reaching to all other countries. The efforts involved mostly concentrated on the backbone of the phone system, switching stations and lines.

**AT&T**

*Cleo Craig (1951 - 1956)*

The next five years were under Cleo Craig's command, culminating with the first transatlantic cable to Great Britain in 1956. Telephone services were starting to be offered in the 1950s, marking the first period in time, outside of two way voice communications and the time-of-day broadcasts started in New Jersey in 1927, that the telephone was used for consumer's information usage. For example, Dial-a-Joke and various escort and companionship services were two of the most popular.\(^{22}\)

Spears of government intervention, however, attempted to penetrate the seemingly armored AT&T in 1951. The Justice Department was now demanding papers and strove for the separation of Western Electric from AT&T. An FCC investigation, involving the current Justice Department's lawyer, Holmes Baldrige, had been started in 1939. It was from his experience in this

\(^{22}\)Brooks, 257.
investigation that Baldridge convinced Attorney General Tom Clark to sue to break up the Bell System.

However, AT&T had inadvertently gained some leverage. As the government was sifting the mountains of paperwork, Eisenhower had been elected President, and a new, Republican administration would take office. Also at this time (1949), the Atomic Energy Commission (AEC) asked Wilson to have AT&T take over Sandia Base, a newly created atomic weapons laboratory, from the University of California. In President Truman's and his AEC's requests, they admitted the government was not able to manage the new installation; they had also mentioned that AT&T was the only entity capable of managing the operations and producing nuclear weapons at the required efficiency. In Wilson's replies, he made it clear that the only way this would be possible would be to keep the organizational integrity of Western Electric and the Bell Laboratories. AT&T would make no profit in running the operations, but did it strictly out of national interest.

These facts, and seven years of litigation and private meetings with government officials led up to the consent decree on January 12, 1956 that laid the anti-trust suit to rest. The company wouldn't have to divest of Western Electric, but Western Electric now couldn't produce things for companies outside of the AT&T. The Bell System had to confine its business to common carrier communications and "incidental operations" (meaning government projects) and had to make all of its patents through 1956 freely available, and any new ones from then on would have reasonable royalty payments. After
22 years, AT&T now had legal substantiation that it was within the Sherman Act.

**AT&T**

Fred Kappel (1956 – 1966)

The FCC had been content to up until the late 1950s to mainly keep a watchful eye on AT&T, but events were starting to occur that caused the Commission to change its thinking. The subject of private microwave relay lines (not connected to the public switched phone network) is what actually started competition. Motorola had had a large share of the microwave relay market during the 1940s and 1950s (as was allowed by FCC regulations). Previously, these systems had been extremely small and company specific, but Motorola wanted to expand their market share with these types of systems to give more businesses a choice. Starting with its Above 890 decision in 1959, the Commission gradually started the opening of competition and usage in parts of the industry. Under this specific decision, companies could use private microwave communications systems if they were cheaper than AT&T's.23

Because of this decision, many start-up companies like Microwave Communications, Inc. (MCI) were started to take advantage of this new market segment. MCI was incorporated in 1963 and applied with the FCC for approval for a microwave link from Chicago to St. Louis. It wanted to sell its usage to companies in small blocks. However, its application would be caught up in the FCC approval system for five years.24

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24 Temin, 47.
Realizing that the industry was becoming somewhat of a marketplace, the current president of the Bell System, Fred Kappel, spearheaded the movement towards customization in the areas of the service itself, as well as the hardware. Some of these would require undreamed of technological innovations in the years to come. For the average customer, limited choices became available in the styles of phones, and in some areas (with the invention of the electronic switching equipment, ESS, in Illinois in 1960) advanced new features. Most of these are now taken for granted: call waiting and forwarding, for example. Businesses now had specialized systems available to them. By 1966, Bell had even developed ink-jet printing for its teletypes.

Arthur C. Clarke, a notable futurist and science fiction writer, first proposed the idea of using relay satellites for communications for "an international microwave radio telephone system" in 1945. That idea turned into reality when AT&T built three prototype satellites in the 1950s and asked NASA for control of the entire communications field. It was denied. The first communications satellite, Telstar I, was put into orbit on July 10, 1962, the same year a newly formed subsidiary, named Bellcomm, was contracted by the government to work on the systems for the Apollo space program. Telephone and television signals could now be sent between Europe and the U.S. by satellite and this event seemed to lead AT&T’s political debate to establish private interests in space.

The government's legions of senators and officials rallied to counter AT&T's argument that "a satellite communications system

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25 Brooks, 274.
was only an extension of the existing telephone network and that it should be owned and operated entirely by private communications companies. They philosophized that it would be a space program, that space is public domain, and therefore that the communications net is also public. This policy was solidified by incorporating an entity called Comsat, a public-private partnership that launched and operated its own communications satellites, leasing circuits to communications companies.

Unfortunately, AT&T was suffering from a stuffy image in this era. The extremely conservative company had grown to a tremendous size. Its stock was considered one of the bluest of the blue-chips on the stock exchange because it was selling for astronomical amounts and because of the $9 dividend that had never been reduced. After much discussion from the conservative quarters about the dividend payout, it was decided to split the company's stock three ways. This helped transform its "old and big" image to one of a high-tech, "growth" company, as the stock became more affordable for smaller investors. The strategy was successful and it solved its debt-to-equity problem by bringing on many new investors. However, at the same time, a cloud the size of the federal government once again hovered over the system in 1964 with another investigation.

From the FCC's inception in 1934, rates had not been regulated. Only informal discussions between the agency and AT&T had occurred. Now, in 1963–4, pressure for investigation increased and an inquiry would ensue. The investigation involved such questions

26Brooks, 275.
of returns and revenues as to allow the company sufficient means to reinvest and continue to provide the public with adequate service.

**AT&T**

**II. Romnes (1967 - 1972)**

The next president, II. Romnes in 1967, would be the first private sector manager ever to direct over 1,000,000 people. He was also at the start of a burdensome, litigious era. The government and telecommunications entrepreneurs alike demanded that Bell's social ends were not in accordance with the idea of a market economy. For the previous 100 years, Bell had offset the low cost of service in certain areas with higher costs in others in order to provide everyone with a phone; more cost is incurred in wiring houses that are kilometers apart in rural area than in the wiring of close-quartered urban areas. Some companies wanted to sell its equipment to use the Bell lines while others wanted to use satellites to provide long distance service. All of this pressure to change occurred at the same time as record amounts of usage strained and deteriorated service in big cities. It was even becoming standard policy that welfare recipients needed phones. To make things worse, unionized electrical workers were staging major strikes at the same time as the company was in the middle of a capital crunch to finance new construction in keeping up with the usage.

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27Boettinger, 182.
28Boettinger, 183.
The first sign that the FCC was resigned to reestablish competition in the telephone industry happened in 1968. Previously, subscribers could only attach Bell’s (or the independent companies’) equipment to the system in order to maintain its integrity (and profits), as protected by interstate tariffs. On the black market, though, many antique and other phones were being sold and illegally connected to the lines. In June of 1968, the FCC decided in its Carterfone decision that customer-owned equipment be allowed connection to the system as long as the telephone company could install devices to protect the network from damage.\(^3\)

William McGowan, a venture capitalist who stumbled onto the fledgling MCI in 1968, fought hard as its CEO in the FCC application hearings to bring the company into the industry. McGowan’s argument was for direct competition against the Bell System for certain services. After months of panel discussions and review, the Commission agreed with his ideas that MCI would be a flexible alternative to AT&T for "'interoffice and interplant communications with unique and special [microwave] techniques'" and accepted its application into the industry.\(^4\)

MCI’s microwave lines, still single user a year after the company’s inception, wanted a way to tie into the communications net, and McGowan posed a question to the agency of whether it would be considered a customer or a competitor of AT&T. MCI argued that new entrants into the field could be more flexible towards its customers than AT&T. The government eventually

\(^3\)Temin, 45.
\(^4\)Temin, 50.
agreed and MCI and any other "common carrier" independent companies were allowed licensing for intercity microwave transmission relays for private leased-line business use and connection to the Bell System in the document *Specialized Common Carriers* in 1971.\(^{32}\) This was an important development for competing companies, as then these systems had access to the expansive, public switched telephone network. The decision also allowed any terminal equipment that met FCC specifications to be connected to the network. This action forced AT&T to the controversial restructuring of its rates call cross-subsidization: local usage prices would have to support competitive prices in the microwave private lines, setting the stage for the regulatory battle that would follow in within years.

Now there was real competition in the industry for terminal and some interconnection, and the competition exploded as competing companies advertised how their prices were lower than Ma Bell's. MCI was becoming large, with revenues by 1973 at $15 million with its leased lines.\(^{33}\)

**AT&T**

**John DeButts (1972 - 1978)**

A prodigy of Vail, John DeButts took over as president in the turbulent time of 1972. As a strong speaker and clear-minded thinker, he had the ability to visualize the true goals and communicate them in this new context. As an orator, he gave 300 speeches in 3 years, many of which involving commission hearings.

\(^{32}\)Temin, 51.

\(^{33}\)Brooks, 300.
In Seattle in 1973, DeButts delivered an important speech, regarding competition and the deterioration of service. In his speech he talked about "...the ill effects of contrived competition and artificially segmented markets...customers would be harmed by the deterioration of service and high costs." and restated Vail's original philosophies of "...being concerned about the welfare [of the consumers]." and non competition. The speech served to solidify the company's stance on competition issues and to spur much more debate over the exact definition of the telecommunications network.

One of the government's chief allegations against the Bell System had always been its relationship to its manufacturing arm, Western Electric. Since AT&T owned 100% of Western Electric, what was to prevent the supplier end of this arrangement from raising its rates? The FCC thought that, under its Carterfone decision, AT&T should purchase components from a variety of suppliers. Western Electric answered that its prices rose only 7% between 1950-1974, much less than the government CPI indices, and that it also has many suppliers.

AT&T's initial protests to the government with the implementation of these competition policies were based on the grounds that AT&T had to unjustly maintain the unprofitable, higher-cost links between small cities. DeButts argued that competitors could break in on the lucrative side of the business without having the financial and moral burden of the unprofitable.

34Boettinger, 186.
35Brooks, 280-288.
Also contributing to AT&T’s internal apprehension towards competition was its organization. Because the company was organized under Vail in 1909, the concepts of markets and competition for terminal equipment did not exist. The company was simply handicapped by the fact it didn’t have the administrative support or structure for these functions. DeButts and other AT&T executives were realizing that marketing was needed as an operating goal, in contrast to the age before when it only needed to overcome technological problems to achieve its goals. The goal of universal service basically had been fulfilled, and the attention then had to focus on research and development and innovations suited to the customer’s needs. DeButts acknowledged that AT&T would have to transform itself from a "quasi-governmental" phone network into a consumer-oriented and market-based company. The network took top priority, but it was clear that some restructuring would occur.

In 1974, the culmination of the FCC investigations would hit the courts in the largest federal antitrust lawsuit ever filed, brought on by the Justice Department.36 Much of the war to maintain Bell’s regulated monopoly in 1974 was fought within the frame of rate regulations and restructurings as well as the basic tenant of competition. The FCC was torn between its conflicting ideologies of competition and keeping local phone rates low (made possible by AT&T’s nation-wide price averaging).37 In effect, the agency and its clashing policies themselves caused much of the regulatory and judicial confusion of the time.

36Brooks, 302.
37Boettinger, 78.
To sum up AT&T's trouble, DeButts' speech in Seattle to promote debate had initiated a war against three anti-trust suits: by the FCC, MCI, and the Justice Department. Were MCI and the other entrants going to be considered as competitors to AT&T or as part of the same universal carrier network? MCI began to demand connection to Bell's exchanges, thereby giving itself connection to other cities; a district court ordered the interconnections in 1974. More intragovernmental contradiction surfaced as it became apparent that the FCC regarded MCI as a customer of AT&T, while the Justice Department regarded it as a competitor.

Judge Skelly Wright overruled the FCC's case, Specialized Common Carriers, regarding the rights MCI and the others had in offering services similar to AT&T's. In specific, the federal court allowed the entry of competitors into only the long-distance part of the network in 1978. It was agreed that the new carriers would pay a graduated percentage of Long Line's (AT&T's long distance department) costs to AT&T for local interconnect charges.

AT&T
Charles Brown (1979 - 1984)

Competition in the industry meant more than just a surface choice of terminal equipment. It also determined a telecommunications company's implementation of technology. A good example of this was the disagreement between marketing and engineering departments in AT&T. As an example, in the 1970s,

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38Temin, 105.
39Temin, 102.
40Temin, 134-136.
Private Branch Exchanges (PBX) were being purchased by private corporations and governmental units for their in-house phones. The technology of these systems soon crossed into the digital frontier as companies demanded direct computer hook-ups to these systems without using acoustic modems.

In order for any discussion of newer technologies in the telecommunications industry to have any bearing, it becomes necessary at this juncture to explain the difference between analog and digital. These are two technologies used to transmit information in an electronic system. Analog transmission in the electrical sense is defined as oscillations (vibrations) in an electromagnetic field (a telephone wire, for instance) that exactly represent the input. For example, voice is an analog representation of sound waves. Digital transmission is simply pulses in the wire in the form of electrical ons and offs represented by '1's and '0's, respectively. Computers that control complex switching and advanced feature functions cannot directly process these complex analog signals, and they therefore have to be converted into the digital pulses of 1s and 0s for input. Bell Labs researchers argued that it would be useless for the customers to have digital devices if the network switches were still analog. However, AT&T's marketers knew that the customers wanted the newest technology, and that customers cared little about the appropriate evolution of the network. In effect, companies such as GTE, Great Britain's ITT, and Canada's Northern Telecom were leading the market with their own digital systems. Vail's

\[41\] See Appendix B.
\[42\] Temin, 151.
philosophy of Universal Service, originally stated in 1885, had become irrelevant in the light of the new marketplace; AT&T's new president, Charles Brown, quickly iterated a new one: "AT&T would concentrate on the needs of business in the information age." 43

Marketing was definitely an area in which AT&T was struggling. Brown had reorganized the company in the early 1970s, but in doing so had compromised AT&T's commitment to provide businesses and consumers with the best possible solution for a specific situation. It pitted two competing technologies developed by separate divisions. As one of the larger examples, the PBX in the business products division was competing against the new Centrex system (a digital system located at the main switching office that does exactly what a site-based PBX does) from the operations division. This argument encompassed some of the engineering staff as well; some of the early supporters for the digital conversion of the phone service resisted the idea of analog PBXs being installed. Historically, the emphasis of AT&T's operations had been on implementing technological innovations to create a national telephone system, but the early years of the 1970s were forcing the company to focus its efforts on terminal products and business needs.

In 1979, AT&T finally recognized long-distance competition in its legislative battles and sought to remove its restraining rate regulations so it could compete against the new entrants of MCI and Sprint. AT&T wanted to compete while retaining all of its local Bell Operating Companies, Bell Labs, as well as the long distance division.

43 Temin, 168.
but its efforts weren't enough since the case wound up in front of Judge Harold H. Greene.

Since 1974, the Justice Department's anti-trust suit had not received hardly any attention from the government. However, with the appointment of Judge Greene to the U.S. District Court for the District of Colombia in 1978, cases were reassigned. Being an activist, Judge Greene wanted a speedy settlement when he got the suit.\textsuperscript{44} After some months of exhibits and deliberation, a plan was drawn up by FCC regulators, entitled "A Modification of Final Judgment"\textsuperscript{45}, that was eventually accepted by AT&T and the court. The operating companies would be separated from AT&T. They could not provide interexchange long-distance service, electronic information services, nor customer premises equipment. The exclusive licenses between Western Electric and AT&T were to be terminated. A later revision gave back the revenue-generating Yellow Pages\textsuperscript{38} to the operating companies and allowed them to produce terminal, customer premises equipment after five years. AT&T was also banned from the new field of electronic publishing for seven years, but Bell Labs would remain a part of AT&T. The 22 operating companies were divided into seven regional holding companies; this was done to give each new firm a sufficient amount of assets in order for them to be able to get reasonable rates for needed capital. The "Baby Bells" were named Southwestern Bell, BellSouth, Pacific Telesis, Bell Atlantic, Ameritech, US West, and NYNEX. Bellcore was formed in AT&T to control some previous general functions as well as to service the

\textsuperscript{44} Temin, 202.
\textsuperscript{45} Temin, 269.
Defense Department. A subsidiary of AT&T, AT&T Information Systems, was created to sell equipment since the court wouldn't allow both long-distance service and selling in the same part of the company. AT&T Technologies was to assume the Western Electric charter at divestiture. The Bell System was effectively dismantled in one instant on December, 31, 1983. Telecommunications would never be the same.

In telecommunications first century, it developed to anticipations of customer desires and executed with technological potentiality. By 1976, AT&T was the only major telephone company not run by the government. AT&T stood squarely in the face of our principle of free enterprise with its regulated economy. However, it had run under the auspices of the government in this monopolistic fashion because of its ability to continually provide the highest standard of telephone service in the world at reasonable costs. The company has been able to survive the most horrendous of financial times (Great Depression) and the explosion in demand for the telephone without compromising its quality of the service provided nor charging outrageous rates. AT&T, related companies, and competing companies have proven that only in a private investment/capitalistic economy can this type of industry meet the needs of the people and flourish in its innovation and implementation of new technologies at reasonable costs.

The fact that people have become reliant on the services of the telephone is supported by the statistics of telephone growth itself.

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46 Temin, 336.
47 Brooks, 95.
48 Brooks, 4.
Even as of the early 1980s, installations have long been at the saturation point, as usage is nearly universal in the U.S. However, this remains as a direct contradiction as to why demand is continually skyrocketing. Attempts have been made by mathematicians and others who study the field for some quantitative measures of this, but have discovered that demand does not grow in direct proportion to the population, nor does it grow by its square. It grows faster. One Bell Labs researcher theorized that increasing mobility in the population (away from families, in the field, etc.) is one of the main reasons. Also affecting the usage is the fact that people appreciate the simplicity of the telephone and its infrastructure. A person can just pick up the receiver, dial a person's number, and not have to worry about how the system works. In relation to other systems of telecommunication, the telephone system is viewed by the general public as a stable, reliable, and user-friendly interface. From experience in the public's acceptance of this simple interface, it can be inferred that any new telecommunications system would have to be as easy and familiar to its customers.

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49Kleinfield, 16.
Basic Telecommunications Technologies

Somewhat synchronous with the breakup of AT&T and the entry of competition into the now wide-open market of telecommunications, the profusion of various new technologies and their applications started to contribute greatly to the information age that was dawning. In fact, the early role of telecommunications was to provide services to computers. This new information age is the revolution where now the computers are providing many services to the field of communications: telephone, facsimile, radio, television, satellite communications, and cellular phones are today all heavily reliant on computer technology.50

Computers

It seems logical that the first uses of computers in communications were used by the telephone companies themselves. As already seen in Bell Labs' development of ESS in the 1960s, they facilitated the high speed switching and advanced phone features demanded by a large population. The newest switches are all digital, requiring analog conversion before switching. These digital types of systems are, therefore, very adept at switching digital computer communications. Many manufacturers today build and compete for sales of digital switches around the world. Computers also service the telephone industry by frequency division multiplexing and time division multiplexing conversations. Both of these mathematical

compression techniques are used to increase the number of conversations over the same wires. The former separates and recombines conversations into different frequency ranges for transmission, while the latter samples the conversation many times a second, thereby not having to transmit the entire conversation. Businesses make excellent use of multiplexers in order to save money in sending data between factories or offices.

Beginning of data telecommunications

The beginning of data communications is typically viewed as the issuance of the Bell System's 1960 report, *Capabilities of the Telephone Network for Data Transmission*.

The report compiled two years of testing by AT&T to determine if computers could communicate over the network with reasonable error rates. Because of Bell's excellent construction and maintenance of the system from its inception, the report was positive. Computers were already transmitting data over regular copper wire telephone lines by the 1960s, but this usage remained limited to individual companies, labs, or other special interests. The earliest forms of telecommunication with computers involved the use of a modem (MOrulation DEModulation) device to send data by acoustical (infer: analog) connection to the telephone lines.

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Modems—The Basis of Data Communications

Using modems, the communications interfaces of the computer, the computer can utilize the existing vast, voice telephone network to communicate. Standards and protocols are necessary for the communication to happen, many of which were developed by Bell Labs, are now regulated by the CCITT (the International Committee on Telephones and Telegraphs), and are continually updated for new technologies. These protocols are much like the rules of the road. On the "information highway" they serve as speed limits, traffic courts for mistakes, and police officers for controlling the flow of traffic. A modem works by emitting an audible carrier wave that other modems can acknowledge and respond to. The device then, by definition, modulates this signal to the 1s and 0s that are being transmitted. This is the technical basis behind all computer telecommunications using the existing analog infrastructure, and also happens to be the way a fax machine functions. The need for modems will be eliminated when all-digital channels are eventually put into place. Computer terminals are good examples of modem usage in business. They are typically used to call up information from a central computer at a far location.

First Generation

First generation computers used off-line techniques to transmit information; computers were not directly linked, but teletypewriters were used with punchcards. After the teletypewriter gave the operator a piece of paper with the information punched into it, he would insert it into a mainframe computer for data input. The IBM
1013 terminal was a widely used example of the card reading computers.52

Second generation

Towards the latter half of the 1960s, the second generation of computers began to use on-line communications that connected the computer terminals directly to mainframes. The original stimulus to the development of these networks was the cost-saving measure of sharing expensive resources. The IBM 360, Honeywell 600, and Univac computers are examples of some that were networked.53 With developing technology, message switching and remote batch processing of data were then possible. On-line systems are, of course, much faster since the intermediate step of card reading isn't necessary. The military, law enforcement agencies, and travel agencies began using these types of on-line systems in this time frame. As an example, travel agencies call the airlines' central computers on a dedicated line to schedule reservations. A dedicated line simply provides a telephone line for direct access without the switching in the public telephone network to the remote computer. Video terminals and printouts are then used in this context for information retrieval.

These types of remote access to computers from around the country are termed as Wide Area Networks (WAN); the telephone system is even a WAN. The development of these systems was also led to the beginning of Local Area Networks (LANs), which are

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52Asten, 8-9.
networks of 1 meter to 1 kilometer in range. Early LANs were based on packet networks which broke information into "packets" of data for transmission over the network. Packet networks themselves had been started in 1969 with Arpanet (Advanced Research Project Agency NETwork), a project of a federal government agency that connected UC Santa Barbara, SRI, and Utah. This WAN network was used to develop LANs.

Third generation

Third generation systems used front-end controllers that were attached to the mainframes to provide communication with the remote terminals and to alleviate the load on the main computers. Minicomputers were developed in the early 1970s that were powerful enough to perform some functions of a mainframe, but were used as these front-ends. Broadband (basically a dedicated, high grade voice line) transmission techniques were also being used by this time.

Fourth, fifth, and sixth generations

As processing power increased and became cheaper, more minicomputers and terminals supplanted previous mainframes in business information systems. LAN and WAN usage began to take off with the larger size companies and government agencies.

Personal computers were originally developed in 1975 with the Altair computer. Apple computer pushed along the market in 1977 with its Apple II computer, and by 1981, International Business Machines (IBM) had developed their version, the IBM PC. Various
companies and models have come and gone since personal computers were invented, but the concept of using small, personal, desktop microcomputers has remained essentially the same. Personal computers (PCs) provide an economical way for anyone to have access to a computer for information processing. Faster processors, high-capacity storage systems like CD-ROM (Compact Disc-Read Only Memory), built-in modems, and facsimile integration are currently providing the capability to manipulate massive amounts of data for both home and business use. For example, the entire *Grolier Encyclopedia* of 21 paper volumes is contained on one disc. The computerized version includes text, graphics, and sound clips. This combination of ways to present information (as compared to just text) is referred to as "multi-media".

Business information systems continue to develop with a combination of mainframes, minicomputers, personal microcomputers, and telephone technology. The big drop in the cost of equipment and the increased performance has been providing a good economic reason for the networking in LANs and WANs over the last ten years, but data telecommunications is not limited to just computer terminals, LANs, and WANs.\(^5\) The telephone itself can even be considered a form of terminal, as the keypad of a touch-tone phone can be used to send data to a remote computer. This application is becoming increasingly popular today as many digital PBXs are programmed to give voice instructions and obtain or receive information in response to the tones sent by the keypad.

\(^5\)Portier, 6.
Facsimile

Facsimile (fax) machines have been around for a long time, but only with recent relaxations of access to the public phone system and digital technology did the medium take off. The fax was actually invented in 1843 by Alexander Bain in England. It used a telegraph system in which the electric current was broken by raised metal blocks instead of a key. Interestingly, this is a crude digital method of transmitting information; technology advanced into analog methods later, but current fax machines use digital transmission (albeit with fast electronics). Commercial use of the medium didn’t take off until the development of the photoelectric cell in the 1870s, when newspapers provided a market by wiring photographs. Newspapers desired to provide the resources necessary and the first transmission of a photograph occurred in 1902 by Arthur Korn in Germany. It soon became possible (1920s) to send photographs via radio over the Atlantic. The large newspapers even had experiments in 1940 to send newspapers directly to subscribers’ houses using UHF radio frequencies. The technology was used extensively by both sides in W.W. II. The analog versions of the fax enjoyed limited usage (with the exception of Western Union, who sold 50,000 in the 1950s to larger companies that wanted direct contact with the telegraph office) due to its slowness and pungent reproductions.55 The 1968 Carterfone decision helped spur some development as well, as any fax machine could have direct access to the telephone network.

55Coopersmith, 46-47.
The developments that followed came from Japan, as U.S. companies chose not to invest in the new digital technology of the late 1960s. Japan remained committed because its symbolic alphabet is difficult to transmit by telegraph or telex. The use of new camera technology, laser scanning, and clean thermal printing brought fax technology into the digital realm, and hence, wide acceptance. With standards from the CCITT (the International Committee on Telegraphs and Telephones), the world became an even smaller place. No other medium of communication "combines immediacy, imagery, and hard copy."\(^{56}\)

The carrier emitted from a fax machine is slightly different than a modem's, but is modulated in the same way to send pictures. The information sent is created from the optical scanner in the fax machine recognizing differences between the light (blank sections) and dark sections (print) of the page that is being faxed. Since the transmission and receival functions of a modem and a fax machine are very similar, it became natural for fax capabilities to become available in conjunction with a modem. In fact, any modem in a computer can be used to transmit information to a fax machine, but a few special circuits are needed to receive fax information.

Fax usage is being swept into the electronic office and the resultant information superhighway by its integration into the desktop PC. GammaLink was the first company to offer a faxboard that goes inside a PC in 1985.\(^{57}\) The capability of integrating or accessing computers with fax machines is a powerful one, as

\(^{56}\)Coopersmith, 48-49.
\(^{57}\)Coopersmith, 49.
receiving computers are often equipped with optical character recognition programs that can turn a page into editable text for a word processor. Accessing a computer by a fax machine over regular telephone lines to get a hard copy of information is fast becoming an indispensable method of information retrieval due to its convenience.

Radio

Radio has always been an important component of telecommunications, as it provides the very basis for "wireless data." Outside of broadcasting, it was used in its early days for long-distance transmission of telephone signals. Today its use is both localized and over long distances. The FCC has sanctioned portions of the frequency band for use by broadcasters, police, taxi, maritime, aircraft, and other users. These frequencies provide two-way voice and data transmission; data can even be sent in conjunction with voice. It is radio waves that connect GTE's Airphone®, installed in passenger seats of 13 airlines, to its 49 ground stations patched into the telephone network. Higher frequencies called microwaves are used, as already discussed in the MCI case, for telephone links between local exchanges and long-distance carriers. In fact, it is microwave frequency radio that is the foundation of cellular telephone systems.

Cellular Telephones

Cellular telephony was invented by Bell Labs in 1947, but use was extremely limited due to lack of high-powered computers for control. In 1982 the FCC licensed two carriers in each metropolitan
area for this technology. One of the licenses went to the existing telephone company, while the other was selected from a group of applicants. Equipment manufacturers, such as Motorola and OKI, quickly teamed up with the new local carriers to get a hold in supplying the new industry. A city is divided up into many 2-10 mile-wide "cells", creating an imaginary grid, with a low-power microwave transceiver tower in each that transmits to and receives from all of the mobile/car units in the cell. The tower is connected by dedicated lines to a central site that is in turn connected into the local telephone office. Only a limited number of radio frequencies are available, and the division of an area into cells becomes necessary to have many users use the same frequencies and still have private conversations. As the mobile/car cellular user moves from cell to cell, powerful computers at the central site transfer the call from cell to cell, maintaining a seamless interface to the telephone network. The only differences between car phones, bag phones, and portable phones cellular phones is size, portability, and power; they all use the same system. Currently, most existing cellular systems are analog. That is, voice is transmitted over the microwaves the same was as it is over the telephone: the speech waveforms modulate the waves. However, the system is subject to much interference and therefore is not very reliable for data transmission. Newer digital systems that provide for error correction, data integrity, and perfect voice clarity are beginning to supplement the analog systems as the cost of the technology decreases.

58See Appendix C.
Personal Communications Services

Personal communications services (PCS) is a newer form of cellular telephony, and is being designed to utilize existing infrastructure and a reallocation of radio frequency usage by the FCC. The systems are currently gaining momentum as they are cheaper to build than regular cellular systems. This is because the frequency spectrum being allocated to PCS by the FCC in May, 1994 is triple the space allocation of the current system and because the receiving module antennae are mounted on cable TV wires, instead of expensive towers.59 The hope of this system is to provide telephone and wireless data service to personal computers at a cost similar to regular, wired telephones. Another goal of the effort, lead by MCI, is to provide a seamless, national system that allows people to retain one telephone number wherever they roam (for life, if desired).

Television

Television works on exactly the same principle as radio, using a different and wider section of the frequency spectrum. There are a variety of systems that broadcast information in certain spaces in the signal during transmission. However, this space is small and only a limited amount of data can be sent.

Cable Television

Besides being broadcast from an antenna like radio, television signals are also sent out over cable. Since a television signal takes a width of 6MHz on the frequency band, a coaxial cable (which Bell Labs previously invented) must be used to carry that much information. Cable systems use multiplexing to send many signals (channels) over the same wire.

The first cable system was built in 1950 in Lansford, PA to provide local TV service to residents of the town who couldn't receive broadcast television signals because of the mountainous terrain. The owner of an appliance store erected the system merely to sell more televisions. This type of system was used somewhat in small towns with the same type problem. Only a decade later did the system really catch on; cable television operators were discovering that the viewing audience wanted programming from the big television networks, and consequently they built microwave systems to access this programming.

Broadcasters and the FCC began to see the impact cable would have on the industry in the late 1960s. While the Commission had prevented a majority of the cable programming from being offered in the largest cities in the U.S., big communications companies such as Cox, TCI, Warner, Viacom, and Time-Life were buying up these small, scattered systems and turning them into larger organizations. They anticipated that cable would be offered in these large cities after certain regulatory issues were worked out. The communications industry also recognized the ancillary data services that could be sold
as well, but the demand for this capability was virtually non-existent.

Cable has expanded greatly in the past two decades to a point where a vast majority of the population is now wired for cable. Services offered have also expanded past the basic television programming to offer such services as live stock tickers, live congressional hearings, all-news channels, all-weather channels, and many others. Currently, cable companies are petitioning the FCC and the Justice Department to provide telephone services.60

Satellites

Satellites remain as an integral part of the telecommunications network. There are currently around 50 satellites orbiting the earth that provide channels for long-distance phone calls, television transmission, radio programs, and other sorts of electronic information. Satellites are pieces of hardware that are placed into what is called a geosynchronous, equatorial orbit 22,300 miles above the earth's surface; the geosynchronous orbit allows the satellite to receive and send signals over the same places on earth at all times. Satellites use transponders (channels) on different frequencies to send their signals; a single transponder on the majority of the existing satellites can carry one color TV channel, 1500 simultaneous phone conversations, or 50 million bits of data per second.61 There are varying types of satellites, containing 10 to 20 transponders

apiece. Those transmitting on higher frequencies can be received by smaller dishes. Certain private satellites, such as SBS from IBM, Aetna, and Comsat, offer intra-company communications to large corporations, while others lease transponders to companies that provide video service directly to homes or to cable companies for broadcast over their lines.

Direct Broadcast Satellite (DBS) is a newly implemented system that can be received by dishes only 18" in diameter. Originally designed around 1977, the cost of building powerful enough satellites outweighed the benefits of the smaller dish size and precluded its use. Many channels currently exist for reception by large (1 - 2 meters), which are broadcast from older and weaker satellites. However, home usage of such large setups is not very popular because of the signal quality and size. Only around 4.2 million have bought this type of system, and most of these also have cable. Using digital compression technology to increase the number of channels available and to increase signal strength, Hughes Communications will deploy a satellite in 1994 that will have 150 channels available for broadcast to these micro size dishes.62 The investors believe that the ease of use, small size, and digital picture quality will provide a market for DBS. Not just a cable TV alternative, this system has a stake in the information services provided to homes since its digital signals are received by a set that connects to personal computers as well as televisions for data retrieval.

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One of the more interesting projects in satellite communications announced to date is the Iridium project by Motorola and its partners. Iridium, Inc., will send into low earth orbit and operate 66 satellites for global communications. The system will allow any person anywhere on earth to call anyone else in any other place using portable handsets like telephones. The satellites will have the ability to hand-off calls to other satellites and have on-board switching. Set up as an independent entity, investors Motorola, Nippon, Sprint, Lockheed, and many others will have a stake in the new system. They will all be allowed to operate the "terrestrial gateways" that connect the satellites to customers and the telephone network. The $800 million raised in financing so far will go towards the private sector's launching and operating of the system, further boosting the rush to privatize space development. Expensive at first, the system is viewed to be the ultimate in global telecommunications. Even though satellite technology appears as a direct rival to fiber optic systems and cable television, that has not really been the case.

Some of the difficulties with satellites include congestion in the equatorial orbit, some interference from the sun, local radio interference, and the .27 second delay that it takes for a satellite to receive a signal. Fiber optics technology has a seemingly unlimited

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65 Thomas, 173.
potential when one acknowledges that its speed (and therefore, the amount of data sent) is limited only to the speed of the laser.

A Global Telecommunications Network

A global telecommunications system is evolving from the integration all of these systems for the most cost-effective methods of communicating and transmitting data. No one technological form of telecommunications will likely ever exist, but rather a combination of fiber optics, Personal Communication Networks, cellular telephone systems, satellites, cable companies, as well as the regular switched telephone network, will provide the communications network of the future. It is highly plausible that a combination of fiber optics in the switched telephone network and in the cable systems will comprise the backbone of a future information highway, while satellites, cellular information systems, and PCNs will serve for distribution of the information.
Electronic Publishing and Interactivity

Starting in the early 1980s, interactive information retrieval was fueled and irrevocably changed by the tremendous growth of personal computer sales. Changes in technology affect storage, processing, and the retrieval of electronic storage systems. The interplay between these new technologies in these interactive services and untested marketing assumptions is showing its reality in the marketplace.66

"Videotex" was originally the generic name for these types of electronic publishing and interactive services, but current grammatical usage favors "on-line services." Videotex67 was originally conceived as an interactive system that, when connected to by a special terminal, could deliver text, numbers, and graphics via the telephone or two-way cable wire. The information provided by the services is stored in large, mainframe computer databases that are dialed-up by these terminals, which were sold by the system's operator for anywhere up to $900. Thus, a user could dial-up the service and receive text-based, screen by screen information on a variety of subjects. In most of the first services of this technology, the operating companies went bankrupt due to the user's dislike of the expensive, dedicated terminals. A lack of updated and useful information also plagued these systems, as they were hard-pressed to create their own information. Notably, two of the biggest failures

67Teletext is a different system that offers only one way transmission of text information over unused portions of the television signal on certain stations.
were Knight-Ridder's Viewtron system in Florida and Time Warner's Gateway.

Information in different subject areas, such as in a newspaper, make up the bulk of information that is accessed. News, weather, finance, sports, and consumer information is continuously updated and available to the subscriber, usually for a monthly fee. Videotex services offered to the home or business are also able to be tailored to a user's preference. A "basket" of services that the subscriber uses the most would be immediately accessible, rather than buried in a maze of commands.

However, in the midst of consumer resistance to videotex, a number of on-line databases appeared that catered to a variety of computer brands on a national level. Anybody with a PC, modem, and software could call up free bulletin boards (BBSs) or fee services, such as Compuserve, Dow Jones News/Retrieval, and The Source.

The services for the PC generation were more specific and were directed towards niche markets, creating a rather substantial base of users. Also facilitating their use was the general acceptance of only about five different kinds of PCs, that could all access. For example, the Dow Jones News/Retrieval (DJNR), containing information from the New York Stock Exchange, Wall Street Journal and Barron's, was aimed directly at the financial markets. Compuserve went after the PC users. Both of these services survived and now define the practice of electronic publishing because there was already a need for this type of information as well as a base of interfaces already

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68"Online" means information available from sources that can be accessed instantaneously via the telephone system or another type of communications system.
existing. The services can be accessed on a world-wide basis. Believing that any type of electronic publishing system has to have cohesion and editorial unity, DJNR's director, Richard Levine once philosophized the service's planning:

People will tire quickly of the razzle-dazzle of technologies and it will just become a quaint, unused gadget if it doesn't deliver useful, accurate, reliable services- both news and informational and transactional services. Shopping and banking at home-these will come later. But if it doesn't serve some real needs as we do with newsprint, then it is nothing more than a piece of exotica.

It was the expansion of the service, from the NYSE tickertape only format in 1974 to the wide variety of databases available in 1980, that introduced the art of electronic publishing. After 1984, DJNR offered the full text of the Wall Street Journal and Barron's from present back about ten years. Real-time and historical quotes on stock can be obtained as easy as personal tracking of 125 companies. These sophisticated services, with text search and encyclopedias, provided a value-added dimension that could eventually pay for itself and save a company some money. This value-added benefit of on-line services will also benefit the general consumer market, but only when the price comes down more.

Both DJNR and Compuserve demonstrated the exploding trends in electronic mail and conferencing. Throughout the middle and late eighties, free "bulletin boards" (basically teleconferencing) sprung up all over the country to create a new era in democratic and interactive communication that is far better than simple frame-by-frame text retrieval or newsletters. Richard Baker, Director of Communications

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69 Aumente, 69.
at Compuserve, determined that electronic mail was the most popular use of the service. MCI is one of the major carriers that carry electronic mail.

Electronic mail, or E-mail, is quickly becoming an indispensable tool for communication in the general consumer market as well as the business and government users. E-mail is simply a generic term for the function of the above services (and many others) that allows users to send electronic messages back and forth to each other. The messages are typed in the fashion of a note or letter and sent to electronic mailboxes (memory locations within the services' computers, actually) for retrieval by the recipient at a later time. E-mail can be company-wide or world-wide, depending on the system used. In the business, governmental, and university sectors where E-mail got its start, the concept was utilized because of its immediacy, economy, and consistent availability.

Many times, E-mail is preferred over telephone or facsimile communications. In contrast to the spontaneity of communication in telephone conversation, E-mail is perfect for users that want to take time to compose a message saying exactly what they want, but want the capacity to send the messages instantaneously. In fact, E-mail can even be considered somewhat of a return from the telephone to the more cultured communication form of letter writing. Because fax machines are typically shared by many people to save costs and use expensive paper, E-mail is preferred to send short messages. The general public uses E-mail to easily maintain an active social network and to keep informed of subjects that receive little attention in the

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70 Aumente, 73.
mainstream media. Some ambitious souls, in fact, set up "mailing lists" on specific subjects and send information to interested users. Voice mail is currently taking its place as a form of E-mail as computers are able to record and send their users' voice messages. E-mail's taking of a strong hold was demonstrated at a recent hearing by the U.S. Court of Appeals for D.C. on August 13, 1993, when the justices ruled that the federal government must protect the privacy of such messages.71

New Telecommunications Infrastructures

Currently, the telephone industry is responding to the increase of computer and other digital communications by installing extensive digital transmission systems. Spurred on by government policies and increasing competition for quality and comprehensive telecommunications service at the lowest possible prices, the industry has fostered the growth and application of technology in telecommunications infrastructures over the past few years. Long-distance conversion from analog to digital systems has already occurred on most long-distance equipment, and local and PBX systems are slowly being replaced. It remains, then, that changes in the wires from the telephone set in the house to the central office have to occur to accommodate digital transmissions. The latter part of this conversion is and will continue to be very slow in the making, as there are millions of such circuits to homes and offices that will have to be upgraded or replaced entirely. The ultimate form of the all-digital communications network is referred to in general as ISDN (Integrated Services Digital Network) by the telecommunications industry. A fully functional ISDN will allow a user to transmit data in any form (voice, data, pictures, and sound) from any place on earth to any other instantaneously. Although digital transmissions can take place over common copper wire, only fiber optical cabling or radio waves operating on high enough frequencies could be used to transmit the extremely vast amount of information contained in two-way digital communications in a public information highway.
The future of the telecommunications web is and will continue to evolve as the world-wide piecemeal installation of digital switching and transmission systems is completed. Most of the world's large economic centers have announced plans for or have thrust into beginning implementation of parts of the conceptual ISDN. The divestiture of AT&T has served as an impetus for countries around the world to privatize and to deregulate their respective telephone systems. British Telecom was privatized in 1984, with Japan and Belgium starting to become liberalized in 1985; many more countries are in the process. This significant shift in policy has allowed hundreds and hundreds of partnerships between communications companies and electronics makers in different countries to all get pieces of each other's foreign markets. It follows that private enterprise in these capitalistic economies have taken the initiative to provide services needed and to create a need for services that could be provided.

Japan's part of the ISDN was formulated as early as September, 1979. At the Third World Telecommunications Conference in Geneva, Nippon Telegraph & Telephone's vice-president Kitahara described their project, called Information Network Services (INS), as "the marriage of computers and telecommunications', and the Japanese expect it to be the key infrastructure of what they call the 'advanced information society' of the 21st century." The Japanese view their version of an ISDN system as a way of saving time, energy, and transportation. British Telecom has also started a pilot ISDN service in London in June of 1985. Based on a digital exchange in that city, it

\[\text{Forrester, 85.}\]
will continue to expand. Although originally a concept touted mainly by government and academia, ISDN is beginning to enjoy a good deal of direct and indirect support from business as well. Directly so in its financial backing of fiber optic and satellite networks, and indirectly by its use of Local Area Networks (LANs).

LANs are essentially high speed wires between computers, terminals, and peripherals in a local environment such as an office or factory. Usually, the LAN is controlled by a central computer or a PBX. The business' headquarters need ways of collecting information from its various LANs. This need can be fulfilled by ISDN, but many large corporations and institutions are fulfilling their own needs by creating private network loops, microwave towers, and satellite transponders. These devices, in effect, bypass the local telephone company. Two potentially grandiose problems of bypassing are a rise in residential local usage rates (as the phone company tries to make up for the lost revenue) and incompatible systems.

ISDN doesn't represent a physical entity or the acronym of a governmental or industrial project. It simply represents an objective for the entire telecommunications industry. The definition of ISDN is:73

An ISDN is a network, in general evolving from a telephone IDN, that provides end-to-end digital connectivity to support a wide range of services, including voice and non-voice services, to which users have access by a limited set of standard multi-purpose user-network devices.

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The definition by the International Telephone and Telegraph Committee (CCITT) views a common, world-wide, all digital electronic highway into a variety of computers and terminals in the office and in the home. Necessary for the full practicality of the network is the capacity for the use of several functions (services) at once. For example, a computer accessing a database, a television program being viewed, a telephone call being made, and funds being transferred electronically would all have to be able to occur at the same time to make the idea of a single connection into the home or office a reality. The objective of ISDN is, therefore, to provide a user with many services using only a single connection to the network.74

Presently, only one infrastructure is capable of the mass availability for users to access such a system as called for by ISDN. That is, of course, the telephone network. Unfortunately, even with the amount of information that is currently sent through the phone system, it has severe limitations. Since it was only designed for voice communications, the physical properties of the copper two-line telephone wire is only capable of carrying analog tone signals in the speech band (300Hz - 3400Hz). By contrast, a hi-fi stereo produces sounds in the 100 Hz - 20,000 Hz range. This narrow bandwidth is too constricting to allow efficient communications for high-speed computers (typically requiring at least 19.2 kbit rates that use the higher frequency range), high fidelity sound, and video signals. In the face of such stringent technological requirements for these new multimedia signals, dedicated private and public circuits for networks and transmission methods of data-only have exploded.

74Romayne, 2-10.
One of the methods used widely used in the industry to avoid the constraints of a single copper telephone circuit is called "packet switching." Because data exchange does not require a continuous two-way conversation, a packet of data can be sent in a manner in which the entire transmission doesn't have to maintain its integrity. A transmitter unit can divide portions of the transmission into packets to be individually sent over different circuits. The packets are recombined at the receiving unit, arriving much faster than possible with the slowness of a single circuit of the phone system.

Development of this technique occurred both in the U.S. and Europe, but its origination is the 1969 Arpanet.75 The state run French telephone system's KIOSK service has used Packed Switched Data Networks (PSDN) since the middle 1970s.76 In the U.S., GTE has been using them since 1975.77 Nevertheless, the application of new technologies is facilitating the ability to transmit great amounts of data as never before. The continual replacement of infrastructure by the private sector will begin to provide an all digital network, when such complex manipulation of data will cease to be necessary and when data transmission of all types will be much easier to accomplish.

The success of the ISDN, and indeed the complete revolution of telecommunications, depends mostly on the installation of fiber optical cables. Optical fibers are strands of pure glass about the size of a human hair. Lasers are used to send digital information in the form of light flashes. A photosensing device at the receiving end

75Refer to earlier discussion in the computer section on p. 45.
76Aumente, 36.
77Aumente, 80.
sees the flashes and converts them back into digital information. Optical fibers are far superior to the copper wires that they are gradually replacing on account of the amount, speed, and lack of interference that they have in transmitting data. A typical single strand can carry 6,000 simultaneous phone conversations. The number of transmissions sent simultaneously and the time it takes to send them are direct functions of the speed of the laser sending the light pulses. As an example of its power, the contents of Encyclopedia Britannica can be transmitted over a fiber optic line in its entirety in eight seconds.\footnote{Forrester, 100.} Because of the obvious advantages, it's not hard to imagine why the world's telecommunications companies and government consortia are speeding the recabling of our existing infrastructure. At present, companies like AT&T and MCI are using a protocol called ADSL to compress and transmit analog information so existing information dispersal can be expanded and utilized to much more productive means.
The New Competition

Presently, many enterprising ventures are vying to have some kind of stake in the future information highway. The complicated regulatory policies and legal theories controlling the telecommunications industry are being taken to task as the dichotomy of regulated local telephone monopolies in a competitive marketplace remains intact. A central issue of competition in the industry regards involves the struggle between the Baby Bells' restraints of the divestiture agreement and their desires to offer video and information services. Currently banned from long-distance and cable television by the divestiture agreement in 1984, the Baby Bells are building up pressure to modify the court's ruling.79 The Baby Bells' contend that they are finding it increasingly difficult to compete in the market forces now taking shape. Some change started to take shape in September, 1991, when the Supreme Court allowed telephone companies to develop video services.80 While they are confined to providing basically local service and limited information services, other companies are bypassing the entire local system with direct microwave and fiber optic links to a long-distance carrier. Also under fire are the rate-setting policies. Since almost the beginning of the Bell System, the companies have subsidized the higher cost of rural residential service at the expense of urban residential service to equalize the cost. They have used the

79Temin, 269.
same policy to subsidize all of the residential service at the expense of business. In other words, regulators thereby have been forcing low rates on local use, while rates for business have to remain high. Some alternative carriers are now even providing some short-distance service (under the guise of long-distance) that clearly qualifies as local. Now the Bell Operating Companies, 10 years after divestiture, want things changed in order to compete in today’s market of alternative carriers. A good example is Ameritech: the chairman, William Wiess, has submitted a proposal to the FCC seeking a quid pro quo that would allow the Baby Bells to give up exclusive rights to local telephone service in exchange for being able to provide cable TV and long distance service.

Competition in local service is now possible through new technologies, where it was impractical for the previous century. Relatively small fiber optic lines carrying massive amounts of traffic can be placed in small conduits with other existing cables. Direct Broadcast Satellite provides the freedom from a wired infrastructure without the disadvantages of a large antenna. Cellular phones and short distance microwave transmission already are one form of competition. Under testing, Personal Communications Networks (PCNs) are potentially others, similar to cellular, but of lower costs and more accessibility. In conjunction with old and new technologies are powerful computers that control the routing of calls and phone numbers. It is a near-future reality that customers will be able to retain one phone number for their entire life because of the

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81Coy, 101.
computers. The computers would be responsible to take an outgoing call, look up on which network with which carrier the recipient is located, and appropriately direct the call there.

Cable companies are increasingly offering communications and information services, bordering on telephony in its interactivity. Time Warner has an interactive fiber-optic system in Queens and Brooklyn, NY that offers 150 channels and the ability to let viewers talk back. Time Warner also has a trial system in Orlando, FL and a new partnership with US West. In Orlando, an all digital, interactive network using video compression techniques will be in place in 1994. The system will provide 500 channels of cable TV, including an interactive system of video on demand. One of the nation's largest cable operators, Continental Cablevision, is connecting some of its customer base directly to Internet in a test in Cambridge, MA. Customers will be able to use their PCs to download the libraries of information available. The biggest deal yet announced is $33 billion merger between TCI and Bell Atlantic. Currently rejected by a Federal judge, the merger would have access to 22 million customers in 59 of the top 100 markets.83 The proposal of the deal itself proves to one and all that a data highway already exists to a degree. All major cable companies are apparently holding talks with all of the Baby Bells84 in order to shape up the market; they believe that government policy will eventually allow phone companies to

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complete directly with cable companies to facilitate the information superhighway.85

The intangible radio spectrum is virtually as valuable as real estate or the physical wires that connect it. Whereas the fiber optic and satellite connections to stationary buildings will comprise most of the superhighway, wireless communications will be indispensable access routes to it. The portability of communication has become a paramount demand of a society more on the move, and has caused scarce radio frequencies to become very valuable. In the FCC’s reallocation of the usable radio spectrum for PCNs in 1994, it will be auctioning frequencies. With AT&T’s purchase of McCaw Cellular for $12.6 billion being the most apparent deal, companies all over the world are dealing for precious frequencies. Some, including Motorola, are buying up old taxi and fleet dispatching frequencies with ambitions of converting them from archaic radio transmissions into complete wireless digital data networks to rival cellular; and investors and bankers are backing them with full enthusiasm. Motorola is using its base in the power of paging systems to connect to personal computers as a start in wireless data. United Parcel Service (UPS) is the currently the biggest user of this small market (200,000 in the total U.S.) with 55,000 drivers keeping track of packages with hand-held computers.86

85Paikert, 22.
The Information Superhighway

The type of on-line connections demonstrated by the Time Warner and Continental Cablevision trials in Orlando and Cambridge, exemplify the most probable of futures for the superhighway; there will be many providers of information services brought into the home or business by a variety of telecommunications carriers. Neither cable companies or telephone companies will probably be able to emerge alone as principal carriers in the superhighway, not only because of regulatory statutes, but also because of technological limitations and the capital outlay required.

Regular telephone wire can be used to send pictures. However, the images must be still or the motion can only be a fraction of broadcast quality. Instead of the 30 frame/second display rate of television, the capability is currently limited to about 10 frames/second over regular telephone wire. Again, this is because the bandwidth necessary for video transmission is much wider than that for voice only. A camera must digitize the picture and the electronics must "squeeze"87 the information to fit within the narrow bandwidth of the copper telephone wire. Coaxial cable, however, was invented to have a greater bandwidth and is capable of transmitting video and computer data at high rates of speed - at about 10 million bits a second, compared to 14,400 bits a second for today's fastest PC modems over the phone line. It follows that coaxial cable is suited for a limited amount of multimedia transmissions, while the phone

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87"Squeezing" information refers to the technique that uses mathematical algorithms to allow less data to be transmitted for the recreation of the information.
network is almost completely obsolete. However, cable companies are unconnected, one-way, scattered entities in comparison to a switched, world-wide telephone network. Forays into each other's domain would require massive sums of up-front capital for infrastructure. Partnerships between the cable companies and the telephone companies are being formed, therefore, to combine the assets of both systems.

In order to utilize the existing infrastructure until ISDN infrastructure can be financed and physically installed, the partnerships are using compression devices and technological tricks to transmit information, video, and voice. Approximately 95% of homes with TVs are wired for cable, even if all don't subscribe. 80% of the cable company's wiring comprises the last mile to the home, representing a massive investment in wiring mileage. These compression techniques are able to funnel the information into existing pipelines to the home, while the major trunk lines and regional distribution centers are refitted with fiber optic cable.

Recent reallocations of the frequency spectrum will allow more competitors into the users' end of the superhighway, bringing prices down on hardware portability and data transmission. Mobility is a huge factor, and is materializing in the development of PCS (Personal Communications Services) and PDAs (Personal Digital Assistant). PDAs such as Apple Computer's Newton, Casio/Tandy's Zoomer, AT&T's EO 440, and the Sharp Expert Pad offer a hand-held,

88*Almost" because some telephone products from AT&T (Picasso and VideoPhone) and other companies can transmit still-images or slow-motion, rough video on top of voice conversation using ADSL compression.
89Vizard, 31.
keyboardless, and (in the case of Apple and Sharp) handwriting-recognizing computer that handles every kind of personal information as well as sends and receives faxes without phone lines.

Currently, many trends in government policies solidify in the minds of many that such a national idea of an information superhighway will be a reality. Two recent statements of policy direction from the Clinton Administration are being catalyst to efforts of the private sector for development. The report by the Clinton Administration on September 14, 1993, offering nothing more than broad guidelines, stated that the U.S. government will not capitalize any of the infrastructure, leaving the construction to private industry. Government's role will be in the deregulation of industries and policy-setting that favors competition. The report doesn't offer many details, but rather is a vision statement describing such things as a minimum standard for communications service to every person and how the superhighway should be developed in the "long-term public interest." In another announcement that could have far reaching effects on the definition of the entire telecommunications industry on December 20, 1993, the Administration is giving its support to pending legislation for the reregulation of the entire industry. The Administration as well as the major companies of the industry both support legislation in Congress to allow cable companies to compete directly with telephone companies in providing the information highway. Policy makers and the communications industry agree in concept that it will

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be a "two wire" future in which both cable companies and telephone companies would offer a full range of video and voice communications in most markets of competition. The Administration also supports the relaxation of restrictions on local telephone companies entering long-distance markets. However much in agreement both parties' views are, there remains many differing methods of implementing the methods to achieve the goals; each player doesn't want to be caught in a monopolistic or unfairly regulated marketplace. Congress and the courts will have a defining role in the future of the industry as the realization that telecommunications is becoming more of a marketplace and less of a public utility sets in.

Clearly, the superhighway is beginning to materialize after decades of telecommunications development. Convergence of technology and the relaxation of regulatory restrictions to foster competition will indeed one day provide every person with immediate and affordable access to an all-digital information superhighway.
Appendix A

Predivesture AT&T (1909-1983)
Temin, p. 13

Postdivesture AT&T (1984+)
Temin, p. 322
Speech represented by an analog waveform.

Sound is converted to this electrical signal before sending over a regular telephone wire. The received sound quality is dependent upon the exact reproduction of the signal. Because the signal is electromagnetic, it is subject to the surrounding interference and can arrive distorted.

Speech or data in digital form

Sound or data is encoded into the binary code of 1s and 0s, equaling an electrical charge (or light pulse) or the absence of one. Data correction schemes can be used to ensure accurate transmission.
Cellular telephone installation

Each cellular telephone emits a signal that is received by the tower in each cell. The call is sent to the central computer that can "hand-off" the call to other cells if the telephone moves. The call is sent from the central computer to the telephone company's local switching office.
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