for FCC
AT&T

PAUL W. EGGERS
Wichita Falls, Texas
50 years of age
Educated at Valparaiso University (B.A., 1941)
and University of Texas (LL.B., 1948)
Engaged in the general practice of law in Wichita Falls
Presently General Counsel, Treasury Department

REESE H. TAYLOR, JR.
Nevada
41 years of age
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Currently Chairman of the Public Service Commission of Nevada

WILLIAM O. COWGER
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47 years of age
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President, Thompson & Cowger Company (real estate mortgage company)
Formerly Republican Mayor of Louisville
Presently serving as Member, U. S. House of Representatives

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49 years of age
Educated at Hillsdale College, Michigan (B.A., 1942)
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Formerly associated with New York Public Utility Commission
Presently Secretary to Governor of New York

JAMES D. MARTIN
Gadsden, Alabama
50 years of age
Educated at Birmingham School of Law
Formerly Member, U. S. House of Representatives (1964-66)
Currently President, Martin Oil Company, Gadsden, Alabama

NILS A. BOE
Sioux Falls, South Dakota
56 years of age
Educated at University of Wisconsin (B.A., 1935 and LL.B., 1937)
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Formerly Governor of South Dakota (1965-68)
Presently serving as Director, Office of Intergovernmental Relations

LEE A. DONALDSON, JR.
Pittsburgh, Pennsylvania
43 years of age
Educated at Allegany College (B.A.)
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Minority Leader, Pennsylvania House of Representatives
Presently engaged in the general practice of law

CHARLES S. ARTHUR
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51 years of age
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Member of Kansas State Senate
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JAMES M. COLLINS
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American College (C.L.U., 1940);
Harvard University, Graduate School of Business Administration (USA, 1
Formerly President, Fidelity Union Life Insurance Company (1954-65)
Presently Member, U. S. House of Representatives

ETW

AT&T

10-15-1970 The Washington Post

Comsat, AT&T Agree on Plan For Satellites

By Robert J. Samuelson
Washington Post Staff Writer

The Communications Satellite Corp. and the American Telephone & Telegraph Co. have reached an agreement to construct a domestic satellite system to serve AT&T's long-distance communications network.

Under the agreement, Comsat would own and lease two satellites to the telephone company, which would own the earth stations to send and receive signals to and from the satellites.

The Federal Communications Commission must give its approval before Comsat could launch its satellites (by contracting with the government) and AT&T could build its earth stations. Both Comsat and AT&T are expected to file applications with the agency soon, probably next week.

AT&T's alliance with Comsat apparently reflects the FCC's new preoccupation with competition. To spur competition, the agency has tentatively suggested that it might bar the telephone company—which has a near monopoly in ground communications—from owning satellites.

Comsat already owns the U.S. portion of international communications satellites, and the new agreement appears to give the company a head start over competitors in winning FCC approval for a domestic system.

The agency has yet to decide how it will handle rival applications. Earlier this year, the White House recommended that the agency allow anyone with adequate money and technical knowhow to build a satellite system, but FCC officials have indicated that the agency might make a selection between competing proposals.

Western Union Telegraph Co. has already filed, and other firms, such as TelePrompTer (a cable television company), have indicated they will probably apply.

If the FCC does decide to pick and choose, one test would be the potential profitability of a proposed system. In the first few years, most communications experts believe that potential communications traffic could not support more than one or two systems.

Aside from AT&T, the largest potential customers appear to be the three television networks. However, they have yet to publicly commit themselves to any one satellite system or even rule out the possibility of constructing their own satellite network.

Under the agreement with AT&T, Cosmat would lease two entire satellites to the telephone company. Cosmat would still be free to orbit other satellites which could be used for other clients, such as the television networks, large data users, or newswires.

If this happened, Comsat would, in effect, be competing with AT&T. The networks, for example, now rely on AT&T's terrestial system for picture transmitting.

Once approved, experts have estimated that it would take about $100 million investment and two years to make a satellite system operational.

TW

AT&T

10- 6-1970 The Washington Post

First Increase in 17 Years

AT&T Plans Rate Boost On Long Distance Calls

By Robert J. Samuelson
Washington Post Staff Writer

The American Telephone and Telegraph Co. is about to request increased long distance telephone rates for the first time in 17 years.

AT&T last requested and received an interstate rate increase from the Federal Communications Commission in 1953 when the company won $160 million in higher charges.

Even since, the FCC and the world's largest private utility have periodically negotiated rate reductions, reflecting increasingly efficient technology. Now, according to AT&T, the cycle is reversing itself, and inflation is increasing costs faster than technology can lower them.

In the interim, however, new technology — in 1953, for example, the best interstate coaxial cable carried 9,300 circuits against 32,400 for the newest cables — reduced long distance rates 10.5 per cent below the 1957-to-1959 average.

AT&T quietly informed the FCC only late last month that it tentatively plans to ask for a $130 million interstate rate increase effective Jan. 1. If approved, the $130 million revision would virtually neutralize the effect of latest long distance reductions of $150 million introduced in January.

Although AT&T might not choose to tamper with the exact changes it made in January, the latest round of revisions gives a good indication of what's involved. Those revisions included:

- Introduction of a 35 cent coast-to-coast, one-minute customer-dialed rate between midnight and 8 a.m. (the cheapest previous rate had been 75 cents).
- A lengthening of the reduced rate period from 7 a.m. to 8 a.m., a change designed to benefit western customers.
- A new schedule of lower rates for customers who dial calls of more than 200 miles (rather than relying upon the operator to place the call).

Technically, the $130 million request does not constitute an outright rate increase, but merely an offset to a complicated accounting change. That change is called "separations," and it involves the distribution of AT&T's $44 billion-plus of plant investment between state phone service (where rates are set by state agencies) and interstate service (where the FCC rules).

For years, the states have been pressing the FCC to take more of AT&T's total investment into the interstate, long distance jurisdiction. Unlike long distance costs, local phone expenses have not been protected from inflation and rate increase by technology advances; since 1969, AT&T has received $489 million in local rate increases, and requests for another $468 million are now pending in 11 states.

The states want the FCC to relieve the pressure. The more telephone plant investment that is transferred to interstate service, the less the local state agencies have to approve in rate increases to provide AT&T with its "fair" rate of return on investment.

What distinguishes this "separations change," almost certain to be approved by the full FCC, from its predecessor is that the others have been offset by technology, not rate increases.

Not only that, but there are rumors that AT&T may actually ask for more than the $130 million increase represented by the "separations" change.

There is little doubt that AT&T's rate-of-return on interstate calls has been declining steadily. It was 8.14 per cent in 1969, 7.70 per cent for the first six months of 1970, and 7.53 per cent after eight months.

Nevertheless, it is unlikely that the FCC will warmly welcome an AT&T request.

By temperament, agencies dislike ordering rate increases (a state-of-mind that explains the states' persistent pleading for "separations" changes), and at least one Commissioner, Nicholas Johnson, already has said he thinks the FCC has not been vigilant enough in requiring rate reductions.

Last year, he points out, AT&T did make more than the "allowable" 7.5 per cent rate-of-return, and, even in ordering this year's $150 million cut, the FCC told Bell that it might exceed the 7.5 per cent ceiling. Johnson didn't like that.

Moreover, FCC officials probably will attribute a large part of the recent earning decline to two factors that don't necessarily call for an offsetting rate increase—January's $150 million reduction, and a slowdown in the economy, which, Bell says, has hurt profits by diminishing the rate-of-growth in long distance calls from 12.6 per cent in 1969 to 10 per cent in 1970.

AT&T, by contrast, may claim that 1967's allowable rate-of-return is inadequate. The company's construction program alone will consume $7 billion in 1970, about half of which is raised in the nation's capital markets. The latest debenture sale drew an interest rate of 8.72 per cent, well above the company's long-term average cost of debt, now 5.50 per cent.

In the short run, at least, the FCC has only a limited number of weapons to stop a rate increase. The agency can suspend the effective date of new rates for only three months pending an investigation. The studies, however, usually take much longer, and, after 90 days, the rates automatically become effective.

If that happens, the agency could order the company to keep a strict record of the revenues collected under the higher rates—which would be refunded or, more likely be used as a credit against future rate increases or reductions, if the investigation found the higher tariffs unwarranted.

ATT

October 2, 1969

Dear Ed:

I want to thank you and all of the other fine people from AT&T for the informative and enjoyable visit I had on September 30th and October 1st. I must say that Bell Labs is every bit as impressive as I recall, and the visit to Long Lines lived up to many years of expectation. I hope you will pass on to Ken McKay, Dick Hough, and all the others my appreciation.

Sincerely,

Clay T. Whitehead
Staff Assistant

Mr. Ed Crosland
Vice President, Federal Relations
American Telephone & Telegraph Company
195 Broadway
New York, New York 10007

cc: Mr. Whitehead
Central Files

CTWhitehead:ed

Viewpoints on Communications Policy

August, 1968

AT&T

Contents

CONTENTS

1

VIEWPOINTS ON COMMUNICATIONS POLICY

Introduction

In an August 14, 1967, message to Congress, President Johnson -- noting the continuing rapid development of communications technology -- established a Task Force on Communications Policy. A basic intent of this message was to set in motion "the necessary studies for a better understanding of policy needs in domestic and international communications."

The Presidential Task Force, headed by Under Secretary of State Eugene V. Rostow and including 14 distinguished officials from other areas of government, was directed to examine a number of major questions, including the following: Are we making the best use of the electro-magnetic frequency spectrum? How soon will a domestic satellite system be economically feasible? Should a domestic satellite system be general purpose or specialized, or should there be more than one system? How will these and other developments affect Comsat and the international communications carriers?

The Task Force also was directed to "examine our entire international communications posture," and to determine if the Communications Act of 1934 or the Satellite Act of 1962 require revision.

In undertaking its assignment, the Task Force staff has asked AT&T and other companies to provide a broad range of information on their operations, as well as their views on various policy matters. The staff's questions to AT&T have covered such areas as domestic satellites, voice/record distinctions, rate base regulation, interconnection, and the structure of the international telecommunications industry.

Papers outlining the Bell System's views on these and other matters which have been presented to the Task Force staff, together with capsule summaries of the subject matter, are included in the sections that follow.

2

COMMUNICATIONS PROGRESS IN THE UNITED STATES

Summary:

In the United States, advances in science and technology are revolutionizing many areas of man's endeavor, including medicine, education, transportation, and communications. The communications industry, which helps provide a framework for change and growth in other fields, is itself being affected by continuing technical achievements.

The communications industry has grown much more rapidly than the economy as a whole. The ever-increasing versatility and dependability of the communications network has made it a major contributor to the effectiveness of business, government, and the public in general. The United States has the finest communications system of any nation in the world.

The Bell System has been a prime contributor to the continuing advances in U.S. and world communications. The record of progress is impressive, not only in terms of growth, but in quality, usefulness, and in the value of service as well.

The advances made in U.S. communications stem largely from certain fundamental factors which have set the tone and the pace of the industry's activities. One of these is the common carrier concept of providing communications. Another is the demanding attention that has been given to the costs and quality and prompt availability of communications service. A third fundamental is the strong commitment to innovation which has enabled the industry to stay ahead of rapidly changing and expanding needs. All of these, to continue, require increasing recognition of the need for adequate profits and reasonable "elbow room" as a stimulus for innovation.

The Bell System provides much of the technological leadership in communications both in the United States and abroad. It was among the first organizations to recognize the values of basic research and development, and most of the major communications advances have been the direct result of its efforts. The benefits flowing to the national economy from Bell System inventions are impressive.

The unification of research, development, design, manufacture, and operation within the Bell System is essential to assure continuous innovation in communications. Close teamwork is possible because the operating telephone companies, Bell Laboratories, and Western Electric share the common purpose of providing ever-improving communications service.

The Future of Communications

Looking to the future of communications, the two key words are abundance and versatility.

New technical capabilities will lead to a continued expansion of the nationwide communications network. The growth in international communications is expected to expand even faster. Communications by satellite will greatly increase and new super-capacity coaxial cable and circular wave guide systems will also be operational. These and other anticipated developments will make long haul transmission facilities available at still lower costs, greatly increasing their potential usage. Advances in long haul transmission facilities plus exceptionally high speed switching and memory features offered by electronic switching systems will result in greater and greater versatility in communication services.

It is essential that the benefits of technical achievements be made available as quickly as possible. But there is great risk in premature commitment to any one system or technique, no matter how promising, for it may yield to better methods tomorrow.

Whatever national policy evolves, it should be flexible enough to accommodate still newer technology and new directions in the desires of society. Most importantly, it seems apparent that the public's interest will best be served by policies that work for the good of the greatest number of people. This underscores the need for continued adherence to the common carrier principle, which makes the benefits of technology and economies of scale broadly available to the general public.

COMMUNICATIONS PROGRESS IN THE UNITED STATES

Introduction

Great social and technological changes are sweeping the nation and the world today, affecting the way people live, the way they think, the way they work. In no other period of history has the tempo of change been so rapid. In no other period have the effects been so pervasive.

In the United States, advances in science and technology are revolutionizing many areas of man's endeavor, including medicine, education, transportation, and communications. The communications industry, which helps provide a framework for change and growth in other fields, is being profoundly affected by continuing technical achievements.

The purpose of this paper is to take a broad look at communications in this country today, providing in effect a brief "state of the industry" report as we move into the final third of the 20th century. The paper reviews the following:

1) Highlights of communications progress in the middle third of the 20th century, with particular emphasis on the Bell System's role in this progress.

2) National policy considerations and other factors that have contributed to the progress of the industry.

3) Communications potentialities for the final third of the 20th century, with views as to how these can best be realized.

The past three and a half decades encompass the Great Depression, a World War, the Korean and Viet Nam wars, and the current strife in the nation's cities. But the trend of events through this turmoil has been one of dramatic economic growth, bringing unparalleled prosperity to the American people. The communications industry has grown much faster than the economy as a whole ... one reason being that the services provided contribute so importantly to all economic growth.

Highlights of U.S. Communications Progress, 1934-1967

The nation's goals and expectations for the development of communications were reflected in the Communications Act of 1934. The Act, which established the Federal Communications Commission, set forth the national policy "... to make available, as far as possible, to all the people of the United States a rapid, efficient, Nation-wide and world-wide wire and radio communication service with adequate facilities at reasonable charges ...."

This policy has served the nation well. Under the provisions of the Communications Act, the publicly-regulated, privately-operated common carriers -- building on the impressive progress they had made earlier in the century -- have developed a versatile communications system which undoubtedly exceeds the expectations of those who drafted the 1934 legislation.

The concept of "universal service" was not a new one. Theodore N. Vail, an early president of AT&T, had articulated this goal shortly after the turn of the century. Today the dream is a reality.

Service has been made broadly available throughout the country at rates which people are generally able and willing to pay. The nation is served by a great communications network, carrying information in many forms at low cost.

The versatility and dependability of this network have made it a valuable resource for business, government, and the public in general. Perhaps the best testimony to the accomplishments of this country's telephone industry lies in the general agreement throughout the world that the United States has the finest communications system of any nation.

The Bell System has been a prime contributor to the continuing advances in U.S. communications. The record of progress is impressive, not only in terms of growth, but in quality, usefulness, and the value of service as well. Some highlights of this progress are:

1) Availability -- Telephone development in the United States is the highest in the world. There are presently 50 telephones for every 100 persons.

   The Bell System operates 84 million telephones. Today 99.9 percent of these are dial-operated, compared with about 47 percent in 1934. Bell companies now serve more than 85 percent of all households in the areas where they operate, compared with only 31 percent in 1934.

   The Bell System does not of course provide all telephone service in the United States. More than 2,000 other companies serve cities and towns in all sections of the country, and their lines are connected to help form the unifying, nationwide network.

A milestone was reached in May, 1967, when the nation's 100 millionth telephone was installed in the White House. This is six times as many telephones as were in service in 1934, and four times as many as at the end of World War II.

2) Usefulness -- The usefulness of communications services offered to business and residential users is demonstrated by continuing strong demand and usage.

Almost 4 million telephones were added by the Bell System in 1967 alone. Long distance conversations increased 8-1/2 percent over 1966 to an average daily total of 16 million. Overseas telephone conversations increased 24 percent over 1966 to an annual total of more than 12 million.

To meet the steadily increasing demand for its services, the Bell System's expenditures for construction in recent years have exceeded $4 billion annually.

3) Quality -- Constant improvements are made in the transmission quality, speed of call completion, and dependability of telephone service.

Thirty years ago, talking from coast-to-coast was like shouting across an open field. Today, talking on transcontinental calls -- and calls across the Atlantic and Pacific -- is like conversing with someone across your desk.

Improved methods and equipment have greatly reduced the time required to complete operator-handled long distance calls. And with direct distance dialing (DDD), calls go through to any point in the country in a matter of seconds. This service, introduced in Englewood, New Jersey, in 1951, is now available to nine out of ten Bell System customers. DDD service to the Virgin Islands was initiated in 1966 and, on a gradual basis starting about 1970, U.S. telephone users will be able to dial their calls to other continents.

The dependability of telephone service is enhanced with each passing year, and during disasters -- hurricanes, tornadoes, floods, and blackouts -- Bell System people traditionally turn in a remarkable performance in protecting and restoring service. During the massive power failure in the Northeastern U.S. in 1965, for example, telephone service was maintained throughout the blackout because plans, people, and equipment were ready to respond.

4) Versatility -- As technology has added new communications capabilities, customers have been offered more and more individual choices in the form of new and improved instruments and optional service features.

The communications network is used to handle information in all forms -- speech, music, photographs, writing, TV and radio programs, and rapidly growing volumes of data communications. Picturephone* service, which enables

* Registered service mark

the user to see as well as hear the other party on the line, is now being field tested; this service will become more generally available within the next few years.

The high speed of operation and "memory" features of electronic switching systems now being introduced in increasing numbers will offer further opportunities to provide services that are tailor-made to individual needs.

5) Value -- The value of telephone service has been steadily increased over the past three decades.

Costs of local telephone service since 1940 have risen, on the average, less than half as much as the cost of living. (See Consumer Price Comparison, Chart 1 attached.) At the same time, the value of this service has been increased because local calling areas have been expanded greatly. For example, more than one-third of the calls handled as long distance calls at the end of World War II now go through as local.

Overall telephone rates (local and long distance) have gone up only 10 percent since 1940, compared with an 138 percent increase in the cost of living, while average hourly earnings have gone up more than 300 percent.

During the same period, rates for interstate long distance calls have been reduced substantially. Thirty years ago, the charge of a weekday, three-minute, coast-to-coast call was $6.50. Today, the same call may be made for $1.75 weekdays and for $1.00 nights and weekends. And calls dialed directly between midnight and 7 a.m. are only 75 cents.

The relative value of local telephone service in the United States also is indicated by Charts 2 and 3. Chart 2 shows the increasing value of service in this country in terms of hours of work required to pay for residence service. Chart 3 compares the required work-hours in this country with the much greater requirements in other nations.

Overseas telephone rates have been greatly reduced, thanks to improved technology and increasing demand. When radiotelephone service was first introduced between New York and London in 1927, the rate for a three-minute call was $75. By 1934, this rate had been reduced to $30. Today, a call to London may be made for as little as $5.70. Further reductions are foreseen as usage increases and increasing numbers of satellite and cable circuits are placed in service.

These brief examples indicate how well the national goals expressed in the Communications Act of 1934 have been met. In virtually every respect, the "rapid, efficient, Nation-wide and world-wide wire and radio communications service" called for in the Act is now a reality. This ability of the nation to communicate at low cost represents a significant contribution to economic growth and a rising standard of living.

Major Contributing Factors to Communications Progress

The significant advances made in U.S. communications in the 1934-67 period stem largely from certain fundamental factors that have set the tone and the pace of the industry's activities.

One of these factors is the continuing adherence to the common carrier concept of providing communications, which makes the benefits of advances in the communications art broadly available to the public in general.

This is a primary reason why common carriers exist -- so that all users can share in economies that accrue from technological progress and from the "economies of scale" that large volume makes possible. The public also benefits in other important ways, because the common carrier approach:

-- Avoids the wasteful duplication of communications facilities that was prevalent in many large cities and on some long distance routes in the early 1900s.

-- Helps insure a close compatibility among the billions of intricate, interdependent parts that comprise the communications network. Past assurance of this compatibility in design and operation of equipment and facilities has been an essential element in the development of high-quality, low-cost communications in this country. As communications systems grow in sophistication and complexity, the need for compatibility is magnified.

-- Permits a coordinated response to the communications needs and desires of the nation, through efficient systems development and engineering.

-- Pinpoints the responsibility for service, so that regulatory bodies can more effectively represent the publics they serve.

Under the common carrier concept, the Bell System and other regulated common carriers have continually expanded the nation's communications capabilities, and have been able to develop the resources needed to meet communications needs on a national scale, including critical defense needs. The regulatory philosophy which fosters this approach is a sound one, and results in the maximum value to the most users.

There is another fundamental factor in U.S. communications progress that can be credited to sound regulation. Regulatory bodies have been demanding, as they should be, with respect to the costs and quality and prompt availability of communications services. At the same time, however, the climate of regulation has generally been one that recognizes the need for adequate profits by viable organizations, and offers management reasonable freedom in pursuing the twin goals of sound earnings and ever-improving service.

A third fundamental to progress in communications has been the strong commitment to continuous innovation that has enabled the industry to stay ahead of rapidly changing and expanding needs.

It is generally acknowledged that the Bell System provides much of the technological leadership in communications (both in the United States and abroad). The Bell System was among the first organizations to recognize the values of basic research and development, and many, if not most, of the major communications advances in the 1934-1967 period have been the direct result of its efforts.

During these years, Bell System scientists and engineers patented more than 11,000 systems and devices of immediate or potential use in communications. These devices have been made widely available to industry and government.

The observation is frequently made that American industry benefits substantially from research and projects undertaken by the Federal government. This is quite true -- particularly in such fields as aeronautics, medicine, education, and rocketry. But is is equally true that knowledge flows in the reverse direction.

The discovery of the transistor at Bell Laboratories started an electronics revolution that greatly advanced the feasibility of space exploration and opened many doors in computer technology. Satellite communications would not be a reality today if it were not for the invention of transistors and solar cells by Bell scientists and Bell Laboratories' development of working masers and rugged traveling-wave tubes.

Although Bell System funds supported that research and development, the resultant knowledge has been freely utilized by American industry and that use is encouraged.

Following the invention of the transistor, for example, Bell Laboratories undertook a broad educational campaign to inform the technological community of the advantages and uses of the devices. Seminars were conducted for university people, work sessions were held for industrial representatives, and patent-licenses were widely granted.

The benefits flowing to the national economy from Bell System inventions are impressive. In one area alone -- that of solid state devices -- Bell System contributions have led to the development of today's $13-billion electronics industry.

Of comparable value has been the work at Bell Laboratories on understanding and "rearranging" the molecular structure of matter. This has resulted in quantitative standards in many fields where such standards were not previously possible, and in the development of synthetic materials -- such as the quartz important to communications -- whose world supply was uncertain.

In the fields of metals and plastics, Bell Laboratories has pioneered in structural changes which have simplified production and increased usefulness, as well as reducing manufacturing costs and maintenance expenditures.

While research is undertaken at the perimeters of human knowledge, a final objective is to utilize new learning to improve the nation's communications. How effectively this objective is being met can be seen in the following brief examples:

1) Long distance transmission systems -- In 1934, the most efficient means for carrying telephone calls between cities was "C" carrier. Three voice circuits could be transmitted over one pair of wires.

   In the intervening years, the Bell System has developed increasingly efficient coaxial cable and microwave radio systems. Since World War II, improved systems have been introduced at the rate of one every two years. Today, the newest microwave system can provide 23,000 voice circuits. The latest coaxial cable in service can carry more than 32,000 simultaneous conversations.

   Chart 4 illustrates the continuing progress through the years in reducing the average investment per circuit mile on long distance routes. Telephone users have benefited directly through substantial reductions in rates.

2) Undersea cables -- Even before 1934, Bell System scientists were working to develop an undersea cable system to supplement radiotelephone service between continents. The first such cable system -- engineered for trouble-free performance on

the ocean floor for a minimum of 20 years -- was placed in service between Newfoundland and Scotland in 1956. It provided 36 voice circuits. This capacity was later expanded to 82 circuits through technical advances, including the use of a high speed switching system called TASI (Time Assignment Speech Interpolation) that utilizes "spare" capacity resulting from normal conversational pauses.

Four cables now span the Atlantic. Others extend through the Caribbean to South America and through the Pacific to Alaska, Hawaii, Japan, the Philippines, Hong Kong, and Australia. The latest cables in service have a capacity of 138 voice circuits.

The newest transistorized system provides 720 voice circuits. One will be laid between Florida and the Virgin Islands this summer. The international carriers also have been authorized by the FCC to place a 720-circuit cable between Rhode Island and Southern Europe by 1970.

3) Satellite communications -- The Bell System pioneered in satellite communications. Its Telstar satellites demonstrated the practicality of global satellite communications on a commercial basis. As the largest user of satellite communications, AT&T now leases 250 circuits in Intelsat satellites (operated by the Communications Satellite Corporation) to bridge both the Atlantic and Pacific oceans. It is expected that 680 satellite circuits will be needed by the end of 1968, and more than 3,000 will be utilized by 1980 to help handle rapidly increasing demand for overseas communications.

The Bell System also is in the forefront in developing a domestic satellite system which can be integrated with terrestrial cable and microwave systems to meet anticipated demand for long-haul circuits to carry voice, television, and data. In 1966, the company proposed a multi-purpose space-earth system that would let the general public share in the benefits derived from this new technology. The Bell System has supported a pilot plan for domestic satellites that was proposed by Comsat.

4) Switching systems -- As more and more customers have been provided with dial telephone service, continuing improvements have been made in the switching systems that provide this service.

The newest development, ESS (Electronic Switching System), offers exceptional reliability and reduced maintenance costs. Moreover, customers will benefit from numerous individualized services that can be made available through the computer-like, electronic memory features of ESS.

Thirty-three electronic offices were in service at the end of 1967, and new ones will be added throughout the country at an accelerating pace. The introduction of ESS throughout the nationwide network probably represents the largest single project ever undertaken by a private enterprise -- in terms of costs, which may reach $20 billion or more, and also in terms of the diversity of technical skills required in the manufacturing, training, installation, and maintenance of the complex system.

These examples are only a selected few of the constant stream of innovations developed within the Bell System. Improvements in the telephone itself are making service more useful and convenient. As stated earlier, an improved Picturephone is now in the product trial stage. A lineless extension telephone is being field tested. Touch-Tone* calling, using pushbuttons instead of dials, will offer small users access to computer capabilities. And Data-Phone* service is increasingly used to link computers and other data machines to the communications network.

Innovations in operating methods and techniques also are prevalent. One example is Network Management -- a control system that provides more efficient use of the nationwide network on a day-to-day basis, and enables managers to exercise control of calling patterns in times of disaster and in other peak calling periods. This innovation has improved both customer service and the utilization of long distance circuits. As illustrated by Chart 5, the annual "conversation minutes" per circuit have been substantially increased since 1960, while the per cent of customers encountering "no circuit" conditions has been reduced significantly.

BIS, a new electronic "business information system," is another current example of innovation in management methods. This new system will use advanced computer techniques to provide the timely and detailed information required to operate the business efficiently. For the customer, BIS will make possible more efficient and more personalized service. For Bell System people, it will add to their abilities and competence to serve.

The unification of research, development, design, manufacture, and operations within the Bell System is essential in assuring continuous innovation in communications. Close teamwork is possible because the operating telephone companies, Bell Laboratories, and Western Electric share the common purpose of providing ever-improving telephone service. The values of

*Registered service mark

this organizational structure have been frequently recognized by governmental agencies, in calling on the Bell System to undertake systems design and engineering for critical projects such as Sentinel (Nike) and the manned space flight programs for the National Aeronautics and Space Administration.

The future of communications in the United States

In a sense, the future is already here.

The nation and the world are undergoing far-reaching technological, economic and social changes that leave each day different than the one before. The exploding potential of instantaneous communications on a national and global scale adds to the ferment, but also holds one of the keys to society's ability to respond positively to these changes.

Virtually any communications service the mind can conceive is becoming technically possible, if not economically feasible. Advancing technology in the final third of this century undoubtedly will make many of today's "way out" service concepts seem commonplace.

Two key words in looking to the future of communications are abundance and versatility.

New technical capabilities coupled with undiminished demand will lead to a continued expansion of the nationwide network. To illustrate the pace of growth, more than 95 percent of the present interstate network has been built new since the end of World War II ... yet the present network represents only about 15 percent of the facilities expected to be needed by 1980. To say it another way, the estimated number of circuits that will be added to the interstate network in the 1980 construction program will be roughly equivalent to the total number of circuits in service today.

The demand for international communications is expected to expand even faster, as overseas facilities are made cheaper and more abundant.

Communications by satellites will greatly increase, both internationally and domestically, and this transmission means should be closely integrated with terrestrial and undersea facilities to form a unified, multi-purpose network.

In the 1975-1980 time frame, new super-capacity coaxial cable and circular wave guide systems are expected to be operational. These may offer as many as 280,000 voice circuits on a single facility. Looking farther ahead, development work is continuing on systems utilizing laser light beams with a potential capacity of millions of communications channels.

All of these developments will make long-haul transmission facilities available at lower costs per circuit, greatly increasing their potential usage. Similar improvements in local exchange plant, through the miniaturization of electronic components and integrated circuitry, promise to extend a widening range of capabilities directly into the home and small business.

These advances -- plus the exceptionally high-speed switching and memory features offered by electronic switching systems -- will result in greater and greater versatility in communications services.

Tomorrow's service needs will require transmission of great new magnitudes of information, involving intermixtures of voice, data, and graphics. The communications industry must be prepared to keep pace with rapid advances in computer and data processing techniques, particularly in regard to transmission and machine response to written and spoken languages. New Pulse Code Modulation (PCM) transmission systems will be widely used to handle these diverse requirements. (PCM is a process of representing any communications signal -- voice, data, or visual -- by a stream of digital pulses.)

Technology may well make "broadband" communications capabilities feasible for homes and small businesses, and lead to the development of home communications centers.

Such centers could give individual telecommunications users a ready access over telephone lines to: a) the contents of libraries (through visual and facsimile devices); b) computer services; c) television and radio programming, on a live or taped basis; d) educational television; and e) a wide variety of other services, ranging from "piped" music to the remote control of household appliances.

In looking at communications policy needs for the future, a central question is how the onrush of technology can best be implemented to meet rapidly changing needs and conditions.

It is essential that the benefits of technical achievements be made available as quickly as possible. But on the other hand, there is great risk in premature commitment to any one system or technique, no matter how promising, for it may be obsolete tomorrow.

Whatever national policy evolves, it should be flexible enough to accomodate still newer technology and new directions in the desires of society. It also should recognize that close compatibility among the myriad parts of the communications network will become even more critical as the complexity of that network increases.

Most importantly, it seems apparent that the public's interest will best be served by policies that work for the good of the greatest number of people. This suggests the need for continued adherence to the common carrier principle, which makes the benefits of technology and economies of scale broadly available to the general public.

Certainly the conditions confronting the communications industry in the final third of the 20th century differ substantially from those it faced in the middle third.

The question for the policy-maker is whether these changes, significant as they are, warrant alteration of the fundamental precepts that have guided communications development in this country up till now. Broadly speaking, it would appear that they do not. Consequently, a perhaps more crucial question is whether, by losing sight of certain of these fundamentals, we do not risk falling short of the potentials for progress that technology affords.

Chart 1

Price changes . . .

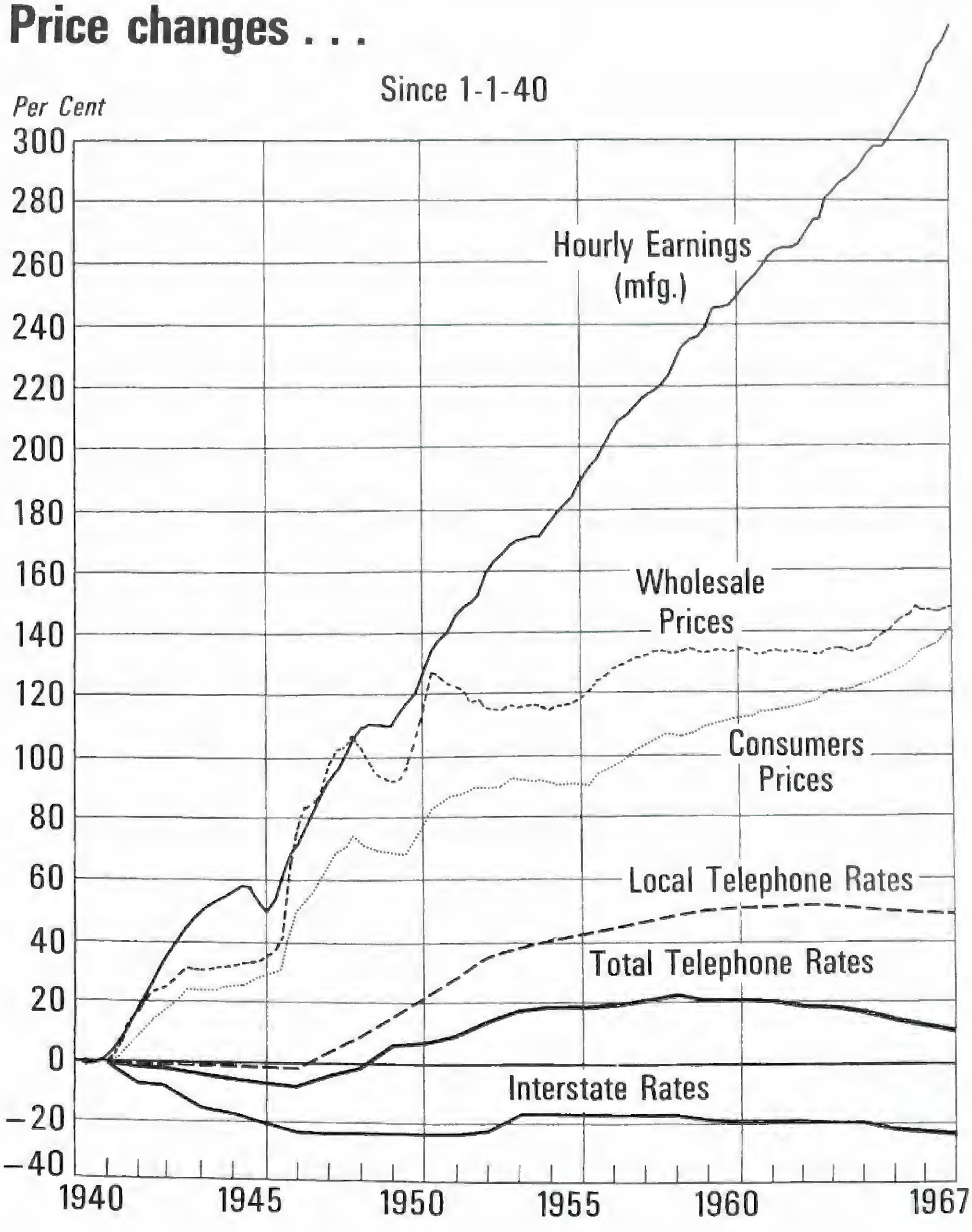
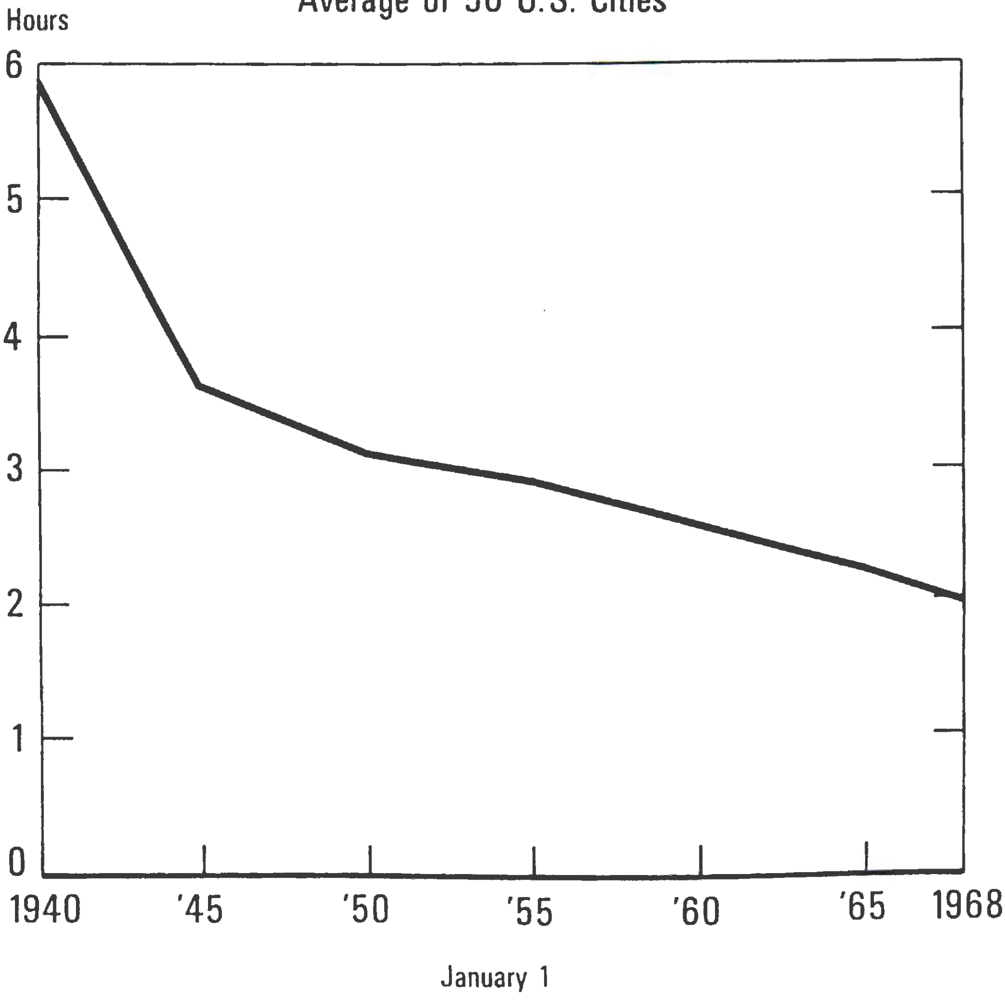


Chart 2

Hours of Work Required to Pay for One Month's Individual Residence Service, with 100 Local Calls

Average of 56 U.S. Cities



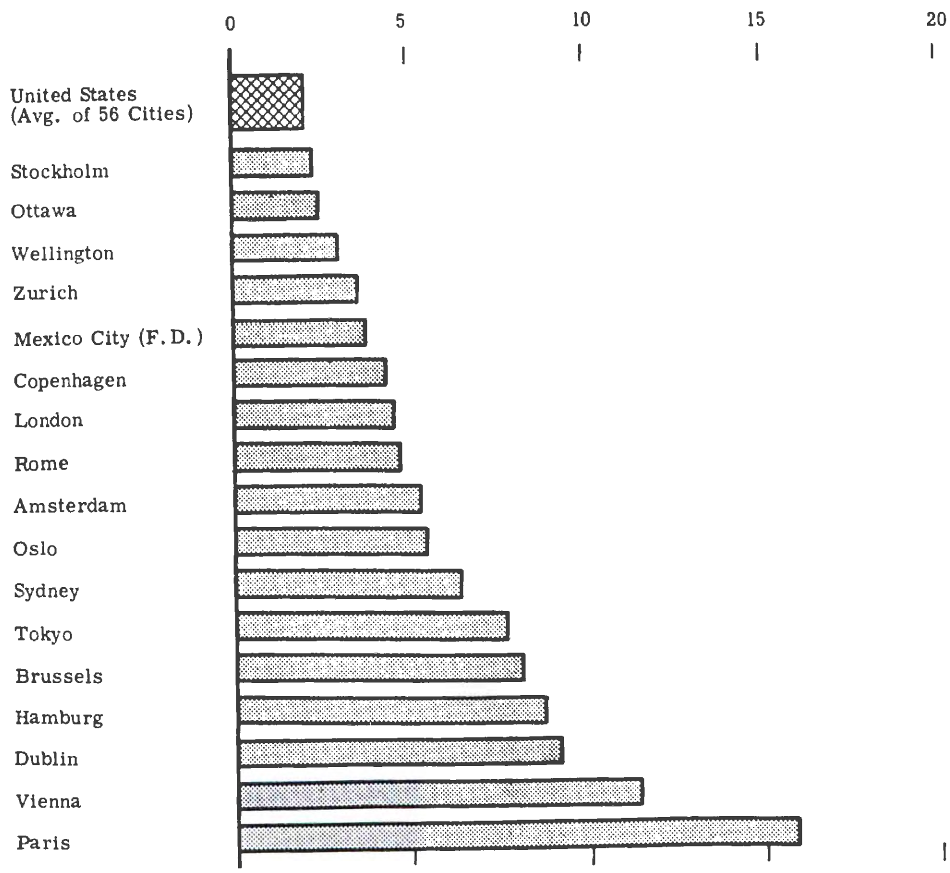
American Telephone and Telegraph Company
Corporate Results Analysis Division
April 1968

Chart 3

RELATIVE COST OF TELEPHONE SERVICE

January 1966

Average number of hours of work required to pay for one month's individual residence service, with 100 local calls



American Telephone and Telegraph Company
Business Research Division
August 1966

Chart 4

Investment per circuit mile . . .

AT&T Long Lines Department

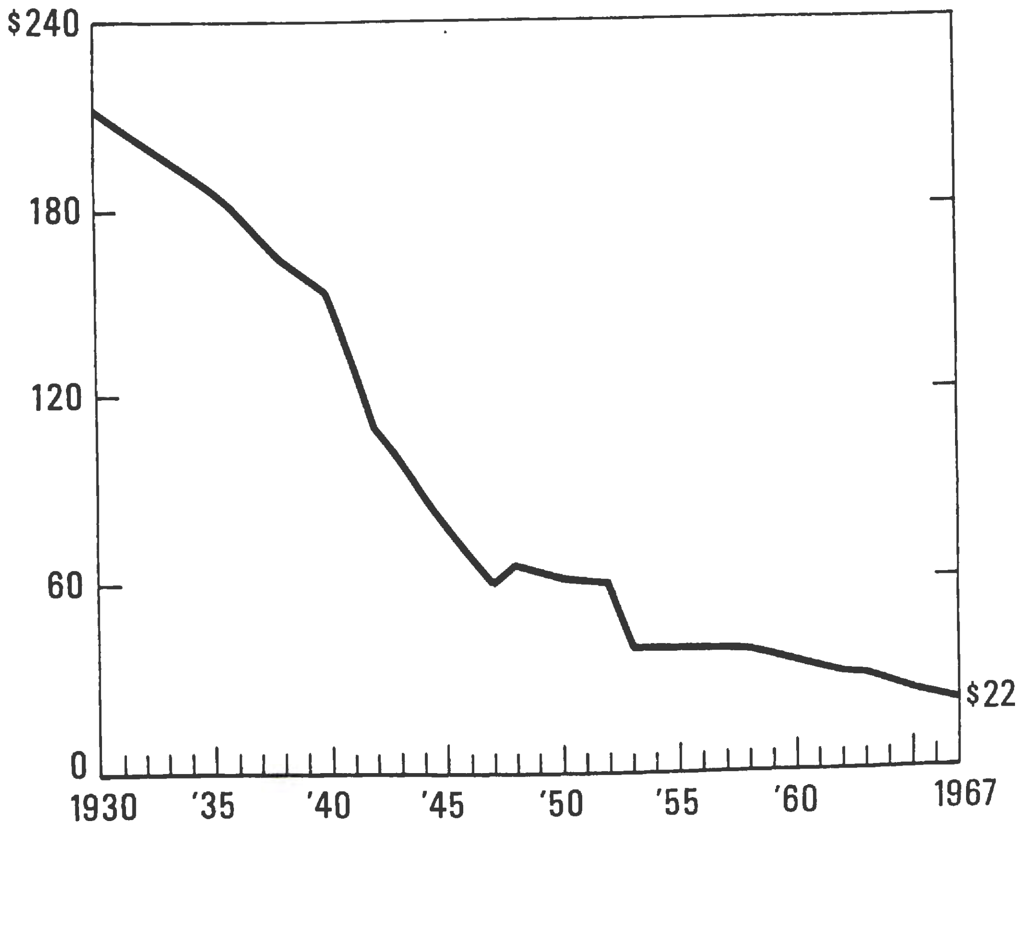
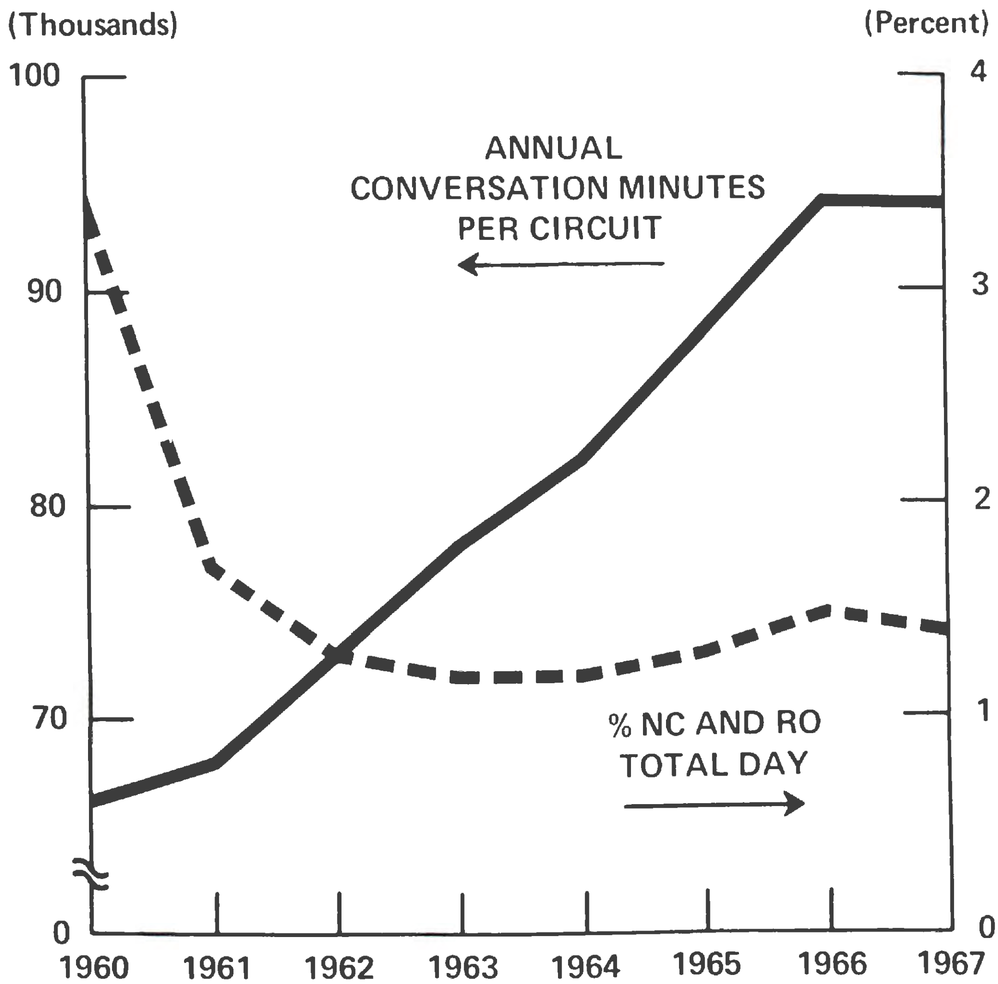


Chart 5

CIRCUIT LOADING VS PERCENT NC



3

INTERNATIONAL COMMUNICATIONS

Summary:

The question of the appropriate structure for international communications has been actively discussed for many years. In 1966 an Intra-Governmental Committee composed of representatives of various governmental departments studied this question and recommended legislation for a permissive merger of international communications carriers. To the extent the international record carriers agree that a merger would solve their problems, they should be permitted to merge.

The Bell System is strongly of the view that the public interest will best be served if the U.S. overseas telephone service remains the responsibility of the company which provides the domestic telephone service. It was primarily the initiative and progressiveness of the Bell System that has brought overseas telephone service to the point that today any telephone in the United States can be connected with 97% of the telephones in the world. The quality of overseas voice communications has reached the point that it is as good as that provided domestically. Service is continually being expanded to provide for the growing demand for overseas service, both by cable and by satellite. The distinction between international and domestic telephone service is rapidly disappearing. With the advent of customer dialing of international calls in the next few years, there will be almost complete integration of domestic and international service.

There is no need or justification for disrupting the present integrated telephone service by including AT&T's international facilities in any merger. Including Comsat in any international merger would be inconsistent with its responsibility for establishing a global communications satellite system.

STRUCTURE OF THE INTERNATIONAL TELECOMMUNICATIONS INDUSTRY

Introduction

President Johnson, in establishing the Task Force on Communication Policy, directed the Task Force to examine "our entire international communications posture" and, specifically, to "investigate whether the present division of ownership in our international communications facilities best serves our needs . . . ."

The question of the appropriate structure for international communications has been actively discussed over many years. In 1966, an Intra-Governmental Committee composed of representatives of various government departments studied this question and recommended legislation for a permissive merger of international record communications carriers. Among the reasons given for such a merger were (1) the ability of foreign communications agencies to play one international record carrier against another to the detriment of all and (2) the existence of unnecessary duplication of facilities and management among such carriers. We believe that to the extent the international record carriers agree that a merger would help to solve these problems, they should be permitted to merge.

Another alternative that has been suggested in the past is to include as a part of such a merger the Communications Satellite Corporation and/or the overseas message telephone facilities of the Bell System. The most extreme form that has been suggested would be to unite the facilities and operations of all the U.S. international communications carriers into one supercarrier which would become the American "Chosen Instrument" in international communications.

We are strongly of the view that the public interest will best be served if the U.S. overseas telephone service remains the responsibility of the company which provides the domestic telephone service. Therefore, the Bell System is opposed to a merger of all U.S. international communications with a consequent severing of the overseas portion of message telephone service from the domestic portion.

The Bell System further believes that including Comsat in any international merger would be inconsistent with its responsibility for establishing a global communications satellite system.

The remainder of this paper sets forth the principal reasons for the Bell System's position and outlines some of the major considerations involved in any restructuring of the international telecommunications industry.

No Structural Change in Overseas Telephone Service is Needed

The extent and quality of the overseas telephone service, as well as its past record, afford no support for the idea that there should be a change. The Bell System has pioneered overseas telephone service and has brought it to the point where any telephone in this country can be connected with 97% of the telephones in the world. It is generally recognized, both in this country and abroad, that it was primarily the initiative and progressiveness of the Bell System that has led to this high degree of development. It was the first to send speech across the ocean (1915); it established the first commercial trans-oceanic telephone service (1927);

and it has kept this leadership for the United States by a continuous program of improvement and expansion in all forms of transmission. Since the first transatlantic telephone cable was laid in 1956 the quality of overseas voice communication in cables has reached the point where it is as good as that which is provided domestically. And this service is continually being expanded to provide for the growing demand for overseas service.

Moreover, from an operating and customer standpoint, the distinction between international and domestic telephone service is rapidly disappearing. With the advent of customer dialing of international calls in the early 1970's, there will be almost complete integration of domestic and international service. Because of the nature and complexities of the message network which is used commonly for both domestic and international traffic, and the fact that the telephone company is held responsible by its customers for the complete service, it would be unfortunate indeed to fracturize this service or to deprive the telephone company of effective participation and responsibility in the decisions relating to the numbers of circuits and the types of facilities which are used for international telephone service.

The solution to some of the problems facing the U.S. international record carriers may make permissive merger legislation desirable. But the resolution of these problems certainly does not justify upsetting the telephone service arrangements which have given the telephone-using public in this country the best overseas telephone service in the world.

Competition Among U.S. International Carriers

One of the primary arguments urged in favor of a Chosen Instrument is the claim that the multiple international record carriers are played one against the other by foreign governments or their communications agencies. It is contended that American interests would be better served if they could speak as a combined entity. We recognize the possibility that a "whipsaw" problem may exist. However, if such a problem does exist, the remedy need only extend to merger of the record carriers. There is already a single telephone carrier, and there has never been a problem of this kind with regard to telephone communications.

Eliminating Duplication of Facilities

It has been claimed that creation of a Chosen Instrument could permit elimination of wasteful duplication of facilities and management. However, any removable duplication that may exist lies almost wholly among the competing record carriers.

The record and telephone carriers already share the same major facilities, both cable (through joint ownership) and satellite. Merger of the record carriers, however, would permit consolidation of duplicating foreign offices, landline facilities and switching centers, and could result in better utilization (fill) of the overseas circuits, particularly the circuits channelized for telegraph use.

On the other hand, any saving made possible through inclusion of the international telephone facilities would be insignificant: Telephone traffic already is consolidated; there are no foreign offices; AT&T already alone maintains and manages the cables as Comsat does similarly for the satellites.

Moreover, including Comsat in a merger would hardly increase efficiency since there is no duplication of its facilities or operating personnel.

Again, whatever advantage might be visualized here would relate only to a merger involving record carriers.

Making a More Viable International Record Carrier

It has been said that a merger which included the international record carriers would make them economically more viable. Although it is true that at the present time the international record carriers are in good financial condition and their expectations are excellent, a single operating record carrier presumably would be a stronger entity. As observed by the Intra-Governmental Study Committee in its recent Report,* such a merger could ". . . result in a more vigorous competition between record services and voice services and may make possible direct competition in the provision of combined voice/record services between AT&T and a strengthened record carrier."

Comsat and the Chosen Instrument

The chosen instrument concept necessarily includes the facilities and responsibilities of Comsat. This would require legislation which would doubtless assign the chosen instrument role to Comsat and its management. In short, Comsat would become the Chosen Instrument.

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* Report and Recommendations to Senate and House Commerce Committees submitted by Intra-Governmental Committee on International Telecommunications at 31-32 (April 29, 1966).

It is believed that this would not be in the public interest. Comsat was organized pursuant to the Communications Satellite Act for the specific purpose of developing a global satellite system in cooperation with other countries. This task is far from accomplished. Indeed, while a good start has been made toward fulfillment of this objective, the most critical period lies ahead. The forthcoming "definitive" Intelsat negotiations and the establishment of a system of advanced high capacity satellites present very real challenges which will require the single-minded efforts of Comsat's already hard-pressed personnel for some time to come.

It is well known that certain foreign Intelsat members are deeply concerned with the conflicts they see in Comsat's various roles as manager for Intelsat, as the U.S. participant and spokesman in Intelsat and as the largest owner of the Intelsat satellite system. This concern would surely be heightened if a definitive proposal were advanced that Comsat should also have responsibility for all our international facilities, including the development of cables which in the eyes of some, including Comsat, are competitive with and threaten the economic well-being of the global satellite system. This added concern could only be assuaged by some expression of intention not to pursue cable development but this would clearly be inconsistent with the broader purpose of a Chosen Instrument.

These considerations bear directly on the future role of Comsat, and through it of the United States, in the establishment of a global satellite system. Comsat is unique; it is a specialist devoting its efforts exclusively to satellite communications. As such, its continuation as manager of Intelsat has logic on its side. However, a significant change in that role at this time would doubtless weaken the chance of continuing Comsat as manager of Intelsat and the loss of the management would mean the loss of the U.S. leadership position which in large measure motivated the passage of the Communications Satellite Act.

Another consideration is the impact of a chosen instrument proposal upon Comsat's role in domestic satellites. It would seem that the concept of an international Chosen Instrument would be inconsistent with Comsat's participation in a domestic satellite system.

Conclusion

It would appear that the principal problems which may exist presently in the structure of international communications arise out of the existence of multiple international record carriers. These problems can be met by legislation permitting their voluntary merger. Inclusion of Comsat in any such merger would impair its ability to discharge its mission. There is no need or justification for disrupting the present integrated telephone service by including AT&T's international facilities in any merger.

SPECIFIC DATA CONCERNING INTERNATIONAL COMMUNICATIONS

Introduction

The history of international telecommunications over the years has been marked by significant growth and technological progress. The catalyst for this evolutionary process has been the basic desire of people the world over to communicate better with one another.

Today, as never before, the international community requires the most modern, efficient and economical communications possible to conduct governmental, business and personal affairs. The technology to meet these needs fortunately is at hand. At the public's service is a diversified and constantly expanding network utilizing undersea cables, satellites and high frequency radio.

Great demands will be put on this complex of facilities between now and 1980 as the pace of transoceanic communications accelerates and the number of the world's telephones increases from more than 200 million to 500 million or more.

The dimensions of the growth in the overseas business can be dramatized by citing the number of telephone calls anticipated by 1980 between the United States and overseas points. Forecasts (Section A) show that the volume of telephone messages, which last year totaled more than 12,000,000 is expected to increase to more than 24,000,000 in 1970 and to nearly 119,000,000 by 1980.

To accommodate this increased volume, existing facilities will be expanded to include new high-capacity cable and satellite systems deployed in a balanced network designed to assure users the optimum in economies and dependability. Circuit requirements for the message telephone business alone are forecast to increase from nearly 4,000 in 1970 to nearly 18,000 in 1980.

With respect to cables, several high-capacity systems are now under investigation or in the early stages of development (Section B). These advanced systems -- utilizing technological experience gained through development of three generations of cables since 1955 -- range from 1,440 to 10,000 channel capacity.

A 2,500-channel transatlantic system -- costing about $92,000,000 or $10 to $11 per channel mile (compared with $325 per channel mile in the 1955-60 period) -- could be ready for service in 1975 or 1976 if development work is continued. By 1980 there will likely be new technological developments which could increase the capacity of submarine cables, and reduce costs, beyond improvements currently foreseen.

The downward trend in rates (Section C) for transoceanic service evidenced over the years is expected to be accelerated as higher capacity facilities are activated and the volume of overseas business increases substantially between now and 1980.

Thus the outlook in international communications between now and 1980 is for continued growth, greater customer savings, and greater customer satisfaction.

Copies of recent financial and sales reports for international communications, provided to the Federal Communications Commission and requested by the President's Task Force on Communication Policy, are included (Section D).

PREDICTED DEMAND FOR INTERNATIONAL COMMUNICATIONS THROUGH 1980

The volume of overseas telephone calls has gone from 2,300 transatlantic messages in 1927 -- when commercial radiotelephone service was established between New York and London -- to more than 12,000,000 in 1967 between the U.S. and some 200 territories and countries abroad.

Forecasts indicate that even greater increases in overseas calling can be anticipated between now and 1980, particularly between the United States and Europe, Latin America and the Caribbean, and the Pacific and Far East.

As the following table shows, this increase in calling volumes will require significant increases in the number of circuits required to handle the accelerated growth projected between now and 1980.

Overseas Message Telephone Forecast And Circuit Requirements

	1970	1975	1980
U.S.-Europe			
Messages (000)	6,743	14,939	36,694
Circuits	969	2,104	4,846
U.S.-Middle East			
Messages (000)	272	582	1,360
Circuits	83	185	374
U.S.-Africa			
Messages (000)	119	330	820
Circuits	59	202	361
U.S.-Latin America and Caribbean			
Messages (000)	8,468	18,240	37,023
Circuits	1,948	3,967	7,853
U.S.-Pacific and Far East			
Messages (000)	8,616	21,453	42,981
Circuits	938	2,284	4,414
Totals			
Messages (000)	24,218	55,544	118,878
Circuits	3,997	8,742	17,848

Note: Above excludes Canada and Mexico

TECHNOLOGIES, COSTS, CAPABILITIES, ETC. FOR SUBMARINE CABLES AS PREDICTED THROUGH 1980

The development of undersea telephone cable goes back to 1921, when three short-haul nonrepeatered cables -- each able to carry one call at a time -- were laid along the ocean floor between Florida and Cuba. With the later development of submarine repeaters to amplify the signal along its journey through the cable, undersea facilities were destined to play a major role in overseas communications.

The first transatlantic telephone cable system was placed in service between Clarenville, Newfoundland, and Oban, Scotland, in 1956. Since then there has been a dramatic increase in the capacity of repeatered submarine cable systems and an equally dramatic reduction in costs per channel mile.

Between 1955 and 1960, more than 20,000 miles of the so-called SB cable system were laid: the first transatlantic cable, a cable to Alaska, a second transatlantic cable between Clarenville and France, a U.S. Mainland- Hawaii cable, and one to Puerto Rico. This system used two cables -- one for each direction of transmission -- with flexible vacuum tube repeaters to provide a base capacity of 48 telephone circuits. The average cost of these systems was $325 per circuit mile.

The next generation (SD system) of Bell System-designed submarine cables, with a capacity of 138 circuits, used a single cable with larger repeaters in a rigid case. Some 18,900 miles of this system have been placed, including transpacific cables from the U.S. Mainland to Hawaii, Guan, Japan and the Philippines; two transatlantic cables; one from the U.S. to Jamaica and Panama; and a Florida-St. Thomas cable. The average cost of this cable was about $95 per channel mile.

The present design (SF), which provides 720 two-way circuits on a single cable, uses transistorized repeaters and larger cable than the SD system. The repeaters are spaced 10 miles apart instead of the 20-mile separation between SD system repeaters. This is made possible by the lower power requirements for transistors, compared with the vacuum tubes used in the SD system, permitting more than double the number of repeaters with no increase in terminal voltages. This system is being used for the Florida-St. Thomas system being installed this summer and will be used for the TAT-5 cable to be installed between Rhode Island and Spain in 1970. The cost per channel mile of this system is $30.

Dramatic increases in capacity and decreases in circuit costs have been effected in the 12 years since the first transatlantic cable was laid. For economic reasons, transistorized cable systems with capacities up to 720 circuits are likely to be used extensively in the future in meeting the growth requirements on most routes. However, larger capacity cables could be economically used on heavy routes -- transatlantic, for example -- by about 1975. Large capacity cables are economical, too, on routes such as England to Europe, where high growth rates are experienced.

Several such high capacity systems -- ranging from 1,440 to 10,000 channel capacity -- are under investigation or in the early stages of development.

It appears that repeaters of up to 10,000 one-way channels will be practicable in the next few years. These involve new techniques and developments which are in reach but require considerable work.

These repeaters could provide about 10,000 two-way circuits by utilizing 2 cables -- one for each direction of transmission. If half of the band width of the repeater is utilized for each direction of transmission, somewhat less than 5,000 two-way circuits would be obtained on a single cable.

To realize the full capability of these repeaters, however, a cable larger than the SF model would be needed to decrease the transmission loss between repeaters. Such a change in cable design is feasible but costly.

Studies of the economical balance of repeater and cable costs, growth rates, etc., indicate that the optimum cable system for utilization on the heavy routes, such as transatlantic, in the 1975-80 period is one utilizing the existing cable (SF design) and new repeaters with a capacity of about 2,500 two-way circuits on single cable.

While the costs of such a system would vary depending on the number and length of the systems built (primarily as a base for spreading the development and factory setup costs), it is estimated that the cost of a 3,500 mile (transatlantic) system of about 2,500 channel capacity would be approximately $92,000,000 or $10 to $11 per channel mile. Such a system could be ready for service in 1975 or 1976.

Present plans are based on improvements which can be realized with current technology. By 1980, there will likely be new developments which could increase the capability of submarine cable systems and reduce costs beyond current estimates.

BRIEF HISTORY OF OVERSEAS TELEPHONE SERVICE AND RATES

A major breakthrough in international communications occurred January 7, 1927, when the first commercial transatlantic radiotelephone circuit was established between New York and London. During 1928 and 1929, service was extended through London to most countries on the European continent.

In those early days, it cost $75 for a three-minute call between New York and London. Today the same call can be completed for as little as $5.70 at night and on Sunday.

Service Expansion

The first expansion of overseas radiotelephone service was southward. In 1930, circuits were placed in service between New York and Argentina and through Argentina to several other South American countries.

Service was established via radio between San Francisco and Hawaii in 1931, and was extended to the Philippines and the Far East shortly thereafter. A third radiotelephone center was opened in Miami in 1932 to serve Central America and the Caribbean. By 1940, telephone service was available to about 75 overseas areas, compared with the 200 countries and territories that can now be reached.

The opening of the first transatlantic cable in 1956 ushered in a new era in global communications. Other cables followed, making available direct telephone circuits between the U. S. mainland and Alaska, Hawaii, Europe, Puerto Rico, Bermuda, Jamaica, Panama, Guam, Japan, the Philippines, Virgin Islands, Venezuela, New Zealand, Australia and points beyond.

Starting in 1965, another significant step was taken with the opening of commercial telephone service via communications satellite between the United States and the United Kingdom, France, Germany, and Italy. Satellites are now used to span the Pacific as well.

Rate Treatment

Prior to 1944, rates for overseas services were generally based on a rate for the radio link plus additional charges at either or both ends.

The $75 rate for calls between New York and London was reduced to $45 in March, 1928, and to $30 in May, 1930. The rate to South America was reduced from $36 to $30 in August, 1930. At the opening of the services via Miami, rates ranged from $15 to $21.

Between July and November, 1936, rates for most overseas routes were reduced 30 to 50% and Sunday rates were introduced which were approximately 30% lower than weekday rates. In November, 1939, another reduction was made in most of the South American rates and in rates to Puerto Rico, Indonesia, the Philippines and Hawaii. Rates to Japan and Australia were reduced in 1940.

In 1936, night rates were introduced for the European services, in 1941 for Hawaiian service; in 1942 night rates were offered to Panama and Puerto Rico and, in 1945, to Brazil.

At the end of 1939, the general range of all direct overseas radio link rates was from $4.50 weekdays and $3 Sundays for the Bahamas to $24 and $18 on the New York-Rome radio link.

Rate Zones

The United States was originally divided into 5 large rate zones with charges -- ranging from 0 to $12 -- to be added to the rate for the overseas radio link. In 1931, as new services were inaugurated, the zone rate structure was modified anticipating the revision in December, 1933, when the zone rate arrangement for all previously established services was changed from 5 to 4 zones. In 1939, the 4-zone arrangement for certain services via Miami -- those with low radio link rates -- was changed to 5 zones. Zone rates themselves were reduced in July, 1937, and in August, 1940, until the weekday zone rates ranged from 0 to $4.50, and the night and Sunday zone rates, introduced in July, 1937, ranged from 0 to $3.75.

Prior to World II -- when all European countries, except France, were reached via London -- zone charges applied beyond London ranged from $.75 to $6.00. Zone charges were also established by some of the other larger overseas countries and ranged from $.75 to $3.00.

Through Rates

Beginning in 1944, negotiations were started to place in effect a basic mileage rate schedule that initially included a rate of $15 for distances over 5,000 miles, but which was revised in September, 1945, when the highest rate in the schedule became $12 for distances beyond 3,000 miles. Rates were "through" rates rather than the "additive" rates previously in effect.

Rates for all services opened thereafter on a direct circuit basis were generally based on the schedule shown below, and were revised for all previously available services by the spring of 1948.

	Weekday	Night & Sunday
0 - 500 miles	$4.50	$3.75
501 - 1000 miles	6.00	4.50
1001 - 2000 miles	7.50	6.00
2001 - 3000 miles	9.00	7.50
Over 3000 miles	12.00	9.00

Classified Rate Schedules

Beginning with Hawaii in 1957, classified rate schedules, which establish lower rates for station-to-station service and lower additional minute rates for person-to-person service, have been extended to 40 countries or areas, usually at the same time improved facilities were put into service. Calls to points with classified rates now account for about 80% of the total overseas traffic.

Chronology of Rate Changes

Following is a chronology of overseas message telephone rate changes from the inception of the service to date overseas private line service was first offered with the laying of the first transatlantic telephone cable in 1956. A review of rate changes for overseas private line service also is included.

MESSAGE TELEPHONE SERVICE

OVERSEAS SERVICE

Effective Date	Description
March 4, 1928	New York-London ocean link rate reduced from $75 to $45 - affected 4 other countries.
May 11, 1930	New York-London ocean link rate reduced from $45 to $30 - affected 20 other countries served via London.
June 1, 1935	Night rate introduced on New York-London ocean link ($21 as compared with $30 day rate) - corresponding reduction to 27 other countries served via London.
July 1, 1936	Reduction in ocean link weekday rates to practically all countries, except Asia, ranging from 25 to 50%; Sunday rates introduced - about 25 to 35% under weekday rate.
November 1, 1939	Reduction in ocean link rates to South America, Puerto Rico, Philippines, Netherlands Indies, Malaya and Hawaii - ranging generally from about 15 to 30%.
August 1, 1940	Rates for United States Zones 3 and 4 reduced from $4.50 and $6.75, respectively, to $3.75 and $4.50; San Francisco-Japan ocean link rates reduced (Weekday from $24 to $15; Sunday from $18 to $12).

Beginning in 1944 negotiations with overseas administrations were on the basis of replacing the existing rate plan of ocean link rates and land line zone rates with through rates varying with airline distances and at appreciably lower levels. The objective was day rates ranging from $4.50 to $12.00. The following changes came from these negotiations:

Year 1944	Involving 18 countries or areas - Argentina, Bahamas, Bermuda, Brazil, Chile, Columbia, Costa Rica, Curacao, Guatemala, Haiti, Hawaii, Honduras, Jamaica, Nicaragua, Panama, Peru, Puerto Rico, Surinam.

MESSAGE TELEPHONE SERVICE (Cont'd)

Effective Date	Description
Year 1945	Involving 12 countries or areas - Alaska, Australia, Brazil, France, Great Britain, Hawaii, Portugal, Puerto Rico, Russia, Spain, Trinidad, Venezuela.
Year 1946	Involving 32 countries or areas - Argentina, Austria, Barbados, Belgium, Bermuda, Brazil, Chile, Denmark, Dominican Republic, Egypt, Eire, France, Great Britain, India, Italy, Jamaica, Japan, Kenya, Luxembourg, Netherlands, Norway, Palestine, Paraguay, Peru, Phillipines, Portugal, South Africa, Spain, Sweden, Switzerland, Trinidad, Uruguay.
Year 1947	Involving 17 countries or areas - Belgium, China, Czechoslovakia, Eire, Finland, Great Britain, Greece, Hungary, Iceland, Japan, Luxembourg, Netherlands, Netherlands Indies, Poland, Roumania, Switzerland, Yugoslavia.
July 1, 1950	Through rates established between the United States and Cuba.
October 15, 1956	Application of United States-Canada Schedule II rates to message telephone service between the United States and points in Newfoundland.
October 9, 1957	Station-to-station rates established to Hawaii - Previous rates offered at person levels only ranged from $6.00 to $9.00 - new station rates range from $5.25 to $7.50.
January 26, 1960	Station-to-station rates established to Puerto Rico and Virgin Islands - Previous rates offered at person levels only ranged from $4.50 to $9.00 - new station rates range from $4.50 to $7.50.
April 1, 1962	Station-to-station rates established to Bermuda - Previous rates offered at person level only ranged for $6.00 to $9.00 - new station rates range from $4.50 to $6.50.

MESSAGE TELEPHONE SERVICE (Cont'd)

Effective Date	
February 19, 1963	Station-to-station rates established to Jamaica - Previous rates offered at person level only ranged from \$6.00 to \$12.00 - new station rates range from \$3.50 to \$8.50.
April 1, 1963	Station-to-station rates established to Panama - Previous rates offered at person level only ranged from \$4.50 to \$9.00 - new station rates range from \$4.00 to \$7.00.
June 18, 1964	Station-to-station rates established to Japan - Previous rates offered at person level only at \$12.00 Weekdays and \$9.00 Sunday - new station rates \$9.00 Weekdays and \$6.75 Sundays.
February 1, 1965	Rates reduced to Hawaii and "after 8" rates established. Previous station rates ranged from \$5.25 to \$7.50 - revised station rates range from \$3.75 to \$7.00. Lowest "after 8" rate \$3.75.
August 2, 1966	Station-to-station rates established to Venezuela - Previous rates offered at person level only ranged from \$6.00 to \$12.00 - new station rates range from \$4.00 to \$8.00.
September 1, 1966 through January 15, 1967	Station-to-station rates established to various Eastern Caribbean Islands - Previous rates offered at person level only ranged from \$7.50 to \$12.00 - new station rates range from \$4.00 to \$8.00.
January 15, 1967	Station-to-station rates established to American Samoa - Previous rates offered at person level only \$12.00 Weekdays and \$9.00 Sunday - new station rates \$8.00 Weekdays and \$6.50 Sundays.

MESSAGE TELEPHONE SERVICE (Cont'd)

Effective Date	
February 1, 1967	Station-to-station rates established to Austria, Belgium, Denmark, France, Germany Ireland, Italy, Liechtenstein, Monaco, Netherlands, Norway, San Marino, Sweden, Switzerland, United Kingdom, Vatican City - Previous rates offered at person level only $12.00 Weekdays and $9.00 Night and Sunday (where applicable) - new station rates $9.00 Weekdays and $6.75 Night and Sundays (where applicable) except United Kingdom and Ireland - new station rates $7.50 Weekdays and $5.70 Night and Sunday.
March 1, 1967	Station-to-station rates established to Spain - same rate levels as February 1, 1967 Europe change.
March 5, 1967	Rates reduced to Hawaii - Previous station rates ranged from $3.75 to $7.00 - revised station rates range from $3.75 to $6.30.
April 1, 1967	Station-to-station rates established to Finland - same rate levels as February 1, 1967 Europe change.
September 1, 1967	Station-to-station rates established to Greece - same rate levels as February 1, 1967 Europe change.
November 1, 1967	Time periods for the application of reduced rate periods revised for Hawaii in conformance with the U.S. mainland interstate pattern.
January 1, 1968	Station-to-station rates established to the Philippines - Previous rates offered at person level only $12.00 Weekdays and $9.00 Sunday - new station rates $9.00 Weekdays and $6.75 Sundays.

Overseas Private Line Rate Changes

Voice Grade

Points	Effective Date Month	Day	Year	Monthly Rate From	To
N.Y. - United Kingdom	10	1	59	$25,000	$17,000
	10	1	66	17,000	8,000(1)
	10	1	67	8,000(1)	6,500(1)
N.Y. - Cont. Europe	10	1	66	20,000	8,000(1)
	10	1	67	8,000(1)	6,500(1)
N.Y. - Bermuda	10	1	66	10,000	4,500(1)
	2	15	67	4,500(1)	9,000
Oakland - Hawaii	4	15	66	17,000	16,922.50
	10	1	66	16,922.50	14,000
	1	20	67	14,000	9,800
Oakland - Philippines	10	1	66	30,000	29,026.50
	1	20	67	29,026.50	10,000(1)
Oakland - Guam	10	1	66	27,500	27,000
	1	20	67	27,000	16,000
Oakland - Japan	1	20	67	30,000	10,000(1)
Oakland - Midway	5	15	67	20,000	11,500
Oakland - Wake	5	15	67	22,500	13,000
Oakland - Australia	12	20	67	30,000	11,400(1)
Oakland - New Zealand	1	19	68	13,750(1)	21,000
Midway - Hawaii	5	15	67	14,000	7,500
Wake	5	15	67	10,000	7,500
Japan	5	15	67	22,500	5,750(1)
Philippines	5	15	67	22,500	5,750(1)
Wake - Japan	5	15	67	20,000	5,750(1)
Philippines	5	15	67	20,000	5,750(1)
Hawaii	5	15	67	17,000	9,800
Miami - Puerto Rico	10	1	66	10,000	9,000
	2	8	67	9,000	8,550
Miami - Virgin Isl.	11	6	66	10,000	9,000
	2	8	67	9,000	8,550
Miami - Canal Zone	10	1	66	14,000	5,000(1)
Miami - Jamaica	8	24	67	10,000	8,000
Teletypewriter Grade					
Oakland - Hawaii	10	1	66	6,160	4,800
Telephotograph Grade					
N.Y. - Bermuda	2	15	67	12,000	10,800

(1) Half way rate - AT&T portion only

Section D

FINANCIAL AND SALES REPORTS FOR INTERNATIONAL COMMUNICATIONS
(Reports to the FCC)

1965-1967

(SAMPLE)

Total amount collected from users in the Continental United States for International Communications

Report of Overseas Leased Channel or Private Line Service

Report of Other Overseas Telecommunications Traffic - Addressed Program Service

Report of Overseas Telecommunications Circuit Traffic

Report of Overseas Telecommunications Traffic by Country or Point

Report of Overseas Telecommunications Traffic by Class of Service

FCC Form 336
September 1964

FEDERAL COMMUNICATIONS COMMISSION

SCHEDULE-T

Name of Reporting Carrier
American Telephone & Telegraph
Period Covered by Report
1/1/66 - 12/31/66

TOTAL AMOUNT COLLECTED FROM USERS IN THE CONTINENTAL UNITED STATES FOR INTERNATIONAL TELECOMMUNICATIONS

Amount collected on message telegraph traffic	$
Amount collected on message telephone traffic	108,075,639
Amount collected on telex traffic	
Amount collected on other telegraph services	
Amount collected on other telephone services (Program)	462,159
Amount collected on P.L. Channel Services	18,784,081

OVERSEAS TELEPRINTER EXCHANGE SERVICE
(Amounts paid for domestic haul in the United States)

Amount paid out for domestic teleprinter exchange service charges on overseas telex calls	$

SAMPLE

FCC Form 330
September 1964

FEDERAL COMMUNICATIONS COMMISSION
REPORT OF OVERSEAS LEASED CHANNEL OR PRIVATE LINE SERVICE

SCHEDULE - LC

Name of Reporting Carrier	Report for	Period covered by report
American Telephone & Telegraph Co.	[X] Cont. U.S. [ ] ______ U. S. overseas point	1/1/66 - 12/31/65

NUMBER OF LEASES FURNISHED DURING PERIOD

Leased channel or private line service furnished to:	No. of leases	Respondent's Revenue
U. S. Government		
Foreign governments		
Press entities		
Other users		
TOTAL		

LEASES IN EFFECT AS OF December 31, 1966 (Cable)

COUNTRY or POINT	Class of User 1/	Details of Service: Number of leases 2/	Type of Channel 3/	Speed of Transmission 4/	Service Period 5/
Bermuda	US Govt.	2	Voice		Full
	US Govt.	3	Alt.Voice/ Non-Voice		Full
	US Govt.	1	Telephoto		Full
France	US Govt.	3	Voice		Full
	US Govt.	4	Alt. Voice/ Non-Voice		Full
Germany	US Govt.	2	Voice		Full
	US Govt.	1	Alt. Voice/ Non-Voice		Full
Guam	US Govt.	[illegible]	Voice		Full
Hawaii	US Govt.	[illegible]7	Voice		Full
	US Govt	[illegible]2-	Alt. Voice/ Non-Voice		Full
	US Govt.	1	Telegraph	100 WPM	Full
	US Govt.	2	Telegraph	60 WPM	Full
	Other	1	Voice		Full
	Other	1	Alt. Voice/ Non-Voice		Full
	Other	1	Telegraph	75 WPM	Full
Japan	US Govt.	2	Voice		Full
Panama	US Govt.	4	Voice		Full
	US Govt.	2	Alt. Voice/ Non-Voice		Full
Philippines	US Govt.	1	Voice		Full
				(use additional sheets	if necessary)

1/ U.S. Government, Foreign government, Press or Other. 2/ Number of each type of lease in effect for each class of user. 3/ Voice, Alternate voice/non-voice, Facsimile, Data, Teleprinter, etc. 4/ Complete only for data (in bauds) and for teleprinter (in words per minute). 5/ Full (service furnished 24 hours per day) or Short (service of less than 24 hours per day).

FCC Form 336
September 1964

FEDERAL COMMUNICATIONS COMMISSION
REPORT OF OTHER OVERSEAS TELECOMMUNICATIONS TRAFFIC

SCHEDULE-OS

Name of Reporting Carrier	Period Covered by Report
American Telephone and Telegraph Company	1/1/66 - 12/31/66

REPORT OF MULTIPLE ADDRESSED SERVICES

	No. of Minutes	Revenues
Addressed Press Service		
Scheduled Photo Transmission and Reception Services		

REPORT OF ☐* FACSIMILE MESSAGE ☒* ADDRESSED PROGRAM SERVICES

Direction of Traffic: Outward

Country or Point	☐* Number of Messages ☒* Minutes	Respondent's Revenues	Foreign Payouts (outbound traffic only)
Aden	34	68	204
Argentina	374	748	748
Australia	1,281	2,650	4,149
Austria	1,512	3,032	3,368
Bahamas	480	285	285
Belgium	826	2,072	2,669
Brazil	205	436	436
Cambodia	84	168	168
Chile	37	74	6,598
Colombia	61	91	91
Cuba	136	242	143
Cyprus	30	60	236
Czechoslovakia	10	20	20
Denmark	41	82	82
Ecuador	10	20	20
Egypt	279	596	2,066
Ethiopia	275	550	1,115
Formosa	95	190	190
France	2,34[illegible]	5,280	6,723
Germany	9,934	20,982	33,464
Ghana	330	640	2,064
Greece	608	1,220	5,173
Guatemala	48	48	48
Guyana	55	69	69
Hawaii	1,680	2,818	2,818
Hong Kong	595	1,188	3,593
Hungary	-	-	15
India	918	1,226	4,572
Indonesia	389	778	1,119
Iran	204	408	632
Ireland	339	678	750
Israel	733	1,466	3,590
Italy	4,657	9,800	10,626
Japan	1,119	2,372	2,697
Jordan	74	148	148

(use additional sheets if necessary)

* Check applicable box.

FCC Form 336
September 1964

FEDERAL COMMUNICATIONS COMMISSION
REPORT OF OTHER OVERSEAS TELECOMMUNICATIONS TRAFFIC

SCHEDULE-OS

Name of Reporting Carrier: American Telephone & Telegraph Company

Period Covered by Report: 1/1/66 - 12/31/66

REPORT OF MULTIPLE ADDRESSED SERVICES

	No. of Minutes	Revenues
Addressed Press Service		
Scheduled Photo Transmission and Reception Services		

REPORT OF ☐* FACSIMILE MESSAGE ☒* ADDRESSED PROGRAM SERVICES

Direction of Traffic: Inward

Country or Point	☐* Number of Messages / ☒* Minutes	Respondent's Revenues	Foreign Payouts (outbound traffic only)
Alaska	9,520	6,366	
Argentina	3,420	12,414	
Australia	806	1,612	
Austria	1,423	4,649	
Belgium	2,371	8,830	
Brazil	4,217	8,434	
Chile	-	18,828	
Colombia	18	20	
Denmark	1,813	4,424	
Ecuador	14	28	
Finland	82	164	
Formosa	26	[illegible]	
France	10,517	29,6[illegible]	
Germany	27,043	58,811	
Hawaii	2,974	7,020	
India	1,053	2,237	
Israel	1,567	3,134	
Italy	10,866	28,205	
Japan	4[illegible]	2,400	
Netherlands	1,9[illegible]	4,669	
Norway	740	1,762	
Panama	594	3,641	
Philippine Isl.	100	374	
Poland	132	264	
Puerto Rico	10,446	24,580	
Roumania	60	120	
Sweden	4,037	11,068	
Switzerland	1,037	3,720	
Turkey	125	250	
United Kingdom	23,974	51,494	
Venezuela	24	48	

(use additional sheets if necessary)

* Check applicable box.

F.C.C. - WASHINGTON, D. C.

FCC FORM 336
SEPTEMBER 1964

BUDGET BUREAU NO 52-R169

FEDERAL COMMUNICATIONS COMMISSION
REPORT OF OVERSEAS TELECOMMUNICATIONS CIRCUIT TRAFFIC

SCHEDULE-C1

REPORT FOR: [X] CONTINENTAL UNITED STATES
[ ] ______ (U.S. OVERSEAS POINT)

CHECK ONE: [ ] TELEGRAPH [X] TELEPHONE [ ] TELEX

NAME OF REPORTING CARRIER: AMERICAN TEL. & TEL. CO.

DIRECTION OF TRAFFIC: OUTWARD

PERIOD COVERED BY REPORT: JAN-DEC 1966

COUNTRY OR POINT	TERMINATING AT OVERSEAS COUNTRY OR POINT		TRANSITING THE OVERSEAS COUNTRY OR POINT		COMBINED TOTAL	
	NUMBER OF MESSAGES	NUMBER OF MINUTES	NUMBER OF MESSAGES	NUMBER OF MINUTES	NUMBER OF MESSAGES	NUMBER OF MINUTES
AMERICAN SAMOA	2,091	14,245			2,091	14,245
ANTIGUA	4,054	24,792	100	541	4,154	25,333
ARGENTINA	29,872	182,321	82	519	29,954	182,840
ARUBA	5,565	32,967	1	11	5,566	32,978
ASCENSION ISLANDS	504	5,050			504	5,050
AUSTRALIA	42,993	431,531	4,643	37,921	47,636	469,452
AUSTRIA	22,299	176,207	6,157	44,369	28,456	220,576
BAHAMAS	299,097	1,988,388			299,097	1,988,388
BARBADOS	8,460	53,172	21	70	8,481	53,242
BELGIUM	44,323	470,140	2,303	21,312	46,626	491,452
BERMUDA	107,303	731,788			107,303	731,788
BRAZIL	31,044	207,315	750	4,533	31,794	211,848
BRITISH HONDURAS	2,976	16,808			2,976	16,808
CHILE	15,065	98,509	474	2,552	15,539	101,061
CHINA-PEOPLES REPUBLIC	17	155			17	155
COLOMBIA	29,429	192,511			29,429	192,511
COSTA RICA	16,239	102,542			16,239	102,542
CUBA	360,395	4,225,049			360,395	4,225,049
CURACOA	7,066	38,185	247	1,288	7,313	39,473
DENMARK	26,836	229,949	217	1,819	27,053	231,768
DOMINICAN REPUBLIC	43,443	280,408			43,443	280,408
ECUADOR	14,767	95,867			14,767	95,867
EGYPT	1,980	13,007			1,980	13,007
EL SALVADOR	10,751	66,688			10,751	66,688
FINLAND	3,789	28,588			3,789	28,588
FORMOSA	13,648	117,789			13,648	117,789
FRANCE	192,545	1,805,129	7,218	53,263	199,763	1,858,392
FRENCH GUIANA	83	726			83	726
GERMANY	363,513	3,029,868			363,513	3,029,868
GREECE	35,646	293,830	1	3	35,647	293,833
GUAM	29,596	276,763	1	4	29,597	276,767
GUATEMALA	17,960	110,906			17,960	110,906
GUYANA	1,688	9,776	4,335	25,437	6,023	35,213
HAITI	9,512	55,205			9,512	55,205
HAWAII	908,127	7,450,789	7,206	62,974	915,333	7,513,763
HONDURAS	13,055	75,529			13,055	75,529
HONG KONG	33,293	346,349	1,474	8,561	34,767	354,910
INDONESIA	258	2,147			258	2,147
IRELAND	28,462	225,173			28,462	225,173
ISRAEL	19,569	119,694			19,569	119,694
ITALY	143,052	1,226,281	978	6,656	144,030	1,232,937
JAMAICA	119,124	821,862			119,124	821,862
JAPAN	215,534	2,379,414	93	620	215,627	2,380,034
KOREA	14,221	100,116	1	24	14,222	100,140

SAMPLE

FCC FORM 336
SEPTEMBER 1964

BUDGET BUREAU NO 52-R189

FEDERAL COMMUNICATIONS COMMISSION
REPORT OF OVERSEAS TELECOMMUNICATIONS CIRCUIT TRAFFIC

SCHEDULE-CT

REPORT FOR: [X] CONTINENTAL UNITED STATES
[ ] ______ (U.S. OVERSEAS POINT)

CHECK ONE: [ ] TELEGRAPH [X] TELEPHONE [ ] TELEX

NAME OF REPORTING CARRIER: AMERICAN TEL. & TEL. CO.

DIRECTION OF TRAFFIC: INWARD

PERIOD COVERED BY REPORT: JAN-DEC 1966

COUNTRY OR POINT	ORIGINATING AT OVERSEAS COUNTRY OR POINT		TRANSITING THE OVERSEAS COUNTRY OR POINT		COMBINED TOTAL	
	NUMBER OF MESSAGES	NUMBER OF MINUTES	NUMBER OF MESSAGES	NUMBER OF MINUTES	NUMBER OF MESSAGES	NUMBER OF MINUTES
AMERICAN SAMOA	1,478	9,356			1,478	9,356
ANTIGUA	3,952	20,534	180	1,088	4,132	21,622
ARGENTINA	31,431	179,461	71	259	31,502	179,720
ARUBA	5,605	30,078			5,605	30,078
ASCENSION ISLANDS	895	3,393			895	3,393
AUSTRALIA	48,298	402,571	7,641	42,414	55,939	444,985
AUSTRIA	9,062	69,085	2,810	20,283	11,872	89,368
BAHAMAS	255,528	1,483,727			255,528	1,483,727
BARBADOS	5,889	32,302			5,889	32,302
BELGIUM	33,016	343,343	2,325	24,405	35,341	367,748
BERMUDA	71,623	487,222			71,623	487,222
BRAZIL	26,075	173,770	52	294	26,127	174,064
BRITISH HONDURAS	1,421	6,396			1,421	6,396
CHILE	17,636	113,566	114	524	17,750	114,090
CHINA-PEOPLES REPUBLIC	3	19			3	19
COLOMBIA	33,556	202,168			33,556	202,168
COSTA RICA	15,557	84,359	12	42	15,569	84,401
CUBA	6,954	62,655			6,954	62,655
CURACAO	7,343	34,552	4	12	7,347	34,564
DENMARK	19,443	135,641	371	2,894	19,814	138,535
DOMINICAN REPUBLIC	38,826	227,797			38,826	227,797
ECUADOR	9,433	60,898			9,433	60,898
EGYPT	1,974	9,049			1,974	9,049
EL SALVADOR	12,443	70,914			12,443	70,914
FINLAND	3,112	24,460			3,112	24,460
FORMOSA	6,405	32,381			6,405	32,381
FRANCE	138,803	1,281,495	7,780	55,089	146,583	1,336,584
FRENCH GUIANA	37	271			37	271
GERMANY	157,235	1,296,611	307	1,879	157,542	1,298,490
GREECE	20,879	131,780			20,879	131,780
GUAM	17,667	119,814	179	1,234	17,846	121,048
GUATEMALA	16,962	101,766			16,962	101,766
GUYANA	1,567	8,235	2,781	12,231	4,348	20,466
HAITI	5,741	25,302			5,741	25,302
HAWAII	724,561	5,658,122	2,490	22,390	727,051	5,680,512
HONDURAS	15,417	78,989			15,417	78,989
HONG KONG	23,133	162,207	1,315	5,210	24,448	167,417
INDONESIA	450	3,375			450	3,375
IRELAND	19,984	166,106			19,984	166,106
ISRAEL	11,301	56,874			11,301	56,874
ITALY	72,934	578,733	1,077	6,673	74,011	585,406
JAMAICA	110,124	700,725			110,124	700,725
JAPAN	135,290	1,468,267	1,986	8,323	137,276	1,476,590
KOREA	5,231	33,256			5,231	33,256

SAMPLE

FCC FORM 336
SEPTEMBER 1964

FEDERAL COMMUNICATIONS COMMISSION

REPORT OF OVERSEAS TELECOMMUNICATIONS TRAFFIC

BY COUNTRY OR POINT

SCHEDULE MT

CHECK ONE	NAME OF REPORTING CARRIER	
☐ TELEGRAPH	AMERICAN TEL & TEL CO	
☒ TELEPHONE	DIRECTION OF TRAFFIC	PERIOD COVERED BY REPORT
☐ TELEX	OUTWARD	JAN. THRU DEC. 1966

COUNTRY OR POINT	ORIGINATING CONT. UNITED STATES				TRANSITING CONT. UNITED STATES				COMBINED TOTAL			
	NUMBER OF MESSAGES	NUMBER OF MINUTES	RESPONDENT'S REVENUE	FOREIGN PAYOUTS	NUMBER OF MESSAGES	NUMBER OF MINUTES	RESPONDENT'S REVENUE	FOREIGN PAYOUTS	NUMBER OF MESSAGES	NUMBER OF MINUTES	RESPONDENT'S REVENUE	FOREIGN PAYOUTS
EUROPE, AFRICA & NEAR EAST												
EUROPE												
ALBANIA												
AUSTRIA	20,843	165,750	349,581	315,507	1,456	10,457	22,482	[illegible]	22,299	176,207	372,063	339,532
AZORES	436	2,537	4,394	5,670	83	547	832	1,334	519	3,084	5,226	7,004
BELGIUM	42,495	455,645	892,554	838,445	1,828	14,495	31,449	33,128	44,323	470,140	923,994	871,573
BULGARIA	173	1,257	2,249	2,788	25	204	434	558	198	1,461	2,683	3,346
CYPRUS	331	2,048	3,110	7,148	3	35	56	119	334	2,083	3,166	7,267
CZECHOSLOVAKIA	1,434	10,915	21,834	21,958	297	2,407	5,495	6,512	1,731	13,322	27,329	28,470
DENMARK	26,188	225,241	424,792	386,855	648	4,708	11,340	11,054	26,836	229,949	436,132	397,909
FINLAND	3,706	27,951	46,592	51,691	83	637	1,508	1,515	3,789	28,588	48,100	53,206
FRANCE	182,993	1,731,526	3,586,609	3,365,825	9,552	73,203	158,528	156,306	192,545	1,805,129	3,745,137	3,522,131
GERMANY-EAST												
GERMANY-WEST	355,655	2,971,535	5,685,771	[illegible]	7,858	57,333	126,872	127,386	363,513	3,029,868	5,812,643	5,282,077
GIBRALTER	165	1,314	2,496	[illegible]	32	179	297	332	197	1,493	2,793	2,549
GREECE & GR. ISL.	33,973	281,430	580,528	[illegible]	1,673	12,400	27,516	28,480	35,646	293,830	608,044	575,869
GREENLAND												
HUNGARY	4,144	[illegible]	[illegible]	57,549	186	1,171	2,661	3,105	4,330	30,220	61,519	60,654
ICELAND												
IRELAND	28,093	222,860	407,465	384,877	369	2,313	5,258	5,396	28,462	225,173	412,723	390,273
ITALY	134,048	[illegible]	2,420,658	2,257,319	9,004	59,348	134,021	130,948	143,052	1,226,281	2,554,679	2,388,263
LUXEMBURG	1,983	[illegible]	36,126	35,172	28	196	438	508	2,011	19,388	36,564	35,680
MALTA	404	2,271	6,919	9,454	381	2,493	4,691	5,321	785	5,764	11,610	14,775
NETHERLANDS	[illegible]	555,375	1,081,370	980,937	1,957	14,087	33,063	32,993	63,158	573,462	1,114,433	1,013,930
NORWAY	[illegible]	198,445	370,246	343,213	457	4,477	11,311	10,542	22,326	202,922	381,557	353,755
POLAND	[illegible]	18,303	29,489	33,484	98	660	1,370	1,509	2,747	18,963	30,859	34,993
PORTUGAL	4,923	33,824	68,415	65,047	422	2,512	5,365	5,774	5,345	36,336	73,780	70,821
ROUMANIA	503	2,991	4,866	7,879	14	65	131	207	517	3,056	4,997	8,086
SPAIN	38,880	340,751	629,874	579,271	14,258	92,676	204,756	209,480	53,138	433,427	834,630	788,751
SWEDEN	38,987	377,900	718,648	646,095	1,375	10,949	24,482	24,866	40,362	388,849	743,130	670,961
SWITZERLAND	91,887	882,271	1,832,861	1,706,032	4,527	37,327	84,256	81,404	96,414	919,598	1,917,117	1,787,436
TURKEY	2,378	15,497	29,954	29,091	91	545	971	1,179	2,469	16,042	30,925	30,270
U. S. S. R.	1,451	10,720	18,652	22,776	78	580	1,335	1,470	1,529	11,300	19,987	24,246
UNITED KINGDOM	465,904	4,690,268	8,926,649	8,344,695	15,967	110,611	275,063	267,644	481,871	4,800,879	9,201,712	8,612,339
VATICAN CITY STATE												
YUGOSLAVIA	2,951	24,926	46,881	48,907	128	1,005	2,296	2,545	3,079	25,931	49,177	51,452
ALL OTHER PLACES	1,095	9,145	15,676	18,724	144	1,103	2,023	2,778	1,239	10,248	17,699	21,502
TOTAL EUROPE	1,571,742	14,485,270	28304,117	26270,702	73,022	513,723	1,180,291	1,178,418	1,644,764	15,002,993	29484,408	27449,120

FCC Form 336
September 1964

FEDERAL COMMUNICATIONS COMMISSION
REPORT OF OVERSEAS TELECOMMUNICATORS TRAFFIC BY CLASS OF SERVICE

CHECK ONE	Name of Reporting Carrier	
☐ TELEGRAPH	American Telephone & Telegraph Co.	
☒ TELEPHONE	Direction of Traffic: Outward	Period Covered by Report: 1/1/66 - 12/31/66

SCHEDULE-MC

CLASS OF SERVICE	ORIGINATING 1/ ~~TERMINATING~~ IN CONT. UNITED STATES			TRANSITING CONT. UNITED STATES			COMBINED TOTAL		
	Number of Messages	Number of Minutes ~~Words~~ 1/	Respondent's Revenues	Number of Messages	Number of Minutes ~~Words~~ 1/	Respondent's Revenues	Number of Messages	Number of Minutes ~~Words~~ 1/	Respondent's Revenues
Station Day	386,561	2,864,754	3,223,600	11	81	98	386,572	2,864,835	3,223,698
Station Night	333,949	2,662,665	2,470,2[illegible]0	2	6	6	333,951	2,662,671	2,470,296
Person Day	2,922,119	24,997,061	[illegible]3,545,924	319,463	2,092,983	3,992,801	3,241,582	27,090,044	47,538,725
Person Night	1,069,954	9,963,9[illegible]	11,499,008	69,244	499,119	619,127	1,139,198	10,463,025	12,118,135
After 8PM	260,817	2,206,942	1,648,363	-	-	-	260,817	2,206,942	1,648,363

SAMPLE

1/ Delete inapplicable portion.

F.C.C. - WASHINGTON, D. C.

4

DOMESTIC SATELLITES

Summary:

The President's message of August 14, 1967, said that "one of the challenges before us is to integrate satellites into a balanced communications system."

The Bell System recognizes this challenge, and has pioneered in the development of communications satellites for both international and domestic purposes.

Domestic satellites, as the newest type of "line facilities" available to telephone engineers, promise to be an important complement to such terrestrial facilities as coaxial cable and microwave radio relay systems. Satellites do have certain limitations, however, especially when used for domestic service.

Continuing research and development have reduced the cost of terrestrial intercity line facilities so that they now account for only a very small fraction of the total cost of handling long distance conversations. Studies of service and cost advantages indicate that maximum cost benefits can be achieved from a balanced integrated system optimizing the advantages of both satellites and terrestrial facilities. However, successful application of satellites will depend upon the availability of sizable amounts of radio frequency spectrum in order to realize the full potential of satellites and to eliminate interference with common carrier terrestrial radio relay systems. Also, the very long distances between earth and stationary satellites, some 23,000 miles, introduce noticeable transmission delays which aggravate echo problems on telephone conversations and affect data transmissions.

The Bell System has suggested the establishment of a high capacity, multipurpose satellite system of advanced technical design which could be integrated with the terres-

trial network for domestic communications. This system would require allocations of frequencies in the spectrum above 12GHz, and would utilize terrestrial facilities in one direction to reduce the transmission delay. Such a multipurpose system could offer to all users the full economies which large volume makes possible. On the other hand, private or specialized satellite systems would be wasteful of both frequency spectrum and orbit space. If there are significant economies to be achieved from the use of satellites in domestic communications, they can best be realized by incorporating the satellite into the common carrier system.

DOMESTIC SATELLITES

I. Introduction

The Bell System views the use of satellites in a domestic communications network as a promising technological innovation, but with some limitations that will be discussed below. The satellite is one of several types of facilities which together can provide high quality communications service at the lowest possible overall cost. Continuing research and development have reduced the cost of terrestrial intercity line facilities now being constructed, such as coaxial cables of the type recently placed in service between Washington and Miami, so that they now account for only a very small fraction of the total cost of handling a typical long distance conversation. The use of satellites, the newest type of "line facility," is another possible step in the process of continuing cost reduction, but line facility costs as indicated above have reached the point where their effect on total costs per message is small in comparison with other elements such as terminal equipment, local distribution, switching, etc.

The feasibility of satellites for relaying both telephone and television signals between continents was first successfully demonstrated by the Bell System's Telstar satellite in conjunction with its earth station at Andover, Maine. Since that time, we have carefully studied the possible service and cost advantages that might be obtained by integrating satellites with the international and domestic cable and radio networks. We believe that minimum cost can be achieved from a balanced integrated system optimizing the advantages of both satellite and earth facilities.

It should be noted that these studies involved no commitment for or against the use of satellites. Rather, they involved an objective address to the broader question;

How can the growth requirements for U.S. communications services be met at lowest cost? The overriding criteria employed were quality of service and cost.

II. Satellites Should Be Part of a Multipurpose Common Carrier System Integrated with Existing and Future Terrestrial Facilities

The President's Message on Communications Policy of August 14, 1967 states that "one of the challenges before us is to integrate satellites into a balanced communications system." The Bell System has recognized this challenge. AT&T, in December 1966, submitted a proposal in connection with the FCC's domestic satellite inquiry for a high-capacity, multipurpose satellite system of advanced technical design to be integrated with the terrestrial network.

Various other proposals have also been submitted to the FCC, including a Ford Foundation plan for a private, single-purpose system leasing space to commercial TV networks and offering free channels to non-commercial TV. We believe that private or specialized satellite systems would be wasteful of frequency spectrum and orbit space, with few if any savings for users. Only a multipurpose system can offer to all users the full economies which large volume makes possible. Any attempt to fragment the traffic among several systems would entirely wipe out these prospects.

In short, if there are significant economies to be achieved from the use of satellites in domestic communications, they can only be realized by incorporating the satellites into the common carrier system. Any economies from the use of satellites would become available to all users, just as would any other economy in the cost of providing service.

III. Ownership of Earth Stations

The Bell System in its filings with the FCC has taken the position that the common carriers utilizing the domestic earth stations in providing services to the public should own and control such earth stations. The basic reason is that earth stations must operate as an integral part of the complex and dynamic nationwide network.

IV. Need for Additional Radio Frequency Spectrum

The Bell System believes that successful application of satellites for domestic communications will depend upon the availability of sizable amounts of radio frequency spectrum above 12 GHz. The presently allocated spectrum, combined with the spatial limitations of the stationary orbit, limits the circuit capacity to an extent that would prevent satellites from realizing their full potential. The present allocations around 6 GHz (for the earth-to-satellite path) and around 4 GHz (for the satellite-to-earth path) need to be replaced by new spectrum allocations of perhaps eight times as much bandwidth in the 12 to 40 GHz range, presently a lightly used portion of the radio frequency spectrum.

In addition to making available adequate capacity, this proposed frequency allocation would eliminate a very serious interference problem. Since satellite systems are presently sharing frequency spectrum with common carrier terrestrial radio relay systems, because of the very heavy concentration of radio relay stations it is often impossible to locate earth stations near population centers where they would be most economically desirable.

Because of the above limitations, a domestic satellite system in the present frequency bands would be very limited in scope. While these frequencies may be satisfactory for an initial trial or pilot system, development of a substantial domestic system on an economic basis will require new spectrum assignments.

Technical developments and transmission experiments performed by Bell Telephone Laboratories and others provide a basis for confidence that new spectrum allocations above 12 GHz can successfully be exploited by communications satellite systems.

V. Transmission Delay and Echo Suppression

The very long distances involved in the use of stationary satellites (23,000 miles from earth to satellite) result in transmission delays of about one-fourth second one way or one-half second round trip which aggravate echo problems on telephone connections. Tests of customer attitudes show increasing customer dissatisfaction as delay increases. This is not overcome even with today's best available echo control devices. To reduce the total round-trip delay, the Bell System has recommended the routing of domestic telephone circuits in only one direction via satellite with the other direction routed via terrestrial facilities. It is hoped that development of better echo control devices now in the experimental stage may some day reduce this problem, but up to now there is no assurance that such will be the case. Such devices will undoubtedly cost more than the echo suppressors normally used on long terrestrial circuits. Since echo suppressors must be applied to each individual telephone circuit, even a small increment in unit cost is multiplied by a large factor.

Data transmission systems are also affected by the delay encountered in transmission via stationary satellites, but it is hoped that this problem can be met by proper design of terminal equipment. However, some loss of transmission efficiency and increased costs for data terminals would seem to be unavoidable. How serious the delay problem will be for PICTUREPHONE service is not yet know, but experiments are under way to evaluate its effect on this proposed new service.

VI. International Aspects of a Domestic Communications Satellite System

As mentioned, frequency interference problems can be largely avoided by making new spectrum allocations available. Such allocations, however, will probably require international agreements. Similarly, international agreements may be required regarding orbital "parking spaces," which are international in nature since they follow the equator.

VII. Notes on the Preparation of the Bell System Proposal for an Integrated Space/Earth Communications System (December 15, 1966)

A joint AT&T Engineering, Long Lines and Bell Telephone Laboratories feasibility study in June of 1965 indicated that the use of satellites for domestic TV distribution and for long haul domestic telephone service might offer the possibility of some savings over comparable terrestrial facilities.

A more detailed feasibility study, prepared by Long Lines Department was published internally in late 1965 which re-enforced the conclusions of the earlier study. By early 1966, the Satellite Systems Engineering group at B.T.L. had described the design of a satellite which they felt could be provided by the 1968-1969 time period.

The general method used in these studies was to describe a reasonable combination of satellite-terrestrial components which could be made available. These components were combined into a system to serve communications needs. The cost per circuit in this system was calculated, and equated to an equivalent mileage of terrestrial facilities. This mileage was then used as an economic crossover in another recycling of the costing procedure. (See Attachment 1)

It is a characteristic of long haul facilities that they are terminated at a series of multiplexing levels. The largest of these levels is the mastergroup, or 600 circuits. The most economical designs for satellites have been based on providing transponders to serve mastergroups or multiples of mastergroups. To provide service for smaller multiples would require some form of multiplexing in the satellite, which seriously erodes the weight budget. While it is possible that to some extent smaller circuit quantities could be gathered and combined into mastergroup size, the cost of such gathering and combining ruled against this approach.

In each of these preliminary studies, the common conclusion was reached that satellite circuits were economical where the distance was great (over about 1300 miles) and the circuit requirement was large (one mastergroup, i.e., 600 circuits). Based on these studies more intensive investigation of the design of a domestic satellite system was undertaken at both Bell Telephone Laboratories and AT&T. Several groups in the Systems Engineering organization of B.T.L. studied the advances possible in the satellite art, the requirements for earth stations, the unique transmission considerations in a satellite system, and the concurrent advances expected in terrestrial facilities during the same time period. At the same time the Long Lines Department forecast telephone circuit and TV network requirements during the study period.

Telephone Requirements

In forecasting the future needs for long haul facilities the Long Lines Department studied the point-to-point circuit requirements between some 8000 points in the United States. These requirements were assembled and projected to 1980 utilizing computers. The telephone circuit requirements used in the initial satellite feasibility studies were manually selected from this projection using the previously mentioned criteria of length of circuit and size of circuit group. To insure a more comprehensive search of the computer output, a computer program was prepared to select from the entire 8000 point study those groups meeting the double requirement of length over 1300 miles and group size of 600 circuits. The resulting circuit groups constituted a 27 point network, i.e., a network comprised of 27 cities, between which were found circuit groups meeting these criteria.

The total two-way circuit requirement represented by this network in 1980 was 166,000 circuits. This figure represents all of the 1969-1980 telephone circuit growth between these 27 points.

The adverse customer reaction to the round trip delay of 600 ms. caused by a synchronous satellite circuit has been studied and discussed at length in papers presented to the CCITT. To mitigate the round trip delay problem, one direction of transmission of each of these circuits was assumed to be served via terrestrial facilities. This procedure is discussed in Section 2, page 12 of the Bell System Integrated Space/Earth Communications System proposal submitted to the FCC in December 1966. In effect then, 166,000 half circuits, or 83,000 two-way circuits would be served via satellite. The use of the term "half-circuits" seemed to cause a great deal of confusion so the convention was established of referring to the satellite system circuit requirement as 83,000 circuits. A similar quantity of 83,000 circuits would be left on terrestrial facilities, but this quantity would be common to both alternatives of any economic selection study.

In accordance with standard engineering study techniques any item common to both alternatives in an economic selection study can be ignored. Therefore, the 83,000 circuits assigned to terrestrial facilities in the satellite plan, being exactly equivalent to 83,000 circuits which would be served in an all terrestrial plan, were omitted from both alternatives. In other words, instead of comparing the cost of a satellite system comprising 83,000 circuits on satellites and 83,000 on terrestrial facilities with a terrestrial system comprised of 166,000 circuits, the comparison was made between 83,000 circuits served via satellite and 83,000 circuits served via terrestrial facilities.

Television Requirements

The intercity video facility requirements of the three major broadcasting networks were investigated, and the possibility of network expansion into new markets was studied. The channel mileage of video facilities dedicated to monthly contract service, and the mileage used for occasional pickups for the peak days in 1965 was used as a starting point. The patterns of regional commercials, regional program control, centralized program origination and the locations of all commercial TV stations were defined. Informal contacts with the broadcasters indicated that, barring unforeseen changes in costs, the commercial TV network of the future would have the same regional requirements as today. It was determined, very early in the study, that the maximum requirement for intercity video channels occurred on weekends in the fall, when professional football games throughout the country were booadcast over a complex and changing regional pattern.

In addition to the three existing commercial networks, a fourth network was expected to start in 1967. This was the "Overmyer" network, later known as the United network. Operation of this network started in mid 1967, and ended shortly thereafter. Early estimates of its size by 1969 indicated the possibility of as many as 123 stations.

The requirements for a nationwide Educational Television network were included in the study, providing one nationwide channel in 1969, growing to four channels in 1980. Four channels and 30 service points were provided in 1980 for Government services, mainly NASA and Air Force. (Attachment 2)

The present and future TV requirements were expressed as numbers of stations and intercity video channel miles. The other aspects of television service provided by the Bell System, such as Television Operating Centers, and local distribution facilities were considered common to both sides of the study.

Comparable Terrestrial Facilities

To provide a reasonable economic comparison between satellite and terrestrial facilities throughout the study period it was necessary to determine the types of terrestrial facilities which would be available, and the full additional cost of adding circuits. Costs were developed for telephone service on a cost per circuit mile basis and for television service on a cost per channel mile basis.

The terrestrial facilities available in 1969 for long haul message service will be TD2A microwave and coaxial cable with L4 multiplexing. It was estimated that long haul message growth in 1969 would be provided using a mix of 50% microwave and 50% guided wave facilities. Video service in the same period would be provided on TD2A radio channels. The mix of long haul message growth facilities during the study period was expected to remain at 50% radio and 50% coaxial cable. The radio facilities, which in 1969 consisted of the TD2A system, would ultimately include the TD3 system with an overbuild of TH3 channels. The TH overbuild utilizes the towers and antennas of the TD system and by using a different frequency develops an additional circuit capacity exceeding that of the TD. These additional circuits are developed very economically since the additional electronic equipment (terminals, filters, etc.) is all that is required.

Guided wave systems in 1969 would consist of coaxial cable with L4 multiplexing and in 1980, would include coaxial cable with both L5 multiplexing and T4 digital multiplexing and millimeter wave guides. The more advanced multiplexing systems such as the L5 and T4 would provide very economical circuit growth since they can be used to convert existing cables to higher capacities.

TD2A microwave channels are expected to provide for all growth in intercity video channel requirements in 1969. By 1980, a 50-50 mix of microwave and guided wave systems would be used.

The unit costs of adding circuits (or video channels) were computed based on an assumption of some build out of existing routes, and some construction of new routes. It was assumed that the long term historical cost reduction trend of about 6% per year in long haul facilities would continue throughout the study period.

Construction of System Model

Knowing the expected requirements for both TV and message service during the study period, and the expected costs of terrestrial facilities led to the description and pricing of future terrestrial networks to serve as a yardstick to aid in the economic optimization of the satellite network.

Earlier studies had confirmed the assumption that using terrestrial facilities to gather large bundles of TV and message service requirements at a limited number of earth stations would be more economical than providing long haul TV and message service using only satellite facilities. To avoid the problems of a complex cutover to satellite facilities in the first year only New York to Los Angeles message circuits were planned to use satellite channels. Nationwide TV service via satellite was planned in the first year however. Two satellites of the 12 transponder Intelsat 4 type, large (85' antenna) transmit and receive earth stations in New York and Los Angeles, and 73 TV receiving stations would constitute the initial system.

The study procedure developed to determine the location and optimum number of TV receiving stations was based on the calculation of the economic crossover between cost of the receiving station, and the cost of terrestrial facilities required to connect a city to a receiving station in another city. In other words, the estimated cost of a receiving earth station could be equated to an equivalent number of channel miles of terrestrial facilities. An earth station was placed in every city where the cost of terrestrial facilities to connect to the nearest earth station exceeded the cost of the station. This procedure resulted in a "hub city" arrangement whereby a number of cities could be provided TV service from the same earth station.

Initially the message loading was confined to six New York to Los Angeles mastergroups so that sufficient satellite capacity would remain to accommodate TV demands. A third satellite would be launched in 1970 to permit serving the Chicago - Los Angeles message requirement and adding to the New York - Los Angeles circuits.

During the course of the study it was determined that a large segment of the TV channel requirements was generated in the Northeastern United States. Investigation of interference problems between earth stations and existing and projected microwave systems had determined that, while these problems were serious almost anywhere in the U.S., they were most critical in the Northeastern U.S. Study determined that if TV service in this area were left on terrestrial facilities, the satellite channel requirement would be cut in half, the number of receiving earth stations reduced from 103 to 73, and overall satellite system cost reduced by $25 million. Consequently, throughout the study period, TV service in the Northeast was assumed to be provided via terrestrial facilities. (Attachment 3)

The continued use of the Intelsat 4 type satellites presented two major problems. First, these satellites receive and transmit in the 4 and 6 GHz bands. These same frequencies are used by long haul microwave systems throughout the U.S. Mutual interference problems between microwave systems and satellite earth stations were expected to increase sharply during the study period. Second, to permit the satellite system to expand at a rate adequate to keep pace with the long haul circuit growth would require additional satellite launches to the point where by 1976 the entire number of equatorial orbit "parking slots" would be used. To solve these two problems, the use of higher frequencies was studied. Sufficient frequency spectrum is unassigned at 18 and 30 GHz to permit significant increases in satellite capacity, and since no other use is made of these frequencies no interference problems exist. Exploratory investigations determined the feasibility of constructing a large, very high capacity satellite utilizing these high frequencies. The antenna beam produced at 18 or 30 GHz is very narrow, actually covering only about one thousandth of the area of the earth covered by a 4GHz beam. These very narrow beams proved to be a difficult, if not impossible medium for furnishing TV network service, which requires broadcasting the same signal to a number of nearby stations in an advertising region. However the small beams are ideally suited for message service which is basically a point-to-point service. To optimize the usage of the frequency spectrum and the capacity of the satellite, transmission to the satellite of both message traffic and TV program originations (camera leads) is via 30 GHz; transmission of message traffic from the satellite is via 18 GHz; and TV broadcast from the satellite is via wide beam 4 GHz.

It was felt that these advanced satellites could be made available by 1972. At that time two of these satellites would provide sufficient additional capacity to serve message TV growth until 1975. Using an assumed service life of 5 years for the initial satellites, the first satellites launched would cease to function in 1975. From then on, a continual program of launches of advanced satellites would be maintained to serve growth and to replace satellites whose service life has expired. The last of the initial satellites would be replaced by 1976.

The transition from the initial 4 and 6 GHz system to the ultimate 4, 18, and 30 GHz system has been planned so that there would be a minimum of system component replacements involved. Since the TV transmitting frequency from the satellite remains 4 GHz no change at all occurs in the numerous TV receiving stations. The major transmitting and receiving stations would be retired when the last of the initial phase satellites were replaced. Some of them might be utilized in international service, although this probability was not one of the study assumptions.

The construction of the system model was an evolutionary and an iterative process. The completion of some of the preliminary models indicated areas where further optimization was possible. The final model represented a synthesis of the best features of all prior models, and the satellites and earth stations used in the final plan represent a significant advance over those used in the earlier studies.

In addition to the objective of constructing an integrated satellite - terrestrial communications system which would be more economical than a solely terrestrial system, it was a study assumption that the levels of quality and reliability of the integrated system would be at least comparable to those available in the network today. Further constraints were that the plan must comply with all existing applicable radio regulations, as for example satellite radiated power, etc.

Cost Computations

A most important study criterion was that a comparable service must be provided by both systems studies (terrestrial only vs. satellite - terrestrial). Attention to this criterion insured that the final economic comparison would be meaningful.

The costs of future terrestrial facilities, and the forecast of facility requirements discussed previously were used to prepare an investment figure for each year throughout the study period. These figures represent the capital investment required to add sufficient line facility capacity to the terrestrial plant to accommodate those items of long haul growth which were included in the study. To develop a more accurate cost comparison which would take into account the effect of investments made at varying times throughout the study period, the annual carrying charges were computed for these investment amounts. The rates used in these computations are comprised of cost of money, rate of return, income taxes, depreciation, advalorem taxes, maintenance and administrative expenses. (Attachment 4)

In the satellite - terrestrial system a similar technique was used. Information on the early phase satellite costs, launch costs, earth station costs and associated annual charge rates was discussed with the Communications Satellite Corporation. Estimates of similar costs for the advanced phase were prepared by Bell Telephone Laboratories based on a reasonable extension of the current state of the art. In addition to the satellite oriented costs, the terrestrial linkages required to build a communications system utilizing satellite repeaters were priced and included.

The investment figures and their concomitant annual charges for the total system were analyzed to determine the proper allocation of costs between message and TV service. Certain components of the system were readily identifiable as TV or message oriented - e.g., the TV receiving stations, the terrestrial links to TV studios, and those to message switching centers. For some components, the allocation is not so obvious. It was decided that the satellite costs would be divided based on transponder usage, and with spare transponders allocated to the two services roughly in the same proportion as working transponders. Costs associated with the combined message and TV transmitting and receiving stations were allocated based on the transponder allocations in the satellites. The resulting cost allocations are intended to indicate a reasonable relationship between the usage of the system and the costs connected with such usage.

VII. Current View of Costs of the Bell System Space/Earth Proposal (June 1968 Cost Updating)

The proposal for an integrated Space/Earth Communications System to serve the U.S. was filed with the F.C.C. on December 15, 1966. The preparation of the proposal occupied most of the last half of 1966, but much of the material used in the study had been prepared earlier.

Section VII has outlined the methods used in preparing the Bell System Space/Earth Proposal. This section will discuss the changes which have occurred since the December 1966 filing and assess, where possible, their effect on the conclusions of the study.

The limits within which the updating was performed were to some extent determined by the requirement that an answer be arrived at within a very short time. To provide a proper context in which to evaluate the results of the updating it is necessary to discuss first the study assumptions which were left unchanged, and their possible effect on the outcome. Following this discussion, the study items which were changed will be described, and the source and reason for changes outlined.

Unchanged Study Assumptions and Costs

a. Telephone circuit requirements -

The telephone circuit requirements used in the initial (12/66) study were the same as those used in the November 1965 Long Lines Department study of circuit requirements between 8000 domestic points. These requirements were the basis for a computer matrix which was used to select the points ultimately to be served by the satellite system. The estimated annual growth rate used in the 1969 to 1980 period equates to about 12.5%. Viewed as an overall growth rate for the period, this estimate still seems accurate. The traffic matrix was, therefore, left unchanged.

Not only the telephone circuit growth rate and the 1980 telephone circuit requirement, but the rate at which circuits would be loaded on the satellite system was left unchanged. In the initial study the loading rate was determined partially by the traffic growth rate and partially by the available satellite capacity. In other words, the rate at which circuit growth was shifted to the satellites was not uniform throughout the period. (Attachment 5)

b. System Timetable -

In the December 1966 filing it was estimated that the implementation of the initial phase could start in 1969, and that the first launch of an advanced satellite could occur in 1972. Viewing the timetable over a year later, neither of these dates can now be achieved. However, in updating the study, the original timetable was maintained. To shift the timetable to more reasonable dates; say initial phase start in 1970 or 1971, advanced satellite launch in 1973 or 1974; would necessitate reworking the traffic matrix.

Changed Study Assumptions and Costs

a. Television requirements -

Some modifications have occurred in the view of 1969 to 1980 television channel mile requirements. Specifically, the channel miles required for the 4th network, ETV and commercial network monthly and occasional service have all been slightly reduced. This has occurred for various reasons. The 4th network envisaged today by a number of entrepreneurs will extend to the top 40 TV market cities, and not the 120 stations projected for the "Overmyer" network. Estimated ETV requirements are more modest due to the apparent shift in focus away from the nationwide ETV network, which was discussed in many of the Docket 16495 filings, toward the state or regional ETV networks which are presently developing. Present channel mileages devoted to commercial network service both monthly and occasional have been reduced slightly over the figures used as a basis for the 1966 study. The gross reduction from all sources amounts to about 10,000 channel miles per year throughout the study period. (Attachment 6)

b. Satellite launch costs -

In the 1966 study it was assumed that the initial phase satellite would be launched by an Atlas Agena vehicle at a cost of about $7M per launch. Recent information indicates that the Atlas Agena is being phased out and will not be available in the required time period (1969-1970). The next choice vehicle, the Titan Agena, cannot be launched from the East Coast without extensive ($20-$30M) pad rearrangements. The launch vehicles which remain, and are suitable for the payload requirement, are the Atlas Centaur and Titan IIIC. The economic trade-offs between cost per launch, and payload favor using a Titan IIIC for the initial phase and a modified Titan IIIC for the advanced phase. This change in vehicle has the effect of increasing the launch costs for the initial phase by $22.5M. Second; because of an estimated reduction in the advanced satellite weight, modifications to the Titan IIIC will not be required, resulting in a $15M reduction in cost. (Attachment 7)

c. Satellite manufacture and R&D -

The cost of the initial phase satellite is currently estimated at $7M which is twice the December 1966 estimate. In addition, the R&D for the satellite, which should be charged against a domestic system, is now estimated at $25M, rather than the $15M originally forecast.

The cost of the advanced phase satellite is now predicted to be $7M, where $8M was the earlier figure. Advanced phase R&D, which was judged to be $15M in the original study, is now $50M.

d. Terrestrial facility costs and mix -

The view of the mix of terrestrial facilities which will be added during the study period has changed. Initially, telephone circuit growth was expected to be served using 50% cable and 50% radio facilities throughout the period. The current view is that this mix will change over the study period until by 1980 the mix would be 90% guided wave systems and 10% radio. A current review of terrestrial growth facility costs indicates that costs would be slightly higher in the early half and lower in the latter half of the study period than the figures used in the December 1966 study. The current forecast of TV growth facility costs is that they will be slightly lower than those used previously.

e. Earth station costs -

Changes are included for each of the three types of earth stations in the system: Receive only; 4 & 6 GHz Trans. & Rec.; and 18 and 30 GHz Trans. & Rec.

1. "Receive only" station - Additional amounts for site shielding and Research and Development have increased the estimated cost of this station from $220K to $262K.

2. 4 & 6 GHz Transmit and Receive station - Current views are that this station has been underestimated with the increase in cost proportionally distributed over the various components. A two antenna station, originally

estimated at $4M is now expected to cost $6M.

3. 18 & 30 GHz Transmit and Receive station - 1966 estimates of $2.2M per pair of antennas have been changed to an average of about $1.2M per pair depending on the number of channels transmitted and received. Much of this change is due to decreases in estimates of antenna cost, and to including the terrestrial link between stations in the terrestrial totals rather than earth station total. (Attachment 8)

Summary of Results

As can be seen from the comparisons of investment and annual charges the combined satellite-terrestrial system still offers some savings over a comparable wholly terrestrial system. The savings have been drastically reduced in the initial phase and only slightly reduced in the advanced phase. In addition the breakdown of the savings between message and TV service has been affected by the reduced forecast of TV demand and the slightly higher cost of the "receive only" earth stations.

A summary of the results of the cost updating follows. Costs as shown in the December 1966 proposal are shown in parenthesis.

A. Net Investment - Total

	Sat. - Terr.	Terr. Only	Savings
1969	$159 M (104)	$173 M (183)	$14 M (79)
1970	$227 M (143)	$245 M (249)	$18 M (106)
1975	$347 M (279)	$434 M (419)	$87 M (140)
1980	$384 M (339)	$532 M (538)	$148 M (199)

B. Annual Charges - Total

	Sat. - Terr.	Terr. Only	Savings
1969	$55 M (35)	$51 M (54)	$-4 M (19)
1970	$79 M (47)	$72 M (73)	$-7 M (26)
1975	$122 M (95)	$126 M (122)	$ 4 M (27)
1980	$133 M (115)	$154 M (156)	$ 21 M (41)

C. Net Investment - Telephone

	Sat. - Terr.	Terr. Only	Savings
1969	$26 M (23)	$34 M (32)	$ 8 M (9)
1970	$76 M (41)	$73 M (68)	$-3 M (27)
1975	$174 M (132)	$226 M (204)	$52 M (72)
1980	$198 M (169)	$299 M (288)	$101 M (119)

D. Annual Charge - Telephone

	Sat. - Terr.	Terr. Only	Savings
1969	$10 M (8)	$9 M (9)	$-1 M (1)
1970	$28 M (14)	$20 M (19)	$-8 M (5)
1975	$63 M (47)	$63 M (57)	$ 0 M (10)
1980	$71 M (59)	$84 M (81)	$13 M (22)

E. Net Investment - Television

	Sat. - Terr.	Terr. Only	Savings
1969	$133 M (81)	$139 M (150)	$ 6 M (69)
1970	$151 M (102)	$172 M (182)	$21 M (80)
1975	$173 M (148)	$208 M (216)	$35 M (68)
1980	$185 M (170)	$233 M (250)	$48 M (80)

F. Annual Charge - Television

	Sat. - Terr.	Terr. Only	Savings
1969	$46 M (26)	$42 M (45)	$-4 M (19)
1970	$51 M (33)	$52 M (54)	$ 1 M (21)
1975	$58 M (49)	$62 M (65)	$ 4 M (16)
1980	$62 M (56)	$70 M (75)	$ 8 M (19)

Cost Trends

The above numbers describe a significant increase in component costs over the figures used in the 1966 study. This upward trend in component costs has been fairly constant throughout the period during which the domestic use of satellites has been under study. If component costs were trended ahead to the proposed implementation date of a domestic system additional cost increases might be expected. To gauge this effect the cost comparison has been re-done with an additional $25 million added to the combined satellite costs. This figure represents a reasonable assessment of cost increases which could occur, and provides a measure of the sensitivity of system economics to further cost increases.

The results of this evaluation are as follows: (December 1966 figures in parenthesis).

A.' Net Investment - Total

	Sat. - Terr.	Terr. Only	Savings
1969	$175 M (104)	$173 M (183)	$-2 M (79)
1970	$252 M (143)	$245 M (249)	$-7 M (106)
1975	$355 M (279)	$434 M (419)	$ 79 M (140)
1980	$384 M (339)	$532 M (538)	$148 M (199)

B.' Annual Charges - Total

	Sat. - Terr.	Terr. Only	Savings
1969	$62 M (35)	$51 M (54)	$-11 M (19)
1970	$89 M (47)	$72 M (73)	$-17 M (26)
1975	$125 M (95)	$126 M (122)	$ 1 M (27)
1980	$133 M (115)	$154 M (156)	$21 M (41)

C.' Net Investment - Telephone

	Sat. - Terr.	Terr. Only	Savings
1969	$30 M (23)	$34 M (32)	$ 4 M (9)
1970	$88 M (41)	$73 M (68)	$-15 M (27)
1975	$180 M (132)	$226 M (204)	$46 M (72)
1980	$198 M (169)	$299 M (288)	$101 M (119)

D.' Annual Charge - Telephone

	Sat. - Terr.	Terr. Only	Savings
1969	$11 M (8)	$9 M (9)	$-2 M (1)
1970	$33 M (14)	$20 M (19)	$-13 M (15)
1975	$66 M (47)	$63 M (57)	$-3 M (10)
1980	$71 M (59)	$84 M (81)	$13 M (22)

E.' Net Investment - Television

	Sat. - Terr.	Terr. Only	Savings
1969	$145 M (81)	$139 M (150)	$-6 M (69)
1970	$164 M (102)	$172 M (182)	$8 M (80)
1975	$175 M (148)	$208 M (216)	$33 M (68)
1980	$185 M (170)	$233 M (250)	$48 M (80)

F.' Annual Charge - Television

	Sat. - Terr.	Terr. Only	Savings
1969	$51 M (26)	$42 M (45)	$-9 M (19)
1970	$56 M (33)	$52 M (54)	$-4 M (21)
1975	$59 M (49)	$62 M (65)	$3 M (16)
1980	$62 M (56)	$70 M (75)	$8 M (19)

A study of the figures indicates that if the initial satellite costs were to increase by $25 million beyond the totals shown in Attachment 3, the initial phase of the satellite system would incur both an investment and an annual charge penalty when compared with a comparable terrestrial system.

Current View

The effect of the increases in component costs, discussed above, and the probability of still further cost increases would also apply to the Comsat Pilot Program. Because of the smaller scale of the Comsat program, the cost disadvantages of these increases should be even more pronounced.

The most significant savings will accrue from the advanced system which serves much larger traffic cross sections with satellites of greater capacity utilizing frequencies above 10 GHz. Because of the delay in initiating the domestic satellite system, traffic densities will be much higher by the time the advanced satellites could be available. In addition, the interference problems involved in locating 4 and 6 GHz earth stations near urban areas are more serious than had been originally judged. Both of these factors increase the advantages of an advanced satellite design utilizing the, at present, unassigned spectrum available around 18 and 30 GHz.

CROSSOVER POINT CALCULATIONS*

(TELEPHONE)

1969 Telephone segment of sat. system = \$23M
Total available circuit capacity = 6720 ckts.
Cost per terr. ckt. mi. = \$3.45

$$\frac{\frac{\$23M}{6720}}{3.45} = 1000 \text{ miles}$$

1970 Telephone segment of sat. system = \$41M
Total available circuit capacity = 10,080 ckts.
Cost per terr. ckt. mi. = 2.96

$$\frac{\frac{\$41M}{10,080}}{2.96} = 1370 \text{ miles}$$

1975 Telephone segment of sat. system = \$132M
Total available circuit capacity = 56,280
Cost per terr. ckt. mi. = 1.71

$$\frac{\frac{\$132M}{56,280}}{1.71} = 1370 \text{ miles}$$

1980 Telephone segment of sat. system = \$169M
Total available circuit capacity = 83,000
Cost per terr. ckt. mi. = 1.34

$$\frac{\frac{\$169M}{83,000}}{1.34} = 1520 \text{ miles}$$

Average crossover point used for study = 1300 miles

*Dec. 1966 study

TOTAL TV ROUTE MILEAGE*

(000 Channel Miles)

	Existing Network					
	Contract	Occasional	4th Network	ETV	NASA & Air Force	Total
1969	55	33.5	20	13	-	121.5
1970	55	34.8	20	13	25	147.8
1980	81.5	51.5	29.5	19.9	40	222.4

1970 - 1980 Annual Growth Rate = 4%

*Dec. 1966 study

Attachment 3

TV SERVICE IN THE NORTHEASTERN U.S.*

1. Satellite Peak Requirement

   a. N.E. included in satellite - total satellite channel requirement = 42 chann.

   b. N.E. excluded from satellite - total satellite channel requirement = 21 chann.

2. Economic Comparison

   a. N.E. on Satellite

4 satellites	$50M	
8 trans. & recv. ant.	10M	
103 Earth Stats.	25M	
22,400 mi. of terr. fac.	30M	
TOTAL		$115M

   b. N.E. on Terrestrial Facilities

2 satellites	$30M	
4 trans. & recv. ant.	5M	
73 Earth Stats.	15M	
7550 miles of terr. fac.	10M	
Sat. sub total	$60M	
27,000 mi. terr.fac. in N.E.	$30M	
TOTAL		$ 90M

Savings (Terrestrial Facilities) $25M

*Dec. 1966 study

Attachment 4

ANNUAL CHARGE RATES* AS A PERCENTAGE OF INVESTMENT

Earth Station -	Amortization (incl. cost of money)	11.7
	F.I.T.	3.7
	Maintenance	13.0
	Ad valorem tax	1.6
	Admin. overhead	3.0
		33.0%
Terrestrial Facilities -	Amortization (incl. cost of money)	9.8
	F.I.T.	4.0
	Maintenance	6.0
	Ad valorem tax	1.6
	Admin. overhead	6.0
		27.4%
Satellites -		40% #

Rate furnished by Comsat Corp. - R. Briskman 6/66.

* These annual charge rates should only be used for engineering economic studies.

TRANSPONDER ALLOCATION#

Year	Satellites in Service 4-6*	Satellites in Service 18-30*	Transponders 4-6*	Transponders 18-30*	Transponders Total	(MSG)	Telephone Wkg.	Telephone Spare	TV Monthly	TV Occ.
1969	2	-	24			25%	4	2 (6)	7	11 (18)
1970	3	-	36			50%	12	6 (18)	7	11 (18)
1971	3	-	36			50%	12	6 (18)	7	11 (18)
1972	3	2	36	114	150	64%	29	67 (96)	24	30 (54)
1973	3	2	36	114	150	64%	33	63 (96)	24	30 (54)
1974	3	2	36	114	150	64%	38	58 (96)	24	30 (54)
1975	1	3	12	171	183	66%	59	61 (120)	24	39 (63)
1976	-	4		228		66%	68	83 (151)	27	50 (77)
1977	-	4		228		66%	78	73 (151)	27	50 (77)
1978	-	4		228		66%	91	60 (151)	27	50 (77)
1979	-	4		228		66%	106	45 (151)	27	50 (77)
1980	-	4		228		66%	124	27 (151)	27	50 (77)

* GHz

June 1968 View

TERRESTRIAL FACILITY MILEAGES#

TV Service	Satellite - Terrestrial System (B.H., IXC, & N.E.)*	Terrestrial Only
1969		
NBC, CBS, ABC	32,000	90,000
ETV	6,600	13,000
4th Network	2,800	9,100
Total	41,400	112,100

Annual Growth Rate, 1969-1980, = 4%

Telephone Service

1969-1980

Same as 12/15/66 Proposal

* B.H. = Backhaul from traffic source to earth station
IXC = Interexchange video facilities
N.E. = Northeastern United States

June 1968 View

Attachment 7

SATELLITE COSTS*

1. Initial phase

   a. Launch vehicle - Titan IIIC @ $15M/launch

   b. Satellites - 3 @ $7M ea.

   c. R&D - Satellite $25M Rocket 0

   d. Success probability - 0.85

   e. Cost per satellite = $\frac{7 + 15}{0.85} + \frac{25}{3} = \$34.1M$

2. Advanced phase

   a. Launch vehicle - Mod. Titan IIIC @ $20M/launch

   b. Satellites - 4 @ $7M ea.

   c. R&D - Satellite $50M

   d. Success probability - 0.85

   e. Cost per satellite = $\frac{7 + 20}{0.85} + \frac{50}{4} = \$44.3M$

* June 1968 View

EARTH STATION COSTS*

1. TV - Receive Only - \$210 K per 25' Station
   - \$235 K per 30' Station

   Assume use of 30' Station

   R. & D. \$2.0M

$$\text{Unit Cost} = 235 + \frac{\$2.0M}{73} = \$262\text{ K}$$

2. 4-6 GHz T & R - \$3.7M for Station & 1 ant.
   \$2.3M for 2nd ant. & elec.

   R. & D. \$4.0M

$$\text{Unit Cost} = 3.7M + \frac{\$4.0M}{3} = \$5.0M$$

3. 18-30 GHz T & R - 290 A + 25 (T + R) + 120 S
   Where A = # of Ant., T + R = # of Channels, S = # of Sites

   R. & D. \$12M or \$230 K per Station

* June 1968 View

January 10, 1968

MEMORANDUM:

In preparing the Bell System Space/Earth Proposal it was necessary to forecast the incremental cost of terrestrial growth facilities during the 1969-1980 period. This forecast was required to provide a basis for measuring the satellite system economies and also to assign costs to the terrestrial links included in the satellite system.

The facilities studied were those suitable for providing for long haul growth in both message and TV service. The costs studied were the incremental costs of adding a voice circuit, or a TV channel. Only the line facility costs were included since all other costs such as multiplexing and terminal equipment would be common to both the satellite and terrestrial systems. The mix of long haul message growth facilities which would be placed throughout the 1969-1980 period was expected to be 50% microwave radio and 50% guided wave systems. TV service, which today is provided almost exclusively by microwave systems, was expected to be furnished in 1980 via a similar mix. By 1980 radio systems, which today include the TD2 and TH type, will consist of TD3 and TH3 which have greatly increased capacities and lower costs. Guided wave systems, which in 1969 will be confined to the L4 system, will by 1980 include the L5, T4 and millimeter wave guides.

There are now some 8,000 miles of coaxial cable in the plant that can be converted to higher capacity by replacing the electronic equipment and by making some small changes in the outside plant. This mileage is expected to double by the mid 1970's at which time the incremental cost per circuit mile is expected to be about $0.60.

In determining the cost per circuit it was assumed that 70% of the capacity of the line facility could be utilized. This "fill factor" represents the optimum trade-off between maximum utilization of the line facility, and minimization of administrative costs and terminating and multiplexing costs.

The history of line facility developments shows a sharply decreasing unit cost over the years. It is expected that this trend will continue at varying rates. That is, facilities which today represent a highly developed state of the art will not be subject to as dramatic a cost reduction rate as those in which much development lies ahead.

Using the assumptions outlined above concerning facility mixes, fill factors, cost reduction programs, etc., following are the incremental line facility costs expected during the study period:

	Telephone (Cost per ckt. mi.)	Television (Cost per chann. mi.)
1969	$3.45	$1250
70	2.96	1185
71	2.53	1130
72	2.19	1080
73	1.89	1032
74	1.80	985
75	1.71	940
76	1.62	896
77	1.53	854
78	1.46	815
79	1.41	777
80	1.34	750

A. T. & T. APPRAISAL OF DOMESTIC SATELLITE SYSTEM COSTS*

	First Cost		Annual Charges		
Satellite (Note 1)					
Material (2 birds)	6.4M		Deprec.	3.8M	
Launch (1 bird)	7.5M		COM(12%)	1.1M	
R. & D.	5.0M		FIT	1.1M	
		18.9M			6.0M
Earth Stations (Each)(Note 2)					
1st antenna	3.9M		Deprec.	.5M	
2nd antenna	2.3M		Maint.	.7M	
			Adm. OH	.3M	
			Taxes	.12M	
			COM(10%)	.37M	
			FIT	.37M	
	6.2M			2.36M	
	x 2			x 2	
		12.4M			4.72M
Total - (To compare with COMSAT figures previously furnished Task Force)		31.3M			10.72M
Omissions from COMSAT Figures					
Connecting facilities	6.0M			1.5M	
Special echo suppressors	4.0M			1.0M	
Total		10.0M			2.5M
		41.3M			12.22M
Circuit miles (Note 3)	23.4M				
Cost per circuit mile	1.77			0.52	
With 70% fill	2.53			0.74	
TV channel miles	31,200				
Cost per TV channel mile	$1200			$360	

NOTES:

1. Satellite costs make no allowance for launch failures.
   R. & D. change of $5M is one-third of $15M total estimate by COMSAT.
   One extra bird on ground for protection. If this bird is launched for interruption free protection, then costs would be increased $7.5M.
2. Earth station cost of $6.2M appears low for a station with two antennas. Compares with costs of almost $10M each for the single-antenna stations being built for overseas communications.
3. 10,800 circuit capacity of satellite system assumed by COMSAT seems high. Estimates given to us by COMSAT are 1800 circuits per pair of transponders. Leaving one pair as standby, total capacity would be 9000 circuits. In addition, N.Y.-Los Angeles distance is only 2600 miles. Thus, total circuit miles becomes 23.4 million.

* Optimum Route (N.Y.-L.A.)

FORWARD LOOKING ESTIMATES OF TERRESTRIAL FACILITIES COSTS#
(1970 - 1980)

	Voice Circuits	FC/Mile	Full AC/Mile	Calculated Per COMSAT Method AC/Mi.*
TD-2B (Added channel to existing route today)	1,200	.80	.24	.10
TD-3 & TH-3 (New route. 1968-1969)	23,000	2.10	.62	.25
L-5 (New route. 1973)	81,000	1.40	.35	.11
L-4 - L-5 conversion (1973)	49,000	1.00	.25	.10
T-5 (New route. Toward 1980)	260,000	.73	.18	.07

Above estimates exclude multiplexing and other terminal equipment costs (as do COMSAT's satellite costs).

All costs represent 100% fill.

* Using only depreciation and maintenance costs, as was done in COMSAT method. This does not, of course, reflect true costs. For example, it does not include such items as property taxes, administrative overhead, cost of money, or income taxes.

Jan. 1968

5

TECHNOLOGICAL INNOVATION IN THE BELL SYSTEM

Summary:

Innovation is not just the discovery of a new phenomenon, nor the development of new products or manufacturing techniques, nor the creation of new markets, but rather, innovation is all of these things acting together toward a common goal.

The Bell System has earned a reputation for technological and scientific excellence. Not only has it provided the United States with the finest telecommunications service in the world, but it has maintained its innovative leadership through the continual development of an enormous variety of new products and services. Its drive to excell in the applications of science and technology is derived from an early recognition that the ability to serve the public well depends upon the constant pursuit of invention and innovation on a broad scale.

An indispensible aid to its innovative success is the Bell System's unceasing effort to sense and anticipate changing public needs and desires and to introduce promptly new products and services to meet them. Not only has it kept pace with growing customer desires in terms of variety and quantity, but it has been able to improve transmission quality, provide faster call completion and increase the dependability of telecommunications generally.

A key element in making these accomplishments possible is the Bell System's organizational structure which integrates research, manufacture and operations. Designed to be responsive to the enterprise's fundamental objectives - ever-improving, low-cost service - it assures the quality and compatibility required for successful operation of a nationwide telecommunication network, a coordinated response to the public's needs, and a common sense of responsibility for service improvement.

TECHNOLOGICAL INNOVATION IN THE BELL SYSTEM

I. Introduction

To maintain a flourishing economy, it is essential that industry sense changing public needs and wants and introduce new products and service to meet them.

This in turn depends on the ability of industrial enterprise to constantly renew itself in terms of its people and purposes.

The Bell System works hard, therefore, to stay alert to the forces of change and to develop the interrelationships among people, processes and environments that will nourish the total innovation process.

Thus Jack A. Morton, vice president in charge of electronic components development at Bell Laboratories, speaks of innovation as "a people process with a purpose. It is not just the discovery of new phenomena, nor the development of new products or manufacturing techniques, nor the creation of new markets." Rather, he says, "innovation is all of these things acting together toward common industrial goals."

This paper limits itself mainly to important aspects of technological innovation. It explores only part, albeit an important part, of the innovative process. But it is well to have in mind that strong, sound, and continuous technical progress depends on the overall "life-style" of the organization and the mutuality of understanding among people working toward common goals.

In the Bell System, certain principles are widely relied on to help foster a constructive commonality in purpose and action. One might say that these principles are closely akin to the disciplines of systems engineering:

1) to identify needs, opportunities, and limitations, so that overall goals can be stated and priorities assigned;

2) to appraise alternative potential solutions and develop measures of their relative cost;

3) to distinguish between what is known and what still needs to be learned;

4) on the basis of the foregoing, to select and develop the most promising avenues for action;

5) to constantly review or monitor the whole process by which innovations are introduced to the public, to the end that the needs of users will be met as fully and promptly as possible.

These "systems" principles, while not limited to technical applications, are of course of first importance in the area of <u>technological innovation</u> on which this paper focuses. They strongly support and energize the Bell System's effort to maintain an innovative process that will not only respond to, but anticipate, the needs and desires of the public.

Our focus here on technological innovation, incidentally, is in response to questions from the Task Force on Communications Policy regarding the introduction of new technology. It should be noted, however, that there are hundreds of other facets of Bell System innovation -- in operating methods, in personnel development and motivation, in the pricing and marketing of new products and services, in quality control techniques, or in new programs to help meet today's urban crisis.

II. A Reputation for Innovative Accomplishment

Ten years ago, the editors of Fortune magazine commented:

> "The preeminent discovery of the twentieth century is the power of organized scientific research. In the Western world this discovery was made not by the universities, nor by governments, but by private industry, which saw in the mobilization of science and technology a gateway to larger sales and profits. The industrial enterprise that has carried out this mobilization most brilliantly in the U.S. -- and indeed in the world -- is Bell Telephone Laboratories, Inc."[1]

By 1958, when this Fortune article appeared, technological and scientific achievements -- born in the basic research of Bell Laboratories and carried forward to production by the Western Electric Company -- had earned the Bell System an enviable reputation for innovative accomplishment. The achievements of its scientists and engineers were known throughout the world. They had twice won the Nobel Prize: for demonstrating the wave nature of matter (1937) and for the discovery of the transistor effect (1956). They had conceived information theory; developed the basic structure of network broadcasting; pioneered sound motion pictures; created the new science of radio astronomy; developed and built the first electrical, digital computer; fathered the first public demonstration of television; given the world hi-fi sound reproduction; introduced microwave radio and coaxial cable systems; and developed principles that would open the way to worldwide communication by satellite. The concept of system engineering had been largely generated in Bell Laboratories and Western Electric to help assure the rapid and efficient introduction of new technology into the nationwide communications network.

[1] "The World's Greatest Industrial Laboratory," Fortune magazine, November 1958.

The concept was subsequently applied to many of the nation's military programs -- including its first operational guided missile system (Nike Ajax), for which Western Electric was prime contractor. Above all, the Bell System has provided the U.S. with the finest telecommunications service in all the world at a cost less than half the cost of service available in most other nations.[2] As Fortune could add:

> "... no organization of its kind in the world is more adept at the conversion of dreams into practical realities.
>
> "The job of creating the modern telephone system has required the solution of problems of such deep complexity that they have had no counterpart in any other industry, and for all the familiarity of the telephone itself, these problems are almost totally unknown to the general public. From the early beginnings of the telephone in the late 1870's, the Bell System has probably had to draw more heavily and consistently on the scientific method of solving problems than any other commercial enterprise. Empirical solutions were almost never good enough. By comparison, the chemical industry of the late nineteenth century was still pretty much of a black art, depending heavily on "secrets" handed down from generation to generation. The infant electric-power industry made greater use than the chemical industry of newly won scientific knowledge, but it was not immediately confronted with anything so complex as the fundamental telephone problem of switching ... or so baffling as the behavior of weak electric currents generated by the human voice."[3]

The problems were solved with astonishing rapidity. For example, less than four decades separated the invention of the telephone from the inauguration of coast-to-coast telephone

[2] See attachment "A".

[3] Ibid.

service in 1915. Only two decades separated this primitive system, which could carry but a single conversation on a pair of open wires, from the development of coaxial systems (introduced on an experimental basis in 1936 and commercially in 1941), able to provide 480 two-way telephone circuits over a pair of tubes. A few years later, microwave systems, which had been under development since as early as 1940, were transmitting over 600 separate coversations on a radio beam. And by the mid-1950's, the voice-carrying capacity of existing systems had been multiplied into the thousands.

Between 1915 and 1958, AT&T and Western Electric expended more than one and one-half billion dollars on research and development. This works out to about seven per cent of the total plant investment of the entire Bell System at the end of this period. And yet, in spite of the huge costs involved, telephone service was becoming, in real terms, less and less costly for the American consumer. In 1940, the average telephone user worked six hours to pay for one month of local residence service. By 1958, despite the spiraling inflation that had characterized the intervening years, he worked only half as long to pay for service that had become far more reliable, efficient and versatile.[4]

In the years since, in the explosive "post-Sputnik" era, which has witnessed so vast a proliferation of scientific and engineering endeavor both here and abroad, the Bell System has continued in its innovative leadership.

That this is so is indicated by the following:

<u>First, the rate of innovation in the Bell System has continued to far outpace that</u>

[4]See attachment "B".

of most other industries. According to a report published by the National Industrial Conference Board in 1967: "For the average company, 20% of current sales are attributable to the sale of products that it first marketed during the past five years...."[5] The comparable Bell System figure (as measured by the rate of new product introduction by Western Electric) was 43% -- more than double the industrial average. Moreover, it is estimated that 65-70% of the products Western Electric will produce in 1970 will have been introduced in the 1960's. Thus, the Bell System's rate of new product introduction is continuing to accelerate. It averaged roughly 3.5% a year in the decade of the Fifties, about 6% between 1960 and 1965, and is currently running even higher than that.

Second, Bell System investment in the innovative process remains well above that of most other businesses. In the 1960's, Bell System expenditures for research and development were totaling about 6.5% of every sales dollar of Western Electric and its subsidiaries. This compares with about 3.5% for the rest of the communications equipment and electronic component industry, and 2.0% for all manufacturing industries. (Figures based upon National Science Foundations definitions of what constitutes R.&D.)

[5] "What Marketing Executives Want Most -- New Products," The Conference Board Record, May 1967

Third, Bell System research and development has continued to produce a steady stream of technological advances. Early in 1968. the National Inventors Council (a body of scientists, inventors and other private citizens who advise the Secretary of Commerce) was asked to list "the 10 most outstanding technological inventions of the past 20 years." The request was also made of government observers who meet with the Council. According to The New York Times of June 30, 1968: "The replies were in great variety but were virtually unanimous in selecting the transistor and the laser, with integrated circuitry a close third." The transistor was of course invented by Bell scientists in the late 1940's. Bell System efforts to produce this device reliably and economically led to the science of micro-electronics, which, in the 1960's, has resulted in the development of integrated circuitry. The invention by Western Electric of continuous processes for the manufacture of so-called "thin films" was an essential step toward broadscale application of this new technology. Bell scientists also shared in the invention of the laser, which is expected to find wide application in telecommunications, scientific research, medicine, the shaping of metals, and the expansion of computer memories. A single laser beam may one day carry telephone calls, data messages and television signals in bundles 10,000 times larger than are now possible with microwave systems. The first industrial application of the laser was achieved by Western Electric, which in 1966 began to use the instrument to pierce diamonds used in wire-drawing operations.

Over the past dozen years, Bell scientists and engineers have developed a broad variety of new products and services. Among them: over-the-horizon radio relay systems, permitting telephone transmission over water (or over inaccessible terrain) to points beyond the curvature of the earth ... the electronic Artificial Larynx, providing a means of oral communication to persons who have lost their voices through surgical removal or paralysis of the vocal cords ... Centrex service, bringing new dimensions of speed, convenience and versatility to business customers ... the world's first international communications satellite, TELSTAR, demonstrating the practical feasibility of multi-channel, two-way telephony, TV, facsimile and data transmission via microwave radio relay systems in space ... Touch-Tone* calling, introducing push-button "dialing" by means of electronic tones, providing the customer with faster service, and opening the way to development of a variety of wholly new services, including access to computer services, and private data transmission ... Picture-phone* service, enabling the user to "see while he talks," inaugurated between New York, Washington, D.C., and Chicago ... ESS No. 1, the first commercial electronic switching system for home and business customers ... transistorized undersea cables, providing 720 voice circuits, five times the capacity of the most efficient previous design ... the first commercial digital transmission system -- T1 Carrier, employing Pulse Code Modulation techniques ... increasingly efficient microwave radio systems (TD-2B and TD-3) and the L-4 coaxial cable system, which can carry 32,000 simultaneous conversations; direct dialing of overseas phone calls ... and a variety of data communications devices to transmit information from computers and other business machines, including the 604-type data set, enabling widely-separated hospitals, private physicians and

*Registered mark

medical research centers to transmit electrocardiograms over regular telephone facilities.

These are but a few of the hundreds of Bell System innovations over the past several years, innovations that have contributed greatly to the advancement of telecommunications and to the scientific and technological capabilities of other industries as well. As already suggested, their variety and multiplicity seem to warrant the conclusion that the Bell System has fully retained its technological leadership.

III. A Drive to Excel

The Bell System's quest for excellence in the applications of science and technology dates back to the beginnings of telephony. Basically, this drive to excel stems from an early recognition by the leadership of AT&T that the organization's ability to serve well -- and hence its very survival -- depended upon the constant pursuit of invention and innovation on a broad scale.

The results of this commitment have been evident for many years. As early as 1925, a Harvard Business Review writer observed that the Bell System stood "head and shoulders over all other public utilities in the extent, in the cheapness, and the standard of its service." He added that: "... few if any competitive industries have moved forward with greater energy and creative genius."

One of the men most responsible for instilling the driving power of innovation in the fledgling industry was Theodore N. Vail, first president of the American Telephone and Telegraph Company.

It was Vail who brought to telephony the great animating concept of "universal service." While others tended to see telephone communication as basically a "local" business, Vail, as early as 1885, could envision a national telecommunications system that could someday be linked "by cable and other appropriate means with the rest of the known world ...."

Very nearly from the beginning, hundreds of telephone companies were organized to provide communications, and thousands continue to do so today. Vail's objective was a uniform reliability of service and, eventually, a high quality, interconnected service throughout the nation. To accomplish this he perceived that the usual practices of competition would not be effective. Dual telephone services in the same area would have to be eliminated wherever possible because such duplication was needlessly costly to telephone users and gave less efficient service.

At the same time, Vail recognized that the company, or companies, entrusted with providing a "single" service would have to be accountable to some higher authority. "Society," he stated, "has never allowed that which is necessary to its existence to be entirely controlled by private interests. Private management and ownership, subordinate to public interest and under rational control and regulation by national, state, and municipal bodies, is the best possible system."

There should be one system, a system capable of providing universal, high-quality service, but a system accessible to regulatory controls. Such a system would enjoy the trust of its customers only so long as it provided the best possible service at the lowest reasonable cost, only so long as it made that service increasingly useful and attractive to the public it served.

This was the foundation of the Bell System's drive to innovate, a drive as powerful today as it was in 1885.

This, fundamentally, was why the Bell System established, and continues to maintain, an organization dedicated to constant study, analysis, criticism and improvement of everything it does.

Over the years, this basic incentive has been augmented by rising customer expectations, by a soaring population and soaring communications requirements, by the need to maintain earnings in the face of rising costs, and by the need to meet emerging public desires and requirements for new communications services. Only by steadily enhancing the quality, economy and versatility of its products and services can the Bell System hope to maintain its strength and vitality.

The drive to innovate, the drive to excel, is built in.

IV. The Management of Innovation

The versatile, low cost telecommunications service this nation enjoys is largely the product of a carefully planned interchange of ideas and information among the basic organizations that make up the Bell System: AT&T, Western Electric, Bell Laboratories and the 24 Bell Telephone companies.

Overall administrative and organizational direction is provided by AT&T; Bell Laboratories is the center for most of the System's research and development effort; Western Electric manufactures and/or supplies most of the equipment used in providing service; and the Bell telephone companies build, operate, and maintain facilities for the use and benefit of Bell System customers.

This basic structure of the System, integrating research, manufacture and operations, is designed to be responsive to the enterprise's fundamental objective: ever-improving, low-cost service. It makes possible the quality and compatibility required for successful operation of a nationwide network and helps assure a coordinated response to the public's needs, along with a common sense of responsibility for service improvement.

That the System has been responsive to the country's requirements is demonstrated by the fact that communications usage has outpaced the nation's growth in population and its economic growth, as well. For instance, in the past 10 years, while the population increased 17% and the gross national product about 40%, long distance messages increased over 100%. During this same period, despite the magnitude of the task of simply keeping pace with growing customer demand, the Bell System was able to improve transmission quality, provide faster call completion, and increase the dependability of telecommunications generally.

Perhaps the most important factor contributing to this kind of accomplishment has been an organizational flexibility that permits free and constant interaction between the various units of the Bell System and between the various groups of specialists within these units. Any part of the System, any unit or organization, can be the originator of an idea to be passed along and developed by any of the others -- or by several working together. Often the inspiration for an improvement comes from AT&T or the operating companies which are constantly assessing the present and future needs of telephone customers. New ideas can -- and often do -- spring from Western Electric's search for improved techniques of manufacture and supply. And, of course, the Bell System's creative core is Bell Telephone Laboratories.

The Laboratories consists today of approximately 15,000 employees, of whom about 5,000 are professionals -- primarily scientists and engineers. These are the so-called "Members of Technical Staff." Over 58% of them have or are in the process of obtaining Master's Degrees, while 19% -- or over 1000 -- already possess their Doctorates.

Geographically, the Laboratories are located at three major centers in New Jersey: Murray Hill, Holmdel and Whippany; in eleven other laboratories distributed among eight states; and in a number of smaller field centers. The laboratories outside of New Jersey are located at or near Western Electric manufacturing plants, where their efforts are focused on the task of speeding the process by which new products are moved through the final design and development stages and into production.

A functional dissection of Bell Laboratories yields three major categories of endeavor: research, development, and systems engineering. While these approximately coincide with the formal organizational structure, sufficient elasticity and functional overlap is provided for ideas to flow freely across the boundaries. This functional interaction is basic to the effectiveness of an integrated innovative effort. It is carefully nurtured through geographic deployment (permitting close association between personnel of the Labs and Western Electric), through enlightened and aggressive recruiting policies, and through the considerable interchange of personnel between the functional divisions.

Research: In relation to the Laboratories' total technical effort on behalf of the Bell System, research constitutes about 17%. Over half of the professional scientists and engineers in this division are assigned to reconnoiter the frontiers of the physical sciences, seeking new knowledge and new understanding; while the remainder work in such fields as mathematics, statistics, economics, learning theory, acoustics, vision, switching and transmission.

The fundamental purpose of these research activities is to extend and broaden the science of telecommunications. This includes discovery, invention, and the building of experimental devices and systems, and frequently means delving into areas which, on the surface, may seem far removed from the basic essentials of communications technology. According to Labs President James B. Fisk, "Our fundamental belief is that there is no difference between good science and good science relevant to our business. Among a thousand scientific problems, a hundred or so will be interesting, but only one or two will be truly rewarding -- both to the world of science and to us. What we try to provide is an atmosphere that makes selecting the one or two in a thousand a matter of individual responsibility...."

It is largely as a consequence of this approach, this cultivation of an atmosphere of freedom and individual responsibility, that Bell researchers have been able to make so many first-rank contributions, not only to the field of communications, but to science and technology as a whole.

Development: The largest of the Laboratories' three functional divisions is that devoted to the actual design and development of new components, products and systems. Over 68% of the Labs' total effort is so engaged. For herein lies the hard-core of the organization's reason for being: the exploitation of new technological resources in operating systems.

From the reservoir of basic and applied research, development engineers select the technology that will best yield designs that are reliable, economical, useful, and susceptible to efficient manufacture. While cost criteria are among the more important and compelling of these considerations, economy of design must be achieved through ingenuity rather than by taking short-cuts -- for the design must also be aimed at long, trouble-free service. Thus great efforts are expended to develop components with extremely low failure rates, and to assemble them into systems in which single failures will not result in interruptions of service. In all of these efforts, the ability to transfer ideas easily across organizational and corporate boundaries is a vital asset.

Hence over 2,000 of the Laboratories' engineers and technicians are today located in branch labs in or near Western Electric's manufacturing centers. Organizationally, these people belong to Bell Laboratories; but spatially -- and, to a degree, functionally -- they are strongly linked to their associates in Western Electric. Because of this, design for best performance and reliability can be balanced on a day-to-day basis against design for minimum cost of manufacture.

This close interaction and coupling of specialties has become increasingly important with the swift advance of communications technology. Permitting a rapid interchange of ideas and information, it assures optimum results in terms of the quality, economy and compatibility of finished products; and, because it allows production planning and the final stages of design work to take place concurrently, it greatly accelerates the total process. For example, prior to the establishment of the branch labs in the mid-1950's, the time period between the final design and actual production of a standard desk telephone set, was about 27 months. Today, far more complex instruments -- such as the new Trimline*telephone -- move from design to production in less than a third of the time.

Sharing mutual respect, common vocabularies and interests, and a desire to efficiently resolve mutual problems, the W.E.-Bell Labs teams at the manufacturing centers contribute immeasurably to the effectiveness of the System's innovative efforts.

Systems Engineering: As indicated earlier, suggestions for improving Bell System service are gathered from a variety of sources: the Bell telephone companies, Western Electric, Bell Laboratories and, most importantly, from thorough-going studies of the needs and desires of the telephone-using public. AT&T, in addition to generating ideas of its own, assembles these suggestions for improvement, subjects them to careful analysis and, with its subsidiary firms, establishes tentative priorities for the development of the ideas which seem most promising.

*Registered mark.

The systems engineering concept provides for testing each proposed innovation against a number of standard criteria. Among the more important:

Need and purpose. The new product, system or service must have a useful purpose and meet a real need of the business and its customers. That is, it must provide an entirely new service capability or, at the minimum, enhance the functional capability of existing equipment. It should, in addition, be flexible enough in design and purpose to allow efficient response to service needs and to new technologies that may emerge in the future. (For example, the "stored program" concept in electronic switching and the "pulse code modulation" techniques embodied in today's transmission systems promise substantial flexibility to meet foreseeable increases in communications traffic as well as growing customer demand for new varieties of service.)

In short, the innovation should be geared to meet the needs of tomorrow, so far as they can be anticipated, as well as the needs of today.

Cost and economy. The proposed innovation must of course be practical from a financial standpoint. And unless a compelling need dictates otherwise, it should not result in an increase in communications costs. Preferably, it should provide for an immediate or long term reduction in costs to the business and its customers.

Cost considerations are especially important in this era of accelerating technology and growing customer demands. Effective utilization of new scientific and engineering capabilities necessarily involves quick and decisive commitments of substantial capital, as well as of scarce and valuable manpower. This in turn entails a high degree of risk; for commitments often must be made in situations where reliable experience and empirical data are largely absent. Obviously, these risks cannot be undertaken unless the potential benefits -- to both the business and its customers -- are sufficient to justify them.

Performance and reliability. The new technology must provide service performance that is, in all respects, at least as good as that already in existence. The objective is that the innovation provide some distinct performance improvement.

Because of the great complexity of the telecommunications network, performance and reliability requirements are exceedingly stringent. The network is today composed of some 100 million telephones, along with television and data facilities, all connected flexibly and at will through the thousands of switching offices that blanket the nation. Superimposed on and connecting to these are long distance transmission and switching facilities which make the whole an integrated entity. Made up of over a trillion parts and components, the network is, in effect, a great computer-like machine that depends upon the quality and reliability of its individual elements for successful performance. Since the network cannot anticipate just who is going to be calling whom and when, it must stand ready to provide any combination of some five million-billion possible interconnections when a call is placed. An ordinary intracity call involves the proper operation of about 1200 relays alone. If just one should fail, the call would not get through.

Telephone switching equipment provides a good illustration of the order of quality and reliability required. It must operate around-the-clock, day in and day out, for year after year -- and with no "downtime" for repairs.

Thus while computer people speak of outages or downtime in terms of hours or even days, telephone people speak of momentary outages of switching equipment in a decade or lifetime. The new electronic switching systems may use as many as a million electronic components, each designed and produced to achieve a reliability against failure that is hundreds to thousands of times greater than that expected of similar components in most consumer products.

Compatibility. Again, because of the nature and complexity of the communications network, all of the pieces, parts and components added to the system must be mutually compatible -- that is, capable of working harmoniously together -- if the network is to perform its essential function. A relay in California must respond unerringly to pulses from Virginia which may have gone through thousands of electron tubes, transistors, or other devices on their journey -- and been kept free of the cumulative distortions of cables, wires, or microwave channels they have traversed. Every new and improved item of equipment, every new service, must operate effectively with what already exists; and what exists today must be fully compatible with what will come tomorrow if large amounts of expensive equipment are not to become obsolete too soon. The present rapid introduction of Touch-Tone calling and electronic switching -- to cite but two examples -- would not otherwise be possible.

Manufacturability. Techniques and facilities for producing the new equipment in sufficient quantity and at reasonable cost must either exist already or lie within the development capabilities of manufacturing technology.

Meeting this criterion is by no means a simple matter today. The sophisticated new products and systems emerging from communications science require the development of equally sophisticated production processes -- a task that is often as complex and as technically demanding as the product innovation itself.

For example, products such as integrated circuits and undersea amplifiers have required the development of dozens of new materials, a vast array of new manufacturing techniques, and of production facilities that are radically different from those of the past. Increasingly, Western Electric facilities look more like laboratories -- or even surgical rooms -- than what one customarily associates with the word factory. At the company's Indianapolis Works, for example, integrated circuits are assembled under microscopes in manufacturing space that is kept ultra-clean to avoid contamination of the circuits by particles of dust. The manufacturing area is in fact 90,000 times as free of dust as the outside atmosphere. Whereas a dust content of thousands or even millions of particles per cubic foot is not unusual in a well-kept household, only 100 particles per cubic foot are permissible in the production of these very tiny and delicate components.

In this and scores of other instances, Western Electric engineers have been, and are being, called upon to create fundamental changes in the manufacturing environment, to develop radical new approaches to the art of production. There seems to be little question that the pace of communications progress would be substantially retarded in the absence of their ability to find imaginative and ingenious solutions to the problems posed by today's advancing technology.

Service maintenance. Products embodying new technology must be easily operable and maintainable by the telephone companies. (This requirement is especially important and challenging with respect to large systems such as No. 1 ESS. In that system a significant portion of the development work was devoted to arrangements for making it easily serviceable. As it finally emerged, the system incorporates means of diagnosing its own troubles and advising maintenance personnel, via a teletypewriter message, of the difficulty in need of correction.)

Once the proposed innovation has met these tests to the satisfaction of the System's research, manufacturing and operating units, a number of formal organizational mediums are used to insure follow-up and minimize the possibility of new ideas withering on the vine. Some of these are: high-level committees composed of representatives of AT&T, Bell Laboratories, and Western Electric; special task forces; market and customer trials; and various communications to the telephone companies, providing information on developments in progress.

Clearly, then, detailed planning is an important, indeed essential, part of the innovative process. As in other instances of Bell System endeavor, planning is a shared responsibility, calling upon the talents and resources of every Bell organization. A major portion of this responsibility, however, falls upon the Engineering Department of AT&T and Bell Laboratories' Systems Engineering division.

Looking outward to the telephone companies and their customers, these organizations continually sift and assess the diverse needs of the telephone-using public and search for new products, new systems, and new services to meet those needs. Relating scientific and engineering capabilities to known customer requirements, the systems engineer formulates all the technical necessities for the new development, assembles all the relevant cost-effectiveness data, selects from among the possible solutions, and takes inventory of all the technology required to achieve innovative success.

Thus it is the systems engineer, more than anyone else, who looks at the <u>total process</u> of innovation, who matches problems with potential solutions, translates these into specific proposals, and catalyzes the work of the Bell System's research, development and manufacturing specialists. For this reason the systems engineer tends most often to be a former specialist with experience in several areas of science and technology, who has broadened his knowledge to include one or more other disciplines such as economics, marketing, sociology or psychology. With the important task of building information bridges connecting social and economic needs to scientific possibilities, he plays a critical role in the Bell System effort to provide its customers with a constant stream of new and better products and services.

Bell Labs - Western Electric Teamwork. This paper has emphasized repeatedly the importance of cooperation, coordination and teamwork between the research manufacturing and operating units of the Bell System. The critical nature of the role played by Western Electric in the innovative process cannot be overemphasized. It is, in fact, among the more important criteria by which Western Electric's Bell System partners measure the company's performance. And by any objective standard, that performance has been consistently high.

Certainly many of the Bell System's scientific and technological breakthroughs would have remained laboratory curiousities had it not been for Western Electric's ability to translate them into satisfactory hardware at reasonable costs.

Increasing needs for research in manufacturing engineering led Western Electric to establish (in 1958) an unique Engineering Research Center near Princeton, New Jersey. Broadly, the Center looks for new ways of making things while Bell Laboratories looks for new things to make. In its brief history, ERC has made an impressive number of outstanding contributions to the art (increasingly, the "science") of manufacture.

Equally if not more important, Western Electric has been able to hold down the cost of its products and services, while, at the same time, advancing their quality and reliability. At the end of 1967 its price level for products of its own manufacture was ten percent lower than it was at the beginning of 1950, despite a 53% increase in material costs and a 110% increase in the wages and salaries paid its employees.

Western Electric is indeed a vital contributor to the innovative process.

The Innovative Role of the Bell System's Operating Units. As already indicated, the factors influencing the pace of Bell System innovation are many and varied. First and foremost, there is the need and desire to maintain the confidence of telephone users and the federal, state and local regulatory bodies that represent them. There are pressures of competition and of rising customer expectations. And there is the ever-present need to maintain earnings in the face of rising costs.

It is of course the Bell System's operating units -- the regional telephone companies and the Long Lines department of AT&T, which provides for interstate and international communications services -- who feel these pressures most immediately and directly. It is they who are closest to the American consumer; it is they who must answer to the consumer for the quality, economy and versatility of communications services; and it is consequently they who provide much of the stimulus for service improvement.

Through day-to-day contact with telephone users, and by means of thorough-going market analyses, the operating units stay abreast of new and emerging communications needs and exert persistent pressure on other units of the Bell System to respond to those needs with efficiency and dispatch. The long-range planning of the operating companies is aided greatly by their close knowledge of the technology that Bell Laboratories and Western Electric have in development.

The weight of the pressure for innovation exerted by the operating units is evident in its influence on the operations and activities of the Western Electric Company.

From any manufacturer's point of view, the ideal new product is one that grows in production volume at a gradual pace -- allowing time for the training and re-training of personnel and for the maintenance of a reasonable schedule of capital expenditures. Eventually, the volume should reach a level that will warrant the extensive mechanization of production processes and, having done so, continue indefinitely with only minor fluctuations. There should be few if any changes in the design of products after their manufacture has begun, and the design tolerances should be such as to permit the most economical use of production facilities.

In the Bell System, however, the needs of the manufacturer are subordinate to those of the telephone companies and their customers. New products, designs and systems are introduced whenever they promise service or economic advantages to the user, and with little regard for the problems, financial or otherwise, imposed on Western Electric.

For example, over a period of several years, a major portion of long distance transmission was provided by TD-2 microwave systems with a capacity of about 600 voice channels. When the need arose to expand this capacity, Bell Laboratories developed an improved system, called TD-3, and Western Electric set up extensive -- and expensive --

facilities for its manufacture. Then, unexpectedly, a means was discovered for doubling the capacity of the older system in a way that would provide considerable cost advantages to the telephone companies and, ultimately, to their customers. It was decided, therefore, that manufacture of TD-3 should be held back, even though this would create a sudden excess of production facilities at Western Electric and impose on that firm an unforeseen financial burden. The needs of the customer came first.

Such disruptions of Western Electric operations are by no means infrequent or unusual. It very often occurs that no sooner has the company solved the problems of manufacturing a product or system than something better comes along to replace it, cutting into existing or forecasted production schedules and commitments.

Thus, while the operating units are innovative in themselves -- as demonstrated by continuing improvements in management methods and operating techniques -- their dedication to the task of providing top-quality, ever improving service also has considerable impact on the Bell System's total process of innovation and on the long-range planning of the enterprise.

V. A Look at the Record

Alexander Graham Bell, whose fertile innovative mind spawned new ideas in areas ranging from aerodynamics to the breeding of sheep, urged his followers to "leave the beaten track occasionally and dive into the woods. You will be certain," he said, "to find something you have never seen before." The following pages provide a sampling of things seen for the first time by the scientists and engineers of the Bell System -- of developments that have been of enormous benefit to telephone users and to the nation at large.

Fusing Sound and Pictures. In the early 1920's, when the System was developing a means of sending still photographs over telephone wires to newspaper offices, a few of its more imaginative scientists and engineers saw the possibility of devising a system that could transmit sound along with pictures and, in addition, accommodate motion. They spoke of this as "television." The first public demonstration of the medium came in 1927 when Herbert Hoover, then Secretary of Commerce, spoke from Washington and his voice and picture were received over wire at Bell Laboratories in New York. On the same day another TV program was broadcast, over the air, from New York to the Labs' facilities in Whippany, New Jersey.

Commenting on the new development, AT&T President Walter S. Gifford said: "It is our constant aim to furnish this country with the most complete telephone service possible. In connection with that aim, we endeavor to develop all forms of communication that might be supplemental to the telephone With that in view, we shall continue to work on television, which although not directly a part of telephone communication, is closely allied to it."

In the years since, television technology, with the aid of many contributions from Bell Laboratories, has not only created a vast new industry, but has advanced to the point where an individualized, person-to-person service is practical;

called Picturephone* service, it will enable the telephone user to "see while he talks." This goes far beyond broadcast television, for it places a compact TV studio, camera and all, in the home or office. A field trial of the system will take place in the fall of 1968 between Westinghouse Electric Corporation offices in New York and Pittsburgh. Trials already completed suggest that the service can be made commercially attractive within the next decade.

In addition to placing face-to-face calls, the Picturephone* customer will one day be able to use the device to display news headlines, stock market and weather reports, airport conditions, and so on. He will even be able to use the instrument in conjunction with a computer as a desk "calculator." A special data set developed by Bell Laboratories links the Picturephone* with a commercial computer. In the experimental system, the data set converts Touch-Tone* -- i.e., pushbutton -- signals into computer language and permits transmission of the computer's response to the user's home or office screen. The potential applications are virtually unlimited.

Listening in on the Stars. Walter Sullivan, writing in The New York Times of July 14, 1968, remarked that "Whenever technology enables scientists to look at nature through a new window, surprises seem to be the rule." He continued:

> "The launching of the first Radio Astronomy Explorer into orbit offers such a window on the cosmos. What will be revealed by the first glimpses through it cannot be predicted. Nevertheless it is likely, even if no world-shaking discoveries are made, that the observations will help explain a variety of long-standing puzzles, such as the intense radio bursts from the planet Jupiter.
>
> "The satellite, also known as Explorer 38, was launched from the California missile range on July 4 and was maneuvered [by a Western Electric-Bell Laboratories command guidance system] into an extremely round orbit some 3,640 miles above the earth. The height varies by only five miles throughout its journey around the earth."

*Registered mark.

Explorer 38 opens a new chapter in a story that began 40 years ago when a young physicist, Karl Jansky, was asked to resolve a problem that was perplexing his Bell Labs associates: the problem created by a peculiar kind of "noise" that was disrupting the recently-opened transatlantic radiotelephone service.

By 1932, Jansky had established, with the aid of the Labs' sensitive new transoceanic radio receivers and a large rotatable antenna, that most of the noise was caused by lightning flashes, some from as far away as the opposite side of the globe. Most, but not all. He also detected a steady hissing whenever his antenna was pointed at one particular section of the sky -- a section that moved synchronously with the shifting canopy of stars.

Jansky had discovered radio astronomy, a science that would provide man with a new "window on the universe."

The "hissing" Jansky had observed was a nuisance to communications, but was at least predictable in occurrence -- and hence engineers could protect against its effects. Studies have continued, since there is the possibility that the new science may, someday, open the way to some form of communications progress.

In the space age, this is becoming increasingly probable, though it is still too early to discern just what the implications might be for the Bell System and for the industry of which it is a part. And Bell System contributions to the science -- limited as they are in terms of manpower and resources -- have continued to be important. For example, in 1965 Bell researchers, using an antenna mounted on a hilltop in Holmdel, N.J., detected what appear to be the radiation remnants of an explosion that gave birth to the universe. Such a primordial explosion is embodied in the so-called "big bang" theory, which seeks to explain the observation that virtually all distant galaxies are flying away from the earth. Their motion implies that they all originated at a single point some 10 or 15 billion years ago. The Bell observations were of radio waves that appear to be flying in all directions through the universe. Since radio waves and light waves are identical, except for their wavelength, these are thought to be the remains of light waves produced by the primordial flash.

On the Nature of Matter. In 1927, as part of Bell Laboratories' effort to clarify the interaction of electrons and solids (which, hopefully, would enable the System to develop improved vacuum tubes), Clinton J. Davisson and Lester H. Germer conducted an experiment that was to add hugely to man's knowledge of nature.

The two scientists directed a stream of electrons at a thin slice of nickel crystal and determined how they bounced off. When the puzzling results were analyzed, it was clear that the electrons did not ricochet off the crystal like the small hard balls they were supposed to be. Instead they rebounded in the form of waves. Thus a fundamental concept of Quantum Mechanics was given experimental verification.

Davisson shared the 1937 Nobel Prize in physics with George P. Thomson of England. Their experiments had convincingly proved the wave nature of matter on which the whole structure of quantum mechanics now rests.

Negative Feedback. In the late 1920's one of the major problems confronting the Bell System was that of overcoming the distortion that vacuum-tube amplifiers produced in telephone signals. While ordinary radio work required only a single amplifier and the distortion could be held to acceptable levels, the extraordinary challenge to telephony was to design improved amplifiers for boosting voice signals every few miles along continent-spanning wires and cable. The cumulative effect of even small distortions in such a system was intolerable.

The answer came in 1927, when the Labs' Harold S. Black, standing on the deck of a Hudson River ferryboat, conceived the basic idea of negative feedback -- a means of subtracting a part of the amplifier's output from its input and thereby canceling the distortion. Black wrote on the back of his newspaper an equation proving that this would reduce distortion by a hundredfold or more, and yield an equal improvement in amplifier stability.

In addition to its impact on telecommunications, Black's discovery provided the principle on which electronic control systems, such as those used for missile guidance and aircraft control, are based. The negative-feedback amplifier also has contributed greatly to the large "hi-fi" and stereo businesses. In the view of many scientists, the device ranks with the audion vacuum tube and the transistor as one of the three inventions of broadest scope and significance in electronics and communications of the past half century.

<u>The Transistor Effect</u>. Shortly before World War II, Bell Laboratories, recognizing that the potentials of vacuum tube electronics had been extended to the limits, built up a team of physicists to explore the behavior of electrons in solids -- the so-called "solid state." Headed by William Shockley, the group concentrated its attention on silicon and germanium, curious elements that are only fair conductors of electricity.

Early efforts, aimed at building amplifiers out of these semi-conductors, were unsuccessful. But in the late 1940's, John Bardeen, a young physicist who had only recently joined the team, proposed a new theory about the behavior of electrons that seemed to explain the initial failures. In the course of testing the theory, Walter H. Brattain made observations that enabled him, with Bardeen's assistance, to devise what is called the point-contact transistor -- an amplifier that worked differently from those originally envisioned. Almost concurrently, Shockley conceived still another variation, called the junction transistor. It was upon the latter version that most development effort would be concentrated.

The three Bell scientists shared the Nobel Prize for their discoveries, in 1956. Their work had ushered in a new electronic era -- and created a whole new industry in which hundreds of firms are now engaged.

The discovery of the transistor also opened new paths in computer technology and greatly advanced the feasibility of space exploration. Satellite communications, for example, would not be practical today without the transistor -- or without the invention of the solar cell and the development of other key communications components at Bell Laboratories.

Information Theory. By the late 1940's, the Bell System had spent several hundred man-centuries on research and billions of dollars in equipment to handle information expeditiously. But since there existed no means for measuring information or the capacity of communications channels, it could not calculate the efficiency of its handling methods.

The solution came in 1948, when Bell mathematician Claude E. Shannon published a paper called "A Mathematical Theory of Communication." Shannon had conceived a simple formula for calculating the information "bits" in any message. It also told how to compute the capacity of any information channel in bits per second.

As further elaborated, Shannon's ideas were to have a profound impact in the fields of signal transmission, message coding, and switching. In transmission, for example, information theory (along with the transistor) contributed to the wide-spread, practical application of Pulse Code Modulation -- a technique that is more effective in overcoming noise than either AM, the ordinary radio signal, or FM. The first successful commercial system to employ the technique (T-1 Carrier) was introduced by the Bell System in 1962.

Microwave Transmission. Today, microwave radio relay systems carry about two-thirds of the nation's long distance telephone traffic and nearly all television network programming. In this method of transmission, microwave signals are relayed between antenna towers spaced about 30 miles apart. The electric energy required to send messages from tower to tower is roughly the same as that used to power an ordinary flashlight.

Research that would lead to the development of microwave systems began in the 1920's when Western Electric and Bell Laboratories undertook fundamental studies into the use of higher radio frequencies. By 1940, the System had spent some $46 million on these and related studies, and it was clear that microwave offered exciting potentials. The work of Bell Laboratories' George C. Southworth (in the development of the waveguide, the interior "plumbing" of microwave systems) greatly advanced the practical applications of microwave transmission.

Plans were established in 1940 for the construction of nationwide facilities for the transmission of both telephone calls and commercial television broadcasting, which was felt to be imminent. Before interrupted by the military needs of World War II, AT&T put into operation the first system which enabled many messages to travel the same radio channel, and executed preliminary plans for a single link microwave system.

Anticipation of postwar television demands led, in 1944, to the announcement of plans for an experimental microwave system between New York and Boston. When it went into service in November, 1947, it was the first system capable of handling both voice signals and video.

The high quality TD-2 system in use today was introduced in 1950, and it has proven to be the workhorse of the entire industry. As indicated earlier, the system has been steadily improved and expanded in the years since. It today accounts for about 82 percent of the channel miles allocated to microwave across the nation.

Communications Satellites. In 1955, Dr. John R. Pierce of Bell Telephone Laboratories made the first serious study of what would have to be done to build a working satellite communications system -- assuming it would one day become possible to put satellites into orbit. In a technical paper delivered at Princeton University, Dr. Pierce envisioned two methods for communicating via satellites: by reflecting microwave radio signals off mirror-like "passive" satellites; or by transmitting to "active" satellites which -- performing microwave relay towers in the sky -- would catch and amplify the signals before returning them to earth.

In 1959, the feasibility of space communications was demonstrated when live voice transmission was accomplished from Bell Telephone Laboratories in Holmdel, New Jersey, to the Jet Propulsion Laboratories in Goldstone, California, using the moon as a reflector.

The following year, Echo I, a 10-story high reflecting balloon satellite, was launched into orbit by the National Aeronautics and Space Administration (NASA) and the practicality of a man-made communications satellite was established. Voice and still photographs were "bounced" off the satellite in tests participated in by the Bell Labs' Holmdel station and the Jet Propulsion Laboratories on the West Coast.

Encouraged by the success of Echo I, scientists at Bell Laboratories moved ahead on the development of an active communications satellite. Less than two years later, the Bell System's Telstar satellite was launched, with immediate and dramatic results. The world's first active communications satellite (and the first satellite built and paid for by private industry), Telstar made communications history on July 10, 1962, when Bell Laboratories engineers used it to relay voice communications and live television across the Atlantic within hours after it was put into orbit. In the weeks following the launch, over 300 technical tests and measurements of every phase of transmission were conducted with the satellite. More than 400 demonstrations, including multi-channel telephone, telegraph, data, telephoto, television and facsimile transmissions also were made.

A second Telstar satellite was orbited on May 7, 1963. Telstar II's larger orbit permitted the first live television from Japan. During the next two years, Telstar II was used for various communications experiments plus the transmission of special television programs such as the funerals of President Kennedy and Sir Winston Churchill.

Satellite communications in all probability would not be a reality today if it were not for a number of key inventions and developments of Bell Laboratories. Some of these are: the negative feedback amplifier (1927); the FM feedback receiver (1933); the horn reflector antenna (1939); the traveling wave tube (1945); the transistor (1948); the solar battery (1954); and the solid state maser (1957).

Today as the largest user of satellite communications, the Bell System leases 295 circuits in Intelsat satellites (operated by the Communications Satellite Corporation) to bridge both the Atlantic and Pacific oceans. It is expected that 594 satellite circuits will be needed by the end of 1968, and more than 3,000 will be utilized by 1980 to help handle rapidly increasing demand for overseas communications.

The Bell System also is in the forefront in supporting a domestic satellite system which can be integrated with terrestrial cable and microwave systems to meet anticipated demand for long-haul circuits to carry voice, television, and data. In 1966, the company proposed a multi-purpose space-earth system that would let the general public share in the benefits derived from this new technology. The Bell System has supported a pilot plan for domestic satellites that was proposed by Comsat.

Digital Transmission. Digital transmission rests on the concept that all information in electrical form can be represented as a series of pulses which can be transmitted, regenerated, retransmitted and finally used to reconstruct the original information in as precise detail as is required. Although the principal method of accomplishing this, called pulse code modulation, was known more than twenty five years ago, its implementation was quite impractical with vacuum tube circuitry. However, as transistors emerged as inexpensive reliable circuit elements, a substantial effort was begun at Bell Laboratories to master and implement this extraordinary transmission technique.

The path to understanding has been difficult and complex but the results have been more successful. An entire series of digital transmission systems is emerging ranging from T1 which operates at 1.5 megabits per second over two pairs of wires, to T4 which will operate at about 600 megabits per second over a coaxial cable. The T1 system is used for short haul (up to about 50 miles) and transmits 24 voice channels or somewhat over 1 megabit per second of data. The rate at which it has been introduced into the actual telephone plant has exceeded that of any other carrier system. The Bell System now has some 200,000 network miles of the system in actual operation.

The next member of the family, T2, operates at 6.3 megabits per second and is designed for intermediate distances (up to about 500 miles). It will accommodate up to four bit streams of T1 carrier thus making possible a cohesive network of digital facilities. Eventually the nationwide network will be pervaded by digital transmission facilities permitting more efficient intermixed transmission of voice, data, Picturephone and video.

Data Communication. Although the Bell System is not in the business of providing data processing services, its researchers have played a key role in the development of this expanding industry. The common control switching systems introduced in big cities almost 40 years ago were the first exemplars of real-time data processing, and the very first electrically operated digital computers were built nearly 30 years ago at Bell Laboratories. All modern computers are born of the solid-state technology developed at the Labs in the late 1940's, and the whole concept of the linking of computers and other machines in data network has been conceived, designed and promoted primarily through Bell System initiatives in the past decade.

Today, the nationwide Bell Telephone network is providing data communications services in ever-increasing variety.

Data-Phone* Service -- which permits the transmission of data from computers and a broad range of other data machines over regular telephone lines -- was first introduced in 1958 and has become increasingly useful and attractive with the development of improved equipment and a steady reduction in service charges, especially for night and after-midnight use of the network.

Switched data communications services over the network are generally available at speeds up to 2000 bits per second, and this is expected to increase to 3600 per second within the next few months.

Over a New York-Chicago-Washington-Los Angeles network, the Bell System is now offering a trial of a service called Data-Phone 50, which will enable customers to send data at speeds up to 50,000 bits per second and facsimile at more than a page a minute.

Touch-Tone* calling, which is becoming more and more widely available, provides an extremely economical input device for small amounts of data.

Private-line data services now handle data speeds from the low range up to nearly half a million bits per second, and speeds in the megabit range will be available in the next several months.

* Registered Mark

As AT&T Board Chairman H. I. Romnes said recently of the development of data processing and data communications systems:

> "The opportunity is now before us to increase the precious resource of knowledge to a degree hitherto impossible, and to manage the use of all resources more effectively. Computers and communications together...can lead to profoundly effective and beneficial innovation in social affairs as well as in economic life. We need this creative innovation, we need it badly. We need it in meeting urban problems, in education, in dealing with the bothersome side effects of technology itself. We need it in building harmonious systems in which people of all countries and races can live and flourish.
>
> "This new emerging world of computers and communications is so full of promise, in so many ways, that none of us can let down in effort to do what is right."

Laser Technology. Hundreds of scientists are today exploring the awesome potentialities of the intense, pure light beams of the optical maser -- or laser, as it is now commonly known. The laser provides an entirely new form of energy, and many of its ultimate applications can only be guessed at today.

Scientists are certain, however, that continuing research into laser applications will uncover myriad uses. Already, several types of lasers are being utilized in such areas as scientific research, medicine, space exploration, and the manufacture of communications products.

The United States is clearly ahead in exploring this new technology. This is due in large part to early research steps taken at Bell Laboratories, and to the benefits accruing to other organizations from on-going research at the Laboratories.

Many scientists, in fact, trace the first interest in the communications potential of light waves back to Alexander Graham Bell's notion in 1880 that light could be used to transmit sound. Bell actually succeeded in using a device called a photophone to transmit speech over unfocused, visible light beams, but radio waves and electric wires turned out to be more efficient carriers.

Experiments with the microwave portion of the electromagnetic spectrum led to the discovery in 1951 that microwaves could be amplified in a coherent, or "in phase," wave process. The inventor, Charles H. Townes, a professor at Columbia University and consultant to Bell Laboratories, called his discovery a maser (for <u>m</u>icrowave <u>a</u>mplification by <u>s</u>timulated <u>e</u>mission of <u>r</u>adiation.)

Shortly after, the Laboratories' interest in the maser's communications potential led to development of the first of the devices to use solid-state amplifying material. These were the masers later employed to amplify signals from the Echo and Telstar satellites, and for study of astronomy.

The first paper on the amplification of coherent light waves (laser) was published in 1958 by Townes and Bell scientist, Arthur Shawlow. Two years later, scientists at Bell Laboratories invented the first continuous-wave laser and were able to transmit a telephone call over its pure and steady beam.

Other laser advances pioneered by the Bell System include the development by Western Electric of the first commercial application: the piercing of holes in diamond dies, through which copper wire can be drawn as thin as a human hair. Western Electric also uses the device in the production of glass encapsulated resistors. The laser beam passes through the glass without damaging it and trims part of a carbon layer deposited on the resistor's ceramic core until desired resistance values are achieved.

Another laser developed at Bell Laboratories has been used by doctors as a "light knife" in performing bloodless surgery on cancerous tumors. Experiments also are being carried out that have enabled surgeons to use the device as a tool to weld detached retinas of the human eye.

Extensive efforts are continuing at Bell Laboratories to find practical communications applications for the laser beam. Ultimately, the laser may be employed to transmit telephone calls, data messages and television. While a number of technical and economic problems remain to be solved, the potential is there to provide a variety of new services and to open a great new swath of frequencies.

Integrated Circuitry. Radar, radio, television, computers, switching and transmission systems, and scores of other products today employ tiny devices known as integrated circuits. Packing 10 to 20 transistors and 40 to 60 resistors into the space of a tenth of an inch square, they provide cost, size and weight advantages that were once unattainable.

The new circuitry involves two complementary techniques. Silicon technology permits integration of transistors, diodes and non-critical resistors. The circuit is a small chip of silicon about 1/16th of an inch in diameter. Tantalum thin film technology is utilized for integration of precision resistors and capacitors. It employs a super-thin film of tantalum nitride only 4-millionths of an inch thick.

The new technologies developed largely out of Bell System studies in the field of micro-electronics; and their widespread applications have been greatly accelerated by Western Electric/Bell Laboratories achievements in the use of so-called "thin film" processes.

Several years ago, experiments conducted at Bell Labs suggested that integrated circuits could be produced economically and in large quantities. It was clear, however, that extensive development work would be necessary to make this practical and economical and that altogether new manufacturing techniques would have to be devised by Western Electric.

Risking substantial amounts of capital, the Labs and Western Electric launched an investigatory program aimed at determining whether the problems could be overcome.

As a result of this collaborative effort, the Laboratories were able to demonstrate the great potentialities of silicon and thin film circuitries, and Western Electric's Engineering Research Center succeeded in developing the necessary manufacturing processes.

Produced by the millions each year, integrated circuits are today playing an increasingly important role in communications progress.

<u>The Needle Bonder</u>. The microscopic dimensions of semiconductor devices, such as transistors, have made necessary the development of radically new production processes. The electrode areas on current devices may be only two ten-thousandths of an inch in width; and each of these tiny structures requires

a minimum of two electrical connections, which must be made with a wire so thin that it is actually invisible to the unaided eye.

For several years, the connections were made by relatively cumbersome techniques, employing high resolution microscopes. The average cost of attaching each lead was 4 cents, which represented a significant fraction of the overall cost of the devices, and the reliability of the connections was not always satisfactory.

Hence in 1958 Western Electric's new Engineering Research Center launched efforts to find a means of lowering the cost of the connections, increasing their reliability, and speeding up the entire manufacturing process. The result of this work was the invention of the so-called thermocompression needle bonder.

With this device, a fine gold wire -- typically, one thousandth of an inch in diameter -- is fed through a hollow needle with a specially machined, tungsten carbide point. When the tip of the needle is pressed against a gold or aluminum contact area on a heated transistor, the wire is intimately welded to the electrode. The wire is then snipped off by a jet of hydrogen flame or by a process known as "post shearing."

The technique has reduced the cost of each connection from 4 cents in 1958 to 6/10ths of a cent today. At current production levels, it is saving the Bell System approximately $1.5 million a year.

In the years since its invention, needle bonding equipment has been adopted by electronics manufacturers throughout the world. In addition, it has created a substantial business in the manufacture of the tools themselves. It is estimated that some 4,000 needle bonding machines were being employed by the electronics industry at the end of 1967.

Electronic Switching. Bell System advances in solid-state physics, information theory, computer programming and a number of other fields led to the rapid development of electronic switching systems (ESS), which are now being introduced at an accelerating pace.

Simply stated, ESS is a system that enables telephone central offices to switch calls electronically instead of electromechanically, using a concept called stored program control. This is the ability to contain in magnetic memory the millions of bits of information that are needed to provide services, process calls, and help maintain the equipment automatically. Its development grew out of the Bell System's recognition that the country's need for faster, more abundant communications - in words, in data, in pictures, in symbols - would require a more efficient, more versatile switching system than electromechanical devices would permit.

ESS offers many advantages, including exceptional reliability and reduced maintenance costs. Also, its electronic "memory" features will offer further opportunities to provide individualized customer services.

The first successful trial of electronic switching took place in Morris, Illinois, between 1960 and 1962. Three years later, the first commercial electronic central office opened in Succasunna, New Jersey.

The success of the Succasunna experience encouraged the Bell System to embark upon the largest, most complex project ever undertaken by a private industry -- that of completely updating the nationwide electromechanical switching network with newer electronic systems. This is being accomplished at a faster and faster pace.

At the end of 1967, for example, there were 30 electronic offices in service and 40 more will be added in 1968. The pace will mount even more rapidly in the early 1970's when the System plans to place a new ESS office into operation each working day.

In computer terminology, the system design of the Central Control of No. 1 ESS employs software of an advanced concept representative of a third generation computer system.

It is a time-shared, multi-processor machine capable of serving thousands of customers, and possessing a diagnostic and maintenance program that far exceeds the capability of any commercial computer program now extant. As an entry in the world of computer design it is outstanding and unique. However, the significance of No. 1 ESS lies in the rapid rate of its implementation in the Bell System; this is a vital measure of innovation. As ESS proliferates, increased flexibility to provide new services will become widely available. More importantly, entirely new modes of network control will be possible resulting in more rapid call set up and more efficient use of the network facilities.

It is significant that the Bell System is far ahead of any other carrier in the world in the use of ESS. Although European and Japanese administrations and companies have devoted great efforts to develop ESS systems, none has yet put a production system into commercial operation.

Improved Management Techniques. While this paper has emphasized the technological aspects of innovation, the Bell System has been no less innovative in the development of new and improved techniques of management. Two of the more recent examples of this are cited as follows:

Network Management is a control system designed to provide the most efficient and effective use of the long distance network, a communications complex of more than 300,000 circuits. It provides a switching plan which divides the country into a desending series of control centers and a routing plan which helps to prevent delays by furnishing alternate pathways when the most direct route is busy. The system enables network managers to exercise control of calling patterns in times of disaster or of high traffic volumes. This helps to insure the most efficient use of circuits and the completion of the maximum number of calls possible.

A Business Information System (BIS) is currently being developed to overhaul and modernize most of the traditional information-handling activities performed by the Bell Telephone Companies. It is the culmination of nearly two decades of study and experimentation in the uses of electronic data processing. For the customer, BIS will provide improved, more responsive and efficient service, personalized to meet individual needs. For the Bell System manager, it will offer more timely information to enhance his control of the business.

Since 1967, a new organization at Bell Laboratories, with special expertise in the development of new computer applications and techniques, has been directing its attention to three principal areas of Bell System operations. All facets of handling customer requests for service will be reviewed, including service order processing, assignment of plant facilities and telephone numbers, repair service and customer billing. Studies will be made to determine how to improve methods for handling inter-office trunks and private line facilities, including forecasting needs and the engineering of new telephone plant. Finally, efforts will be directed toward improving and modernizing the information, intercept and directory services provided customers.

A Final Measurement. Here is one last indicator of the Bell System's scientific and engineering leadership: The Physical Review is the nation's leading journal of theoretical and experimental physics. Among the 2,703 papers it published in 1967, only about 12 percent came from U.S. industry. Bell Laboratories provided 29 percent of the industrial total, and ranked second among all contributors. Here are the top twenty, with a count of their papers.

U. of California (Berkeley)	150
Bell Laboratories	101
Argonne National Lab.	101
Brookhaven National Lab.	92
M.I.T.	92
Stanford	78
U. of Chicago	69
Oak Ridge National Lab.	68
U. of Illinois	56
Cornell	50
U. of California (L.A.)	45
U. of California (La Jolla)	44
Princeton	44
Los Alamos (AEC)	43
U. of Pennsylvania	43
Harvard	42
Yale	41
Cal. Tech.	39
U. of Massachusetts	38
U. of Rochester	37

General Electric, with 33 papers was in twenty-sixth place. Beyond that, only two industrial firms, IBM and North American Aviation, contributed more than 20 papers.

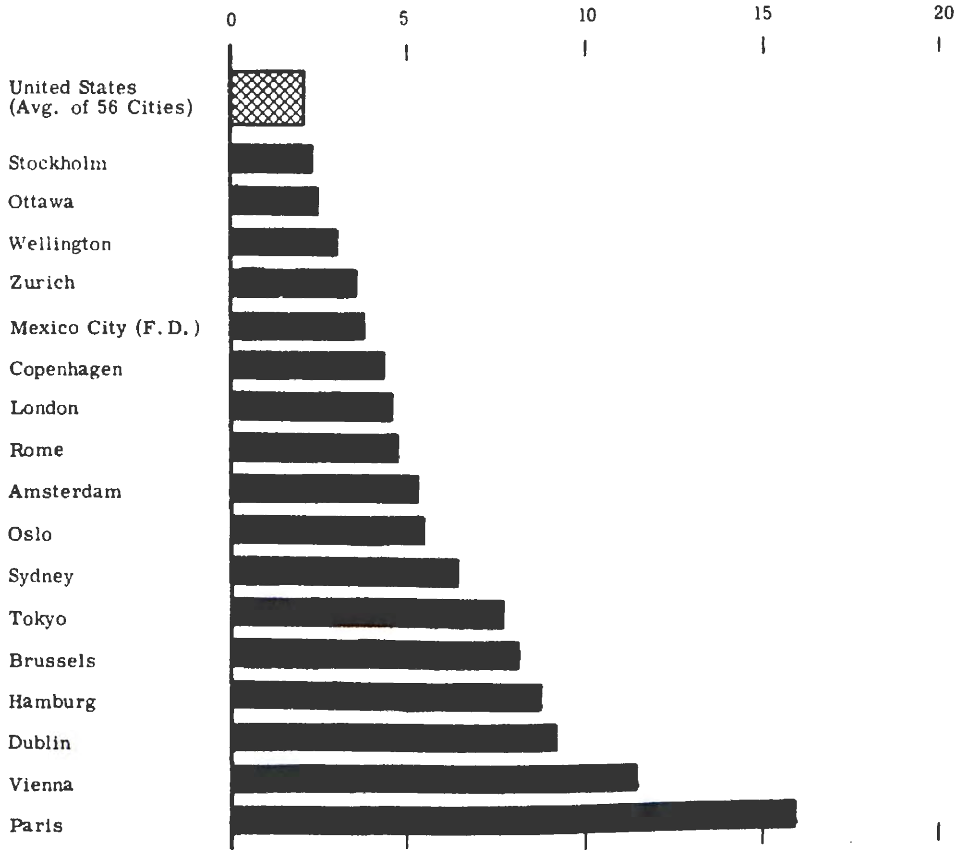
VI. Conclusion

Such, in briefest outline, is the story of how the Bell Telephone System has combined scientific, engineering, manufacturing and operating talents to create what *Fortune* (Feb., 1965) has termed "today's incomparable telephone service," a service that continues to grow in quality, economy and versatility. As indicated, the System's innovative achievements are largely the result of its form of (integrated) organization, a form of organization which encourages an uninterrupted flow of ideas from research and development into manufacture and thence to the telephone user, a form of organization which, in the words of *Time* magazine (June, 1968), provides a service that is "far and away the best in the world."

Attachment A

RELATIVE COST OF TELEPHONE SERVICE

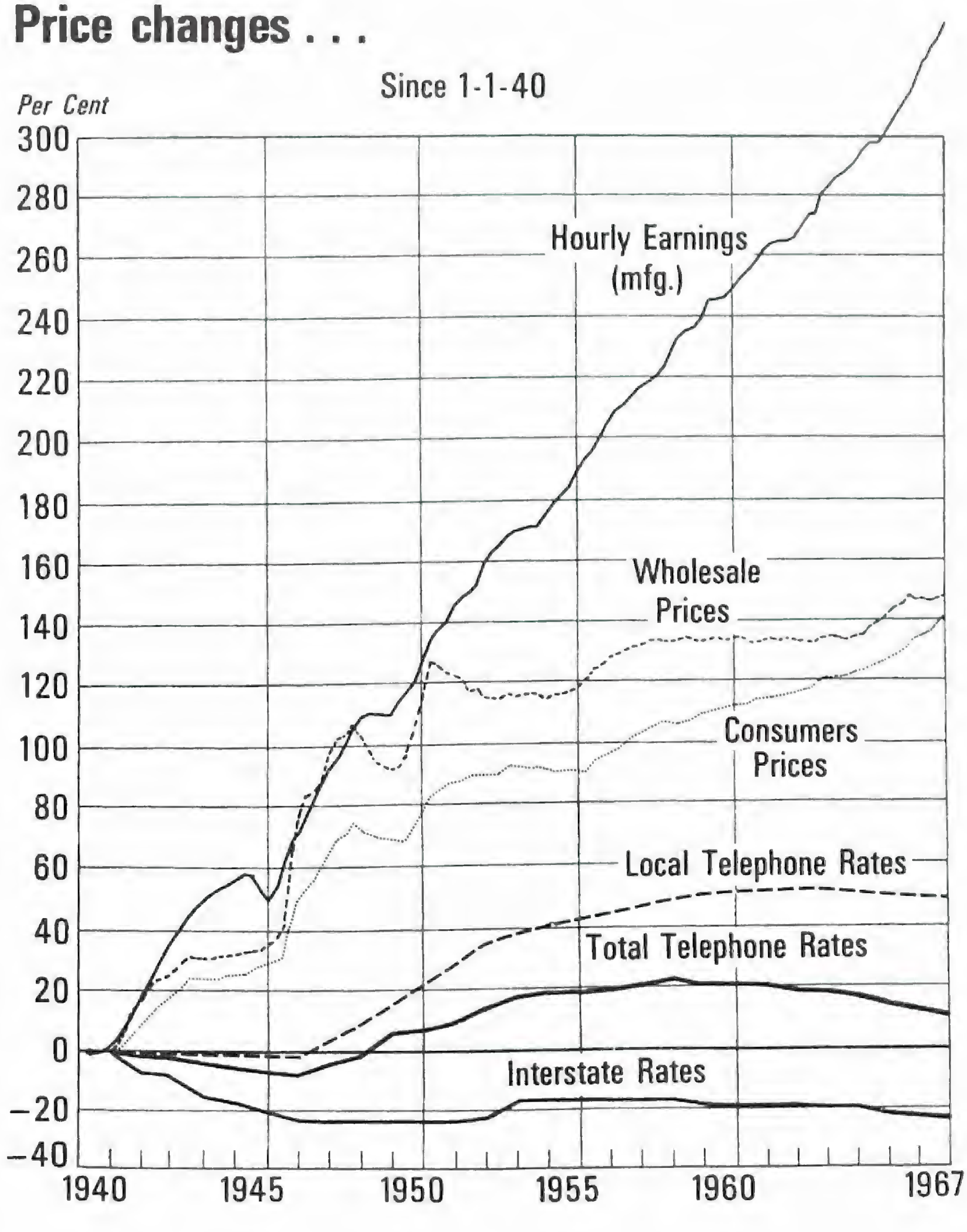
Average number of hours of work required to pay for one month's individual residence service, with 100 local calls



American Telephone and Telegraph Company
Business Research Division
August 1966

Attachment B

Price changes . . .



INTRODUCTION OF

ELECTRONIC SWITCHING SYSTEMS (ESS)

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

195 BROADWAY, NEW YORK, N.Y. 10007

HUBERT L. KERTZ
VICE PRESIDENT

AREA CODE 212 393-1000

March 29, 1968

Mr. Leland Johnson, Research Director
President's Task Force on Communication Policy
Department of State
Washington, D.C. 20520

Dear Leland:

In my recent letter to you regarding potential applications of pulse code modulation (PCM) transmission systems, I promised to send you some information on the rate of introduction of electronic switching systems (ESS) by the Bell System.

Here are some highlights which indicate how rapidly ESS is being introduced into the system:

- The first commercial ESS office was placed in service in Succasunna, New Jersey, in 1965.

- There were 33 electronic central offices in service at the end of 1967.

- In 1968, 44 more are scheduled for service.

- By the mid 1970's, we expect new ESS offices to be placed in service at the rate of one each working day.

As you know, the statement has been made that all Bell System customers will be served by electronically-controlled switching equipment by the year 2000. You will note that this is stated as an "outside" date and its relative importance has been misconstrued in many instances. As is the case with all long range plans, the program for introducing ESS will be reviewed from year to year and adjusted as necessary to meet public needs and take advantage of further technological advances. Consequently, there is nothing "magic" about the 2000 date. It simply is a rounded-off, ultimate target date for completing the <u>total</u> task throughout the country.

The majority of customers will, of course, be served by electronic offices much sooner than that. We also expect to provide a great many additional customers with special service features that ESS provides by applying electronic "appliques" to existing exchange and toll switching equipment. Such services include "speed calling" of frequently-called numbers, automatic transfer for temporarily diverting incoming dial calls to another telephone, three-way conference calls without the aid of an operator, and "call-waiting" -- a signalling feature which lets the user know another caller is trying to reach him. In the toll systems we are developing electronic devices to replace our "card translator" which you saw in the 4A toll office in Washington. In addition, we are planning for electronic toll offices to replace the #4A toll switching system.

Development work on "appliques" has been underway for some time. Plans call for putting growing numbers of these units in service in the near future in many of our present central offices.

In all probability, the introduction of electronic central offices throughout the nationwide network represents the largest single project ever undertaken by a private enterprise. By this I am not referring only to the costs, which are expected to reach $20 billion or more, but also the skilled manpower and manhour requirements and the intrinsic complexity of the task.

To give you an over-all impression of how much effort has already gone into the development of ESS, I'm attaching a copy of the June, 1965 issue of Bell Laboratories Record, which devoted an entire issue to the subject.

One final thought which goes back to my earlier statement about the year 2000: At the pace technology is moving today, even the present ESS system may seem pretty much "old hat" long before the year 2000. For even today, the newer integrated electronic circuits -- which offer substantial improvements in performance and reliability as well as savings in manufacturing and maintenance costs -- are affecting the plans and future designs for ESS. Thus ESS, as we now know it, is not the ultimate, and may never achieve the status of a sole switching medium. Rather, it represents a tremendous step forward and also paves the way for whatever the next technological advance will bring.

Sincerely,

Al L Kertz

FEASIBILITY OF USING PULSE CODE MODULATION ON TRANSATLANTIC CABLES

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

195 BROADWAY, NEW YORK, N. Y. 10007

HUBERT L. KERTZ
VICE PRESIDENT

AREA CODE 212 393-1000

March 19, 1968

Mr. Leland Johnson, Research Director
President's Task Force on Communication Policy
Department of State
Washington, D.C. 20520

Dear Leland:

During our tour of some of the newer communications facilities in Washington recently, you raised two questions. One dealt with the feasibility of using Pulse Code Modulation (PCM) on existing transatlantic cables. The other concerned the rate at which electronic switching (ESS) will be introduced throughout the Bell System. We are developing some detailed information on your ESS question and will send it along to you in a few days.

In considering the PCM question, let me say first that the Bell System sees great promise in this transmission method. For certain situations, PCM improves the quality of transmission and reduces costs -- both very desirable attributes. There are, however, some basic technical reasons why PCM is not used on undersea cable systems.

Pulse Code Modulation involves transmitting a signal which employs a large amount of bandwidth (i.e., frequency spectrum) to greatly reduce the sensitivity of the signal to interference from such channel deficiencies as extraneous noise and crosstalk. When this method of modulation is used on paired or coaxial cables, the signal attenuation associated with this large bandwidth must be compensated for by repeaters spaced at approximately one-mile intervals compared to the 20 or 40 mile intervals on the present underseas cables. Since pulse code modulation repeaters must not only overcome the loss of signal power but also regenerate and retime the train of pulses, they become quite complex in comparison with the amplifiers used at less frequent intervals for handling the narrower band analogue or amplitude modulated signals.

Feeding power to several hundred undersea repeaters and insuring their reliability are primary limitations on the design of intercontinental submarine cable systems. Also, the coaxial cable used in these systems is not subject to extraneous noise or crosstalk. Careful system studies, based on these considerations, have clearly shown that PCM is not at the present time the optimum technique for transmitting signals on long submarine cable systems. It would be more costly than the techniques presently used, and would actually decrease the number of circuits available.

However, in designing systems for use on land, complex close spaced repeaters can be maintained and powered. Furthermore, extraneous noise and crosstalk are often difficult to cope with on land systems. For these reasons the Bell System has been developing and implementing PCM carrier systems for the past decade or more.

I'm attaching a non-technical memorandum which provides some additional general information on the advantages and uses of PCM carrier systems.

Sincerely,

Al R Kertz

Attachment

APPLICATIONS OF PULSE CODE MODULATION IN THE BELL SYSTEM

Introduction

From the earliest days of telephone communication, Bell System people have been working continually to improve the quality and reduce the costs of transmission. From open-wire lines through successive sizes of cable with improved insulation and protective sheaths to modern carrier techniques, the design objectives have remained firm: reproduce faithfully the communication signals at a reduced cost.

In 1918, the Bell System introduced a technique for adding more voice channels onto existing telephone wires and cables. It was called "carrier" because the voice messages were "carried" by different radio frequencies. This application of radio technology to wire circuits was accomplished by putting frequencies on a circuit with a small radio sending set, then taking them off with a receiving set. Electrical filters prevented the different bands of frequencies from getting into the wrong receivers.

These carrier systems employed Amplitude Modulation (AM), identical to the modulation technique used by standard radio broadcasters. Improved many times, through several generations of equipment design, AM, -- until recently -- accounted for all Bell System carrier systems in service.

Following World War II, the Bell System introduced microwave transmission into the telephone network. A microwave communications system is a high-frequency radio relay system, using electromagnetic waves. Each link or repeater section requires essentially the same elements: a transmitter, a transmitting antenna which radiates and directs the energy produced, a receiving antenna that intercepts a maximum of this energy after its transmission through space, and a receiver. Frequency Modulation (FM) techniques are used in microwave systems.

In 1962, the Bell System introduced the T1 carrier system, which employs completely different techniques for combining many voice channels on one transmission medium. This new technique is known as Pulse Code Modulation (PCM).

Pulse Code Modulation is a process of coding any communications message -- voice, data, TV, etc. -- into a series of uniform digital pulses. The pulses representing different messages are interleaved -- by an electronic gating system -- into a high speed stream. After transmission the pulses representing each message are separated and the original signal format is reconstituted.

This mode of transmission has four basic advantages:

1. The coded messages are less sensitive to deficiencies in the transmission channel, such as noise and cross-talk.
2. Since the individual pulses, whose presence or absence represent the coded messages, are identical, radically different messages can be easily interleaved on a common transmission medium with minimum interaction.
3. The on-off or digital pulses which constitute the signal on the transmission channel can be regenerated periodically, thus essentially eliminating extraneous noise and distortion accumulated from previous sections of a transmission channel.
4. Modern digital and solid state electronic techniques are well suited to processing and transmitting digital signals.

These advantages are accompanied by two principal disadvantages:

1. The pulse coded signals require several times more bandwidth -- e.g., frequency spectrum than a corresponding amplitude analogue signal. This increased

bandwidth is accompanied by greater attenuation of the signal on wire pair and coaxial cable transmission media, which must be compensated for by more amplification along a repeatered transmission line.

2. More electronic components are required to code, process, regenerate and decode analogue messages into pulse code signals, than to process and amplify the analogue signals directly.

If the message to be transmitted is already in digital form -- as in the case of some forms of data or encrypted voice, the regenerative transmission system designed to transmit PCM signals, is ideally suitable.

In view of these considerations the design of transmission systems to handle a required mix of the various kinds of services and to utilize existing and new media involves determining an optimum balance of the advantages and disadvantages of PCM against other modulation techniques. This optimization process has and will continue to lead to the provision by the Bell System of a variety of analogue and digital transmission systems each adapted to meet tne total service requirements of all types of customers in the most economical way.

Bell System Applications

Development of PCM applications in the Bell System is accelerating. One system is operational, a second is nearly ready for testing and a third is "on the drafting board."

T-1 Carrier

The first PCM application in the Bell System is T1 carrier, introduced in 1962. It was designed for local telephone and data applications, for short distances (less than 50 miles).

T1 provides a total of 24 telephone channels over 2 pairs of wire. Transmission rate of the system is 1.544 million bits per second. (64,000 bits per second for each of the 24 channels.)

Data terminals are available which transmit at speeds of 50, 250 and 450 thousand bits per second. Terminals which will transmit 1.3 million bits per second will be available in 1969.

At the end of 1967, there were approximately 18,000 T1 systems in service. The average length is about 17 miles; fewer than 1/2 of one percent exceeded 50 miles. Another 6,000 systems are planned for service in 1968.

T-2 Carrier

The T2 carrier system, scheduled for field trial this year, is a higher capacity system and will provide the quality needed for long distance applications. It employs more up-to-date technology including integrated circuits in place of earlier, transistorized components. Some of the design improvements include:

- larger capacity, to 96 voice channels.
- faster speed, to 6.302 million bits per second.
- longer range, to 500 miles.

As with T1, T2 systems will operate over 2 cable pairs (22 gauge or better). Regenerative amplifiers will be spaced at the same intervals, approximately 6,000 feet.

On a per circuit basis, costs are expected to be about the same as for T1 systems.

T-4 Carrier

The first PCM system for very long distance telephone applications will probably be T4, a system currently under development at Bell Telephone Laboratories. Present plans call for a field trial in late 1971, systemwide availability in 1973.

At this stage of development, the complete system design is not final, but the following is anticipated:

- coaxial cable will provide the transmission path.
- range will extend to 4,000 miles.
- speed will be at least 281 million bits per second.
- capacity will be at least 4032 voice circuits.
- regenerative amplifiers will be spaced about 1.15 miles apart.
- main stations will be required every 150 miles, to furnish power for transmission and access for maintenance.

Summary

Pulse Code Modulation techniques are emerging fast as a means of handling certain transmission requirements and the Bell System is excited about the many potential benefits. In the Bell Laboratories and at Western Electric, a major program is underway to improve the system performance and reduce costs. Looking ahead, PCM may be the only practical way to take advantage of supercapacity transmission media, such as circular waveguides and piped laser beams.

6

VERTICAL INTEGRATION IN THE BELL SYSTEM

Summary:

Common ownership of operating telephone companies and equipment suppliers is characterized by some economists as "vertical integration." The basic need to integrate research, manufacture, installation and operations in the telephone industry flows from the fact the business faces problems that by their very nature are unique. While the smooth functioning of the Bell network is generally taken for granted, it is none-the-less the most complex assemblage of equipment in the world today. The nationwide network and each of its billions of interconnected parts must provide service on demand 365 days a year without down time and must be reliable to a degree not matched in other industries.

It is the commonality of purpose among the units of the Bell System - the Bell Telephone Laboratories, Western Electric and the operating companies - that underlies the high quality of communications service the nation benefits from today. If this association did not exist, the Bell System's ability to serve the nation in the future would be critically impaired.

The Bell System's integration of R & D, manufacture and operation permits a total systems approach to telephone service; it facilitates and speeds innovation; it assures that the demand for telephone equipment is met promptly; it assures the required quality of equipment; and it provides substantial cost advantages. Those who question the value of Western Electric's association with the Bell System allude to theoretical gains that they presume would flow from competition. The fact is, however, that the destruction of the Bell System's integrated structure would inevitably and substantially reduce the quality and increase the cost of telephone service to the public, and slow the System's capability for introducing new technology and services.

By all objective standards, Western Electric's performance has been outstanding. Western's prices for its manufactured products are, on the average, about 50-60% of those available elsewhere. Western's profits on its Bell business have averaged lower than other large manufacturers. In the period 1950-67 Western's prices for its total manufactures were down by 10% in spite of wage rates which were up by 110% and raw material costs which were up by 53%. During the same period Western's prices for apparatus and equipment decreased by 16% as compared with an increase of 53% in the Bureau of Labor Statistics price index for electrical equipment prices generally. Western's annual improvement in productivity in the period 1948-1966 has been about twice the annual improvement for the electrical equipment industry and more than twice that of the private domestic economy and the manufacturing sector. All of these facts constitute a proven record of performance which no amount of abstract theory can overcome.

If Western had achieved only the average annual improvement in productivity realized by other electrical equipment suppliers, the Bell operating companies would have paid several billion dollars more for the equipment they purchased in the post war period and rates for telephone service would have been significantly higher. This remarkable achievement is in large measure the result of the coordinated efforts within the integrated structure of the Bell System to achieve maximum efficiency and economy in providing new and improved telephone plant which the Bell System must have to meet its public undertaking.

TABLE OF CONTENTS

VERTICAL INTEGRATION IN THE BELL SYSTEM: A SYSTEMS APPROACH TO TECHNOLOGICAL AND ECONOMIC IMPERATIVES OF THE TELEPHONE NETWORK

The Bell Telephone System is a single, integrated enterprise engaged in the provision of nationwide telecommunications services. In addition to AT&T, the parent organization, the System includes:

> 23 regional Operating Telephone Companies, which together with AT&T's Long Lines Department provide common carrier telecommunications services to the public.
>
> Western Electric Company, Incorporated, which is the manufacturing and supply unit of the System.
>
> Bell Telephone Laboratories, Incorporated, which is the research and development unit of the System and is jointly owned by AT&T and Western.

This common ownership of the Operating Telephone Companies, an R & D organization and an equipment supplier is often characterized as "vertical integration."

The purpose of this paper is to provide an insight into the technological, economic and service imperatives that have shaped the Bell System's vertically-integrated structure, and into the ways in which this structure has made possible the reliable, progressive and economical telephone service we enjoy in this country.

Prologue

The Bell Telephone System exists -- and it has always existed -- for the purpose of providing the best possible telecommunications services to the people of this country. This means service that is high in technical quality and in reliability. It means service that is reasonable in cost and is constantly improving.

At the core of this undertaking is an "integrated systems-approach" to a vast, highly complex and dynamic organism: the telecommunications network of the Bell System. This nationwide network consists of a web of millions of intricate and complicated mechanisms, all of which must work reliably and compatibly at a moment's notice to make any of five million billion possible connections. It is an ever-changing and delicately balanced machine, designed and nurtured to meet the System's responsibility to the public to provide a first class nationwide service -- and it does just that.

This efficient network could only have come into being through the closest possible cooperative efforts between R & D, manufacture and operations, and through progressive attention to systems engineering and to the need for network optimization. Thus the three-way tie between R & D, manufacture and operations in the Bell System is not simply a response to the imperatives of the network; it is the principal explanation of why this country enjoys the best, the most dependable and the most universal telephone service in the world today.

Curiously, however, while the smooth functioning of the Bell network is generally taken for granted, from time to time questions are nevertheless raised as to the need for Bell's vertically-integrated structure and, in particular, with respect to Western Electric's continued role in the System.

The argument for vertical dis-integration of the Bell System is based on the assumed advantages of a theoretical competitive model with a multiplicity of suppliers dealing directly with the Operating Telephone Companies. But to paraphrase Mr. Justice Holmes: "General propositions about competition do not decide concrete cases." Neither competition nor integration is an end in itself. Each in reality is a vehicle to an end, i.e., efficient and progressive performance. Each case must be judged against this standard on the basis of its own record in its own technological environment.

Those who would invoke the theoretical competitive model would argue that the efficiency losses from divestiture of Western would be offset by the gains that they presume would flow from competition. The Bell System management, on the other hand, is certain that divestiture of Western would inevitably and substantially reduce the quality and increase the cost of telephone service to the public, and slow the System's capability of introducing new technology and services. There are many reasons for this which are developed more fully below in Parts II and III.*

One of the foremost reasons lies in Western Electric's unusual performance record within the Bell System: its cost reduction efforts, its productivity improvements and its innovative efforts. Let us consider but one aspect of this performance. Western's prices to the Bell Operating Companies for its manufactures were 10% less on the average at the end of 1967 than they were in 1950, despite the fact that in the same period its raw material costs increased by 53% and its wage levels went up 110%. In contrast, in this same period the prices for electrical machinery and equipment generally have gone up by 53%.

It is also well to keep in mind that the three telephone systems which are generally acknowledged to be the best in the world today are those of the United States, Sweden

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*It should be noted at this point that the model advanced ignores the effect of the divestiture of Western Electric on Bell Telephone Laboratories. The point is that the Bell Laboratories simply could not continue to function as effectively as it has without its coupling to Western. Its efforts would inevitably be scattered and diluted, and the backbone of its fabric ruptured. Thus, when one speaks of divestiture of Western one must also weigh carefully the consequences of such action upon Bell Laboratories as well, upon the integrated systems capability inherent in the existing Bell System's structure, and upon the telephone user. The implications of the loss of this systems capability involving the close working together of the Bell Laboratories acting with Western to meet the needs of the Operating Companies would be felt most acutely in terms of capability of future growth and innovation in the network.

and Canada, each of which has an integrated manufacturing capability. Competitive bidding has been tried abroad and, where integration does not exist, long-term requirements contracts have been substituted in an attempt to deal with the unique technological problems of telephony. Thus, experience indicates the futility of even hypothesizing the feasibility of a pure competitive model for such a technologically complex business.

The Government has encountered similar complex systems problems in the acquisition of major military systems. In discussing the procurement of these systems, Paul C. Warnke, General Counsel of the Department of Defense, recently pointed out to the National Industrial Conference Board:

> "But this (competitive) ideal is, I fear, impractical in dealing with highly complex and sophisticated weapons systems that represent major advances in the state of the art. For such systems, the creation of the multiplicity of choice would greatly increase the defense budget and could significantly delay the acquisition of the new arms we need. I recognize that it approaches heresy to say that competition ever may not be worth what it costs. But in this field, I think we would all agree that the price would be too high."
>
> -- "Competition, Antitrust and National Defense," address to the N.I.C.B., March 2, 1967, Mimeo, at p. 9.

In the final analysis, the ultimate focus in appraising the appropriateness of integration must be on obtaining optimum performance in a particular technological environment. What the reader is thus asked to consider in the case of Bell's integration is a known and proven record of performance in a highly technologically complex and dynamic environment against a classic theoretical model based largely on a static and fragmented view of the telephone network.

* * *

One further observation should be made in this prologue, lest what has been said be misconstrued. The Bell System does not attempt to, nor does it desire to, manufacture for itself everything that goes into the telephone plant or is required in its operation. The guiding principle is that the System companies purchase from outside suppliers when there are no substantial technological or economic advantages in having Western manufacture. However, for the reasons developed in this paper, the Bell System's integrated research, engineering and manufacturing arrangement make it technologically and economically advantageous to have Western manufacture most of the products that are designed by Bell Laboratories and are peculiar to the System's telecommunications business.

For instance, the Operating Companies are the single largest user of commercial computers outside of the Government. In addition to their direct purchases, such as for computers, the Operating Companies in 1967 purchased $480 million in equipment and supplies from outside suppliers through Western

Electric which were delivered without significant change. Moreover, Western purchased from outside suppliers another $735 million for raw materials, expense supplies and apparatus units and components for use in making products for the Bell System, making a grand total of outside purchases by Western in 1967 for Bell System use in the neighborhood of $1.2 billion.*

Summary of Discussion

In the sections which follow, we shall develop:

1. The major technological, economic and service imperatives of the Bell network to vertical integration.
2. The advantages of a nationwide telephone system having an integrated research, development and manufacturing capability. A central theme that emerges here is the importance of having a manufacturing organization which is run in the interests of the Operating Companies and their customers, rather than for the interest of the manufacturer itself.
3. An appraisal of Western Electric's record of performance compared with that of other manufacturers operating in related fields. In this connection, we shall discuss some of the major reasons why divestiture of Western would be injurious to the telephone-using public.

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*This $1.2 billion is about one-half of the total value of all equipment and materials delivered by Western to the Bell Companies in 1967 of around $2.4 billion.

I.

NETWORK IMPERATIVES TO INTEGRATION

> "The job of creating the modern telephone system has required the solution of problems of such deep complexity that they have no counterpart in any other industry, and for all the familiarity of the telephone itself, these problems are almost totally unknown to the general public."
>
> -- Francis Bello, "The World's Greatest Industrial Laboratory," Fortune (Nov. 1958)

The basic need to integrate research, development, manufacture and operations in the Bell System flows from the fact that the requirements and characteristics of the telephone network are, by their very nature, unique. The uniqueness of the Bell network stems from its universal service capabilities, the fact that it must operate on demand 365 days a year without downtime, its complexity, the interdependence and interconnectivity of its parts, and -- finally but not least -- its dynamism. These factors give rise to compelling technological, economic as well as service imperatives to integration.

First, Complexity and Service Capabilities

As we have pointed out, the telephone network is a vast assembly of interdependent, intricate and delicate equipment. It is the most complex assemblage of equipment in the world today. It has been called the "World's Largest Adaptive

Computer;" but even this characterization falls far short of depicting the enormity of the functions it must perform and the problems which it must overcome.

The network, for instance, must be ready at all times to make any of trillions of possible connections between each of the 102 million telephones in the country today. During a typical day it must handle between 300 and 400 million calls. Tens of thousands of connections must be set up and taken down every minute. For instance, more than 3 million people may be using their telephones simultaneously at this moment. Five minutes later, a new pattern of 3 million different people may be using the network. Complex things must be done on demand and at a very high rate of speed. To do all of this requires a web of complex switching and diversified transmission media. The network has hundreds of millions of switches and relays, millions of miles of cables and wires, hundreds of thousands of radio channels, thousands of electrical and electronic memories and route control devices, and various varieties of input and output devices -- all scattered over thousands of cities, towns and rural areas.

Despite this complexity the faint electrical impulses from a voice falling on a transmitter must find their way through this maze of equipment quickly, clearly and reliably, even though in overcoming successive losses in long distance calls their strength may have to be amplified countless times.

The network must also be capable of carrying a multiplicity of services and providing for alternate routes when needed. It must have flexibility for growth and innovation. It must operate on an around-the-clock basis, without downtime for repairs. Finally, the network must be capable of rapid restoration after storms or other emergencies.

This all places a tremendous responsibility on planning, on the selection of methods and type of equipment, and on the production of the pieces that go into this overall complex.

Second, Compatibility

A direct consequence of the complexity of this network, and of the myriad demands placed upon it daily, is the requirement for a degree of coordination and compatibility between its parts and functions which is far and away beyond that of any other industry. Specifically, each particular piece of plant regardless of its vintage or type -- telephone set, cable pair, switching equipment, carrier system, etc. -- must be designed, built and operated to work compatibly as part of the network. The sure performance of every part depends upon the quality and technical compatibility of every other part -- all must function accurately in complete unison, and in proper dynamic balance. An incompatible incoming signal or distortion of a signal by any part at any point along its intricate path, could cause interference with hundreds of other signals, adversely affect service at distant locations, tie up switching machines, cause service outages and wrong numbers, and lead to inaccurate accounting and billing information. Seemingly simple and inconsequential things, therefore, are vital in the overall scheme. Frequently, they cannot be anticipated in formal specifications but are the fruit of feedback under actual operating conditions, to be promptly reflected in changes in design or process of manufacture in order to meet "the intent of the design."

Third, Reliability

The network and each of its parts must also be reliable to an extraordinary degree, and the tyranny of numbers and variety of components (any one of which may cause a failure on one or many circuits) is so dominant that here too specifications, though useful, become inadequate. Reliance must be placed on process and materials controls, on cooperative testing, and on rapid response of laboratories and manufacturing engineers to incipient or actual field troubles. The manufacturer must comply with "the intent of the design" and meet the actual operating need regardless of the specification.

One example should suffice to illustrate the problem. A good amateur radio transmitter contains something over 100 components. So do certain carrier telephone amplifiers, though a short-haul 12 to 15 mile system in which they are used will have 12,000 components. But some of the System's long-haul systems, such as the L-3 coaxial cable system, typically contains 1,000,000 components.

Now, if it is assumed that the System can afford to have a failure rate about as often as in the amateur radio, which for obvious reasons it cannot, then it would follow in theory that the components in the L-3 system should be 10,000 times as reliable as in the amateur radio transmitter. Now it is not as simple as the theory would suggest because there are limits to quality, a point where spare paths or added maintenance become cheaper than "first cost." But whether you use a figure of 500, 1,000 or 5,000 doesn't really matter. The point is that the very large numbers of components in the subsystems in the network place the Bell System up against the frontiers of reliability.

And the problem is intensifying because the major subsystems in the telephone network are becoming more and more complex and the numbers of components in these systems are reaching hitherto unimagined levels. The new L-4 system between Miami and Washington, D. C. presently contains more than 2,250,000 components. But when filled out, the number of components in this one route alone will rise to upwards of 10,000,000.

Telephone switching, which has always been regarded as being extraordinarily complex, is growing even more complex as new electronic switching comes into more pervasive use. In view of its critical nature, this equipment is designed for an objective of two hours of downtime during its expected service <u>life</u>. By contrast, computer manufacturers generally provide for two hours downtime per day to service and maintain their equipment, and system outages measured in hours and even days are common occurrences.

In short, the Bell System cannot tolerate commercially accepted levels of reliability. This is why it must go beyond formal specifications and resort to process and materials controls, and why design and manufacturing engineers must work together closely to assure that "the intent of the design" is carried out.

Fourth, Technological and Physical Change

The requirements for compatibility and reliability are, of course, essential to obtain the most from even a static technology. But the network is also dynamic. It is subject to the rapidity of technological change, whose rate is increasing.

The nature, variety and number of different elements in the network today compared with 20 years ago almost defy description -- not just because the Bell System is continually introducing new technology and services, but because it is also constantly adding to and modifying the existing equipment to provide new and improved services. Thus technological change involves both the introduction of new technology as well as the broadening of the dimensions of existing technology.

<u>Technological change</u> in the telephone network always involves at least two critical problems. First, changes must be compatible with what already exists, or serious waste and disruption of service may result. This frequently means the modification or adaptation of existing equipment. Major examples of this include Direct Distance Dialing, Touch-Tone Calling, Centralized Automatic Message Accounting and Unigage Cable. Second, changes must be made so as not to add unnecessarily to the multiple varieties of equipment, making other future changes more difficult and costly.

Technological change in the network is far from as simple matter as might be assumed. In switching, for example, there are now at least four general types of local switching offices in use. In transmission, there are three major kinds of carriers and a number of variations on each. Messages originating at any of several kinds of stations must be switched by any type of office, carried by any type of transmission, switched by another office that may be different from the first, and received by another station that may be different too. And even this is a very simplified picture of the actual complexities. Many calls must be switched more than once; different transmission systems must interface with each other; many kinds of auxiliary equipment connect to the network to perform various functions. Thus, even the introduction of what might seem like relatively simple auxiliary services requires great ingenuity to ensure that the services can be used with as many different kinds of existing equipment as possible.*

The network is also constantly subject to still another kind of change -- the physical change of additions and of rearrangements necessitated by the growth in, and changes in demand for, service. Yet this physical change must take place without interrupting or degrading service. For example, changes are going on at this moment in about one-quarter of the many thousands of central offices and repeater stations in the network. Some large offices, as in New York City, are never free of such effort. All this is now coordinated by Western Electric, which not only has furnished the equipment, but has full records as to the location of every piece of it.

In contrast with the dynamic nature of the telephone network are the more commonly recognized electronic, military and space systems which are designed not for future modification and growth, but as basically static units, to meet present purposes and needs within a limited time frame. While a change in an electronic subsystem in one Boeing 707, for instance, does not require a change in all other commercial aircraft or even necessarily in other subsystems in the same 707, it is seldom possible to introduce a new service or a new product or subsystem into the telephone network without simultaneously

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*For instance, the recently initiated Coin Service Improvements Program which, among other things, permits the dialing of emergency calls without a coin, involves changes in 200 circuits in just one type of central office.

modifying other facilities in the existing network and without anticipating possible future developments as well.

The fact of constant growth and innovation, together with the interdependence of what is new with what already exists in the network, represent unique and critical characteristics of the network which also dictate the need for integration of R & D and manufacture with operations.

Fifth, Economic and Systems Considerations

These then are four of the principal technological characteristics of the telephone network which dictate the need for an integrated design, development and manufacturing capability within the Bell System. They are not, however, the only imperatives to vertical integration. There is always the matter of cost and economy which becomes critical in a system that is as complex as the telephone network. The economies and opportunities of scale inherent in internal manufacture require little explanation. Moreover, in a complicated system of this nature, it is the long-term annual cost of equipment that is significant, i.e., the sum of the initial cost and maintenance and repair cost divided by years of service. Thus, reliability is not simply a technological and service matter; it is also an economic imperative.

But by far the most important characteristic of the network, and the one which pervades all of the other factors, is the fact that the network can best be developed, managed and operated, both economically and technologically, as a single system. This "system" characteristic requires the closest possible teamwork among many units, working cooperatively with common goals for the combined benefit of all users of the system. And this is why Western Electric has been an integral part of the Bell System ever since 1882.

II.

THE ADVANTAGES OF INTEGRATION

> "The imperatives of technology and organization, not the images of ideology, are what determine the shape of economic society."
>
> -- John Kenneth Galbraith, "The New Industrial State," (1967) at p. 7.

* * *

> "To my mind the most exciting aspect of the systems concept is this striving to accomplish something never before possible."
>
> -- Glen McDaniel, "The Meaning of the Systems Movement to the Acceleration and Direction of the American Economy," Mimeo, 1968, at p. 4.

* * *

> "I think I am not exaggerating in claiming that for this reason (i.e., the integration of R & D, manufacture and operations) the installation cost per subscriber at the automatic telephone exchanges of the Telegraph Administration is considerably lower than in other countries, even those where the telephone industry is well developed but where there is no manufacture under the control of the operating undertaking."
>
> -- Hakan Sterkey, former Director General Swedish Administration, "Telecommunications in Sweden," Tele, 1950, No. 1, at p. 6.

* * *

The Need for Common Goals

The problems which the unique requirements and characteristics of the telephone network imply can be met -- and Bell's responsibilities for efficient, economical and progressive service properly discharged -- only through complete teamwork and free and open exchange of information and ideas. Thus, the singleness of purpose inherent in Bell's integrated structure is peculiarly adapted to the needs of the network and of the telephone users.

The main advantage of integration in the Bell System is that the agencies of research and development and of manufacture are directed toward the same goals as the operating entities. Their activities can thus be focused with those of operations on what is in the best interest of telephone system as a whole and on what is in the best interests of the telephone users with respect to the relationship between technology, service and cost.

The importance of this was recently stressed by the Select Committee of the British Parliament when it criticized the existing division of responsibility for R & D efforts between the

British Post Office and its telephone equipment suppliers. The Select Committee underscored the importance of "associating research work as closely as possible with the operation of the equipment developed" and added:

> "They (the Committee) note the advantages obtained within the Bell System in America, where the research work of Bell Laboratories is closely co-ordinated with the production requirements of the Western Electric manufacturing company but where both are completely under the same ownership and control as the operating companies."
>
> -- 1st Report, Select Committee on Nationalised Industries, "The Post Office," Vol. I, Feb. 24, 1967, at pp. 161-2.

This undivided focus on the goals of the operating entities means that the manufacturing organization is run in the interests of the Operating Companies and their customers, rather than for the narrower interest of the manufacturer itself. Since Western Electric constitutes a relatively small part of total Bell System operations, it would hardly make sense for the System to seek to optimize the lesser to the detriment of the larger part of the business, i.e., Telephone Company operations.

This running of Western Electric primarily in the interests of the Operating Companies is a unique condition -- at least to a major degree -- which is possible because of the unified structure of the Bell System. For instance, Western's contributions to the recent improvements in the TD-2 microwave system (Western lost more than $200 million in sales while the Operating Companies doubled the circuit-carrying capacity of their TD-2 system at nominal cost) demonstrate that it is not run for its own individual interests but to optimize the systems capability of the Bell network. It would be too much to expect other manufacturers, acting at arm's length, to similarly subordinate their interests.

Expanding capacity to meet long-term forecasts of growth is another area where unaffiliated manufacturers understandably operate in their own interests and not in the interest of their customers. We note, for example, that electric utilities must wait six years for generating equipment and that, according to the Postmaster General of Britain, about 80% of telephone equipment orders in Britain are running behind delivery schedule -- schedules which are, at the very least, twice the length of Western's delivery intervals. Moreover, with Western an integral and subordinate part of the System, there is no need to quarrel over whether the manufacturer complied with formal specifications while a project remains uncompleted -- as in the case of the current dispute over the electrical and braking systems for the new high-speed train between New York and Washington, D.C. -- since Western undertakes to comply with "the intent of the design" and not solely with what might be set down in formal specifications.

The present situations in the supply of electric equipment in this country and with respect to telecommunications equipment abroad are reminiscent of the earlier complaint of

Dr. Philip Sporn (former Chairman, American Electric Power Co.) about problems caused by the "obtuseness or ineffectiveness of manufacturers" of electrical equipment. ("Research on the Foundations of the Electrical Supply Industry; Load and Load Growth," The Citrene Lecture, 15th British Elec. Power Convention, Torquay, England, June 18, 1963, at p. 22.)

Outline of Advantages

The principal advantages of Bell's integration of R & D, manufacture and operations lie in five basic factors:

1. It permits a total systems approach to telephone service which could not be obtained under structurally competitive circumstances.

2. It facilitates and speeds innovation.

3. It assures the Operating Companies that their supply and logistics problems will be quickly and economically met and that there will be manufacturing capacity to meet their public service requirements.

4. It assures the necessary compatibility, reliability and quality of equipment needed for the network.

5. It provides substantial cost advantages.

1. The Advantages of an Integrated Systems Capability

It is obvious from the characteristics of the network that its innovation and growth must be a total system process, not just a series of discrete acts. Planning, research, design, development, manufacture and operations must be coordinated toward a single objective -- systems optimization. The unified relationships between Western Electric personnel and organization with the Operating Companies, Bell Laboratories and the parent AT&T, thus allow a total systems approach to telephone service which could not be obtained under structurally competitive circumstances. (For a more complete discussion of the total systems approach embodied in the Bell System structure, see J. A. Morton, "The Innovation Process in the Bell System," published by Stanford Electronics Laboratories, Nov. 1965)

With the Bell Laboratories working simultaneously for and with both the Operating Companies and the manufacturer, it is in a unique position to know the possibilities coming out of research and fundamental development for providing new and improved devices, systems, materials and methods; the needs for these things by the Operating Companies; the requirements to be met by them for use in the Operating Companies' plants; and the results which can be obtained in manufacture. All of this facilitates the optimal resolution of specific needs within the framework of the dynamics of the network as a whole.

In the process of development and design for manufacture, the interactions between service requirements and manufacturing conditions and costs can be fully weighed in the interest of getting the best balance. The materials, processes and controls to be used in manufacture can be determined on the basis of desired length of life and freedom from trouble in service. The factors of reliability and cost in use are controlling, rather than - for example - the manufacturer's concern with respect to discontinuing profitable lines or starting new ones with all their attendant problems of tooling and training. Manufacturing costs can all be taken into account in the general interest of the telephone business rather than in the immediate direct interest of the manufacturer.

Another important factor in this development procedure is the determination of the basic design which should be selected for standardization both in the interests of the Operating Companies to meet field needs and in the interests of production at the lower costs resulting from restriction of varieties. This again requires interplay, which can be most economically worked out in the development stage.

An allied matter is the determination of the steps to be taken in modifying or replacing designs. With integration, modifications can be introduced continuously as needed and complete new designs made when the system's needs or overall economies justify it. Network improvements need not be delayed or frustrated while a series of manufacturers haggle over the details and finally agree to incorporate the necessary modifications. This problem would be particularly serious in the case of network innovations such as Direct Distance Dialing which require extensive redesign and modification of existing equipment in the field, which must be implemented on a coordinated basis to assure prompt system cutover.

The biggest loser in the dissolution of this integrated systems relationship would be the Operating Companies and the telephone user. The loss would be felt most acutely in the capability for future growth and innovation in the network. It is important to recognize that the communication revolution is really only starting as Picturephone service and other broadband uses of the network, such as Dataphone service, become more widespread. Substantial modifications in the network will need to be made. If these changes cannot be made effectively at minimum cost, with maximum integration of effort, it is the telephone user who will ultimately suffer the most.

2. Integration Facilitates and Speeds Innovation

The constant development of new and improved equipment is a basic cornerstone of the Bell System's ability to perform its service undertaking properly. Every function, subsystem, and component part of the network is subject to attention at Bell Laboratories. It is a dynamic process that never ceases. As soon as an instrument, a subsystem, a component or a function has been improved, the quest begins all over again for further improvement.

The magnitude of the effort to bring on line new and improved products is indicated by the fact that during the year 1967 Western Electric funded $261 million for development and related engineering (including Bell Laboratories development activities), for new and improved products for the Bell System. Over the last ten years, 1958-1967, a total of $1.64 billion was expended for this purpose. These figures exclude R & D on government work, as well as the basic research and related activities funded directly by AT&T (see p. 31 below).

These efforts have led to the rapid development and introduction of a proliferation of facilities which have permitted new and improved services:

Carrier. In the short haul carrier equipment field, Western has successively introduced since 1950 the N-1, ON-1, ON/K, N-2, N-3 and T-1 (digital) systems and has the T-2 and other advanced digital systems under development. In the long haul carrier field the complex L-3 and L-4 coaxial systems have been introduced since 1953 and the L-5 system is now under development.

Microwave. Similarly in the short haul microwave field Western has introduced TJ, TL-1, TL-2, TM, all since 1955. In long haul microwave, also since 1955, have come interstitial TD-2, TH, TD-3, TD-2A, TD-2B and TH-3.

Switching. In switching have come DDD, CAMA, LAMA, ANI, Centrex service, ESS No. 1-2W, ESS No. 1-4W, Custom-Calling services, the 1A1 Concentrator, TSP, a proliferation of PBX's (756, 757, 758, the 800 electronic and the 101 Time Division Switching) -- all since 1950. ESS No. 2, TSPS, electronic appliques for Crossbar and other advanced switching systems are now under development.

Stations. In the station field, since 1955, have come the Call Director, the Princess telephone, Touch-Tone Calling, repertory dialers, Picturephone service and the Trimline telephone, and a new electronic telephone set is presently under development. Picturephone service and Touch-Tone Calling, of course, involve major changes in the network and not just the development of new pieces of station apparatus.

Cable & Wire. In cable and wire have come PIC cable, electro-formed wire, self-supporting cable, PVC central office cable, Ready-Access terminals, the B-wire connector, D-wire and Unigage, all since 1950, and the development of a new Corax cable is now nearing conclusion. In addition, in the same time frame, there have been several generations of overseas cable and related developments: SA, SB, SD, the SF transistorized cable and TASI.

Data. In the data field, in addition to digital transmission systems, has come Dataphone service which was introduced on a general basis in 1958. Since then several hundred different data sets have been developed and introduced, covering a wide range of speeds, signal format, coupling and auxiliary features. Of these, 78 have already been discontinued and displaced by more advanced and more economical models. By the end of this year, 156 new codes will have been introduced in the past two years alone. The new models being introduced will cover still further applications at substantially increased speeds.

This list is far from a complete enumeration of even the major developments that have emerged in recent years from development; it does not include, for example, any of the major device or component developments nor does it include the Telstar satellites. It simply serves to show that the rate of introduction of new facilities has been substantial in its magnitude and pervasive in its scope, and that there have been a steady flow of major improvements in the art that have made possible many new and improved services.

The impact of this development effort may also be illustrated in terms of its effect on Western's sales. It is expected, for example, that 65% of Western's sales in 1970 will be for new products introduced during the 1960-70 period. In comparison, only 35% of the products manufactured in 1960 were introduced in the 1950-1960 span. Thus the rate of product change has almost doubled in recent years. The rate of the introduction of new products by Western Electric, both in the past and as projected for the future, is well above the average for the manufacturing industry in general, and the prospect is for still further acceleration in the rate of change.

It is in the development phase of the innovative process, at the threshold between idea or invention and practical application, that the advantages of the close association among the Bell System units come into clearest focus. It is here that intimate collaboration between development and manufacturing people is absolutely essential. The design engineers must be thoroughly familiar with shop problems, and indeed help develop new manufacturing techniques. Conversely manufacturing engineers contribute vital improvements in designs that can be produced effectively and cheaply. This relationship requires a complete community of interest, unimpeded by either patent considerations or bargaining complications. An effort to use outside sources of supply would at best create conflicts resulting in delays and increased costs, and at worst make it impossible for the System to obtain improved equipment of the desired type and quality.

The contributions of Bell Laboratories to the development process are well recognized. (See Bello, "The World's Greatest Industrial Laboratory," Fortune (Nov. 1958).) But the key role of Western Electric in innovation is often overlooked, even though its efforts have been instrumental in speeding the transition of new developments from the drawing board to the production line. In a non-integrated environment, innovation customarily follows a phase-by-phase progression, with one phase completed before the next phase is begun. Because of Western's close association within the Bell System, these steps can proceed concurrently, accelerating the pace of innovation. At all times, Western knows intimately the direction which development is taking and can both expedite production and develop appropriate manufacturing methods and techniques in a coordinated way. It can start production before designs are set and thereafter make changes and eliminate troubles without contractual involvements and delays. Its centralized records of all the existing telephone plant furnish guidance and complete technical information in planning for and executing additions to, or changes in, existing plant. These advantages are consistent only with internal manufacture.

This close collaboration between the product design and manufacturing functions is becoming increasingly vital with the advent of the new generation of equipment based on the transistor, integrated circuitry and microminiaturization, where product designs are becoming increasingly complex and are dependent on materials, and must be defined to a large extent in terms of the required manufacturing processes.

One of the major advantages here lies in the fact that Bell Laboratories' product development engineers are geographically located at Western Electric's major manufacturing locations, where they work in tandem with manufacturing engineers to speed the introduction of new and improved designs. Obviously, it would unreasonably tax Bell Laboratories' resources if it had to work this way with many manufacturers on each new design, nor could a standardized design emerge economically and readily which would be tailored to the varieties of manufacturing processes among manufacturers.

Another significant interchange between the design and manufacturing engineers occurs through the Western Electric Engineering Research Center located at Princeton, New Jersey. The aim of this center is to do research into new manufacturing processes and methods of significant applicability to the Western Electric. The relevance to this activity of oncoming designs in Bell Laboratories is clear and pressing; the degree of collaboration is high. For example, while developing thin film integrated circuit technology, Bell Laboratories' engineers developed a process for producing thin film components in a manner suitable for laboratory use. Concurrently, Western Electric engineers evolved a continuous production process for large-scale production before the design of a thin film component for specific application was completed and the feasibility of the technology fully established. This type of collaboration is a way of providing for the future before that future has become the present.

There are many other evidences of the way in which close collaboration between Bell Laboratories and Western has permitted the telescoping in time between a useful idea and its application. For instance, the new, solid state, L-4 coaxial cable system was developed and placed in service in only 45 months, including the time required for trenching and installation, to meet the needs of a new hardened system on the east coast and at an annual savings to the Long Lines Department of $30 million over existing alternative possibilities. The magnitude of this accomplishment in such a short time frame is indicated by the fact that the system is extremely complex and will use upwards of 10 million electronic components when fully equipped for carrying 32,000 conversations simultaneously. Unique problems of reliability and transmission had to be overcome and yet the system had to be available to meet the service date specified by Long Lines. This was accomplished only by the closest possible collaboration of the Bell Laboratories-Western Electric team at the Merrimack Valley Works and by commencing production well before the final designs were available.

The introduction of electronic switching and digital transmission systems provides still further examples. Electronic switching, which represents the largest single technological development ever undertaken by private enterprise, involved the successful resolution of stupendous problems. By the end of this year, more than 70 electronic offices will be in service. In contrast, there are only a few small prototype electronic offices in use today elsewhere in the world. Similarly, while

Bell introduced the first digital transmission system, T-1 carrier, into service in 1962, and will have more than 400,000 T-1 channels in service by the end of this year, foreign manufacturers and telephone administrations now are just beginning to introduce such systems. In the meantime, Bell Laboratories and Western are at work on second and third generation digital transmission systems with far greater capacities and operable over much longer distances which will be coming into service in the next few years.

Finally, any reference to innovation would not be complete without consideration of the interaction between the product development engineers at Bell Laboratories and their basic research and systems engineering associates. The Bell System is unique among industrial concerns in the degree to which it undertakes these basic activities. Last year alone AT&T funded $89.5 million for research, fundamental development and the systems engineering activities at the Bell Laboratories. In the 10-year period, 1958-1967, the total exceeded $675 million. From these activities have come the transistor and many of the other discoveries that have made possible present-day electronics.

Bell Laboratories' research and fundamental development specialists are constantly looking to the future and have already established, in broad outlines, the feasibility of still further revolutionary possibilities. Many of these are now simply ideas in search of a use; they need only an economically justifiable application. Thus, as demand is anticipated or needs develop, a useful idea or theory is already likely to be available for a new product development. This was the case in television transmission, in microwave and in satellite communications, and it will be the case when waveguides and lasers become economically useful as new transmission media. This ability of the development specialists to draw on their research associates is another important factor that assures that advanced concepts will be introduced into technology just as soon as they are economically justifiable.

In summary, Bell's integrated structure and its ties between R & D, manufacture and operations have greatly facilitated a rapid progression of new technologies into the network. Its record of accomplishments proves it and no effort to rewrite history can change that.

3. Integration Assures that the Demand for Telephone Equipment Is Met Promptly

The service the Bell System furnishes requires that its operating plant be extended to meet the public demand, even though conditions are not such as to induce the requisite expansion of capacity by an outside manufacturer of telephone equipment. At present, the System has a manufacturer completely devoted to fulfilling that duty, without being tempted to schedule its production so as to maximize its own profits.

Western has knowledge of estimated Operating Company requirements, organizes and tools up accordingly and begins production far in advance of actual orders and without assurance that the estimated requirements will materialize. Outside competing suppliers could not foretell the demand on them unless contractually assured of definite business, and would be reluctant to invest money to meet even predicted demands for the specialized equipment required for telephony without contractual protection.

The demand for telephone equipment is a derived demand and highly sensitive to the rate of acceleration or deceleration of the demand for telephone service. Hence the demand for telephone equipment is highly volatile and highly responsive to general economic conditions. This presents not only the problem of scheduling particular types of equipment, but a vastly complicated problem of coordinating the availability of the various types of associated central office, outside plant and subscriber equipment which must all operate together or be useless. Western must and does make available maintenance and repair parts required in small quantities for old equipment still in service but no longer manufactured. It must and does devote its full resources to rapid replacement of equipment in time of emergencies. The introduction of competing suppliers into this complex and variable picture would seriously impair the System's ability to carry out its public duty.

The importance of this is underscored by the situation that exists throughout the rest of the world where the telephone systems do not have manufacturing affiliates. Held orders and no-circuit conditions are the rule and not the exception as in this country. Indeed, in some of the most industrialized nations waiting lists of two or three years are commonplace; toll service is depressingly slow and its quality inferior due to overloading. It is not surprising, therefore, that foreign telecommunications administrations frequently visit and consult with Western Electric to ascertain why its shipment intervals are consistently so much shorter than they themselves can obtain from their suppliers. The answer lies in Western's unique commitments to its sister companies.

The situation in Great Britain is typical and has led to a general Parliamentary investigation of procurement practices and of the structure of the General Post Office, which operates the telephone system. Standard procurement intervals in Britain for complex switching equipment are generally at least double, and in some cases quadruple, the interval quoted by Western. And yet as the Postmaster General, Edward Short, recently pointed out, "1,350 out of 1,700" major contracts have fallen behind agreed delivery dates. (Electronics Weekly - British, Feb. 14, 1968) In contrast, Western Electric typically quotes a one-year interval from receipt of an order for engineering, manufacture and installation for its most complex equipment.

Obviously, it cannot manufacture such equipment and tailor it to local traffic requirements in such a short span; it must start the purchase of raw materials and components, as well as the manufacture of devices and subassemblies, far in advance of the actual receipt of the order. It does this because of its role in the System and with full realization that the long-term forecasts may not in fact materialize in the form of hard orders. This is illustrated by the fact that Western recently geared up to produce the new TD-3 microwave system, only to see the bottom fall out of the market because of the dramatic improvements in the circuit carrying capacity of the existing TD-2 facilities.

One need not only look abroad for evidence of contrasting performance; it also can be found domestically. Unaffiliated manufacturers, as for example in the electrical equipment industry, often wait for hard orders to materialize, and back orders of six years are now the general rule for generating equipment. As a result, the electric utilities must wait to have current needs met and must make hazardous estimates of their needs six years from now to be sure of the generating capacity adequate for customer demand.

In commenting on this situation Nucleonics Weekly, a McGraw Hill publication, cited the fact that "Nuclear plant lead time is now nudging seven years," and quoted an"unidentified utility executive who warned that 'anyone who commits himself seven years ahead of operating date is foolish.'" (Gene Smith "Equipment Needs of Utilities Rise," N.Y. Times, Feb. 6, 1967, at pp. 41 & 43.) In contrast, the Bell Operating Companies obtain their major equipment generally within a year or less of their orders, and can wait until the need for capital equipment is reasonably clear before making contractual commitments.

But situations such as in the electric industry are not just a matter of economics and orderly planning; they sometimes lead to basic breakdowns in existing service. Indeed, the Federal Power Commission attributed the recent rash of electric power failures in the Northeast and Middle Atlantic areas in part to "manufacturing delays." (Report by the Federal Power Commission, March 1968, at p. 54.) The fact that telephone service continued throughout these blackouts and helped to avert more serious public consequences is further evidence of the value of its integrated system capability.

4. Integration is Necessary to Obtain the Required Quality of Equipment

Quality, in the sense both of the ability to give the best service and of the ability to give that service throughout a long, trouble-free life, is of fundamental importance in telephone equipment in order to assure continuity of service and lowest life cost. Western, because of its common service objective and long training and experience, is extremely quality conscious. Moreover, its quality standards are established by Bell Laboratories in the interest of the Operating Companies, and its operations are inspected and its product checked by the Laboratories. There is no resistance to changes in methods of manufacture while the process is going on. The complete intermingling of design and manufacturing engineers enables the latter to carry out the true intent of the design in a way that could never be translated into specifications. These procedures, together with specialized machinery and highly precise control of the manufacturing process, are necessary to obtain quality in the only sure way for equipment of this type. This cannot be obtained by merely inspecting the finished product of competing outside suppliers.

It is obvious that if other manufacturers were to bid on the production of an equipment or subsystem after development and preparation of manufacturing specifications have been completed, the Bell Laboratories would be presented with the monumental task of evaluating the many critical components the supplier would propose in place of the specific units used in the development work and laboratory model. The substitute components would, of course, be represented as equivalent in external characteristics and performance to those used in the original design. But external measurements and even life tests cannot assure equivalence in the critical items required for the network. In addition, the whole manufacturing procedure and processes must be thoroughly investigated along with the materials employed, which outside suppliers would tend to resist.

5. <u>Cost Advantages of Integration</u>

The advantages of integration discussed above also have a direct and favorable impact on Bell System costs. Integration makes possible cost savings at all levels of the enterprise and at all stages of the procurement process -- in the design of the product, in the scheduling of production and in the introduction of new equipment or services, in the economies of scale in manufacture, in the economies of transfer and distribution, and in the cost of operating and maintaining equipment in its day-to-day use in the Operating Companies.

<u>Economies in design</u>. Bell Laboratories and Western Electric engineers work closely together at major manufacturing locations, unrestrained by patent, trade secret, commercial or other considerations, to assure that new product designs represent maximum value, in terms of performance and cost, to the telephone companies. This is accomplished by: (a) designing to assure minimum total life cost to the Operating Companies considering the costs of manufacture and maintenance and the extent of trouble-free product life, (b) designing to incorporate where possible existing standardized components and subassemblies to fully utilize existing facilities and manufacturing expertise, and

(c) meeting performance needs with designs which most fully exploit advanced methods of manufacture.

Economies in scheduling. Manufacturing capacity is geared to System needs and commitments are made in advance of demand; and production and major system cutovers are planned, scheduled and coordinated to achieve maximum System economies. Equipment engineers and installers are assigned to the work of different Operating Companies to meet their fluctuating demands throughout the year, thus making most efficient use of specialized personnel. Major new subsystems with significant cost reduction potential in the field, such as the new L-4 coaxial cable system, can be speeded into use by the development of new manufacturing processes and by commencement of production before designs are set. Moreover, Bell Laboratories' design changes to meet Operating Company needs are promptly implemented in equipment already in production without waiting for model changeovers as is the usual commercial practice, and without delays resulting from contract amendments and price redeterminations in advance.

Economies in manufacture. Integration makes possible economies of scale in manufacture and creates maximum opportunities for cost reduction at virtually every component level. It avoids unnecessary duplication of engineering and capital investment in production and testing facilities and in product inventories in process, which would ultimately be reflected in equipment price levels. These advantages are reflected in the low cost of equipment.

<u>Economies in transfer</u>. Integration permits substantial economies in purchasing and distribution of equipment. Centralized purchasing and warehousing permits the most efficient use of manpower and facilities and the maintenance of minimum field inventory levels to meet daily and priority needs. Integration permits the rapid and economical transfer of men and materials on a nationwide basis to meet special service needs and to deal with emergencies. Sales, advertising and product inspection costs are kept to a minimum and wasteful product differentiation unrelated to real Telephone Company needs is avoided. All of this reduces expenses and capital investment while assuring effective and efficient logistics management to meet the needs of the Operating Companies.

<u>Economies in operation</u>. There are substantial economies in the operation and use of equipment in day-to-day operations. Equipment is designed with emphasis upon low operating cost and low maintenance and repair cost. The standardization made possible by integration reduces training costs and permits the use of uniform operating methods and practices in engineering, installation, maintenance, and repair. Minimum redesign and facility modification and testing costs are needed to accommodate the introduction of new facilities and services into the network. Standardized equipment drawings which can be centrally maintained by the manufacturer also permit the rapid and economical engineering of additions and modifications of central office equipment.

All of these savings, whether in initial cost of the equipment or in the operating costs of the System, are passed on to the telephone-using public or help to offset rising labor costs which would otherwise necessitate rate increases.

* * *

To recapitulate, the integrated structure of the Bell System is dictated by the unique characteristics of the network. The advantages which this integration afford are compelling; they could not be obtained if arm's length bargaining were substituted for the integrated manufacturing capability provided by Western Electric. The ultimate beneficiaries of these advantages are the users of telephone service, who thereby obtain better service at lower cost.

III.

PROVEN PERFORMANCE VS. ABSTRACT THEORETICAL MODELS

> "In truth, (we) can be almost completely envious of the American telephone system whose public service, while not guaranteed by doctrine, functions, in fact, with a speed and reliability which leaves nothing to be desired."
>
> -- Raymond Cartier, "Where Does France Stand?", Paris-Match (Dec. 2, 1967)

* * *

> "At a time when a telephone investigation is making news in the U.S., telephones abroad are making news for a different reason--delays, breakdowns, inadequate equipment. This report from 11 countries shows what foreign phone users put up with."
>
> -- U.S. News & World Report, March 14, 1966, at p. 98.

* * *

In appraising Bell's integrated structure, the ultimate question comes down to the consideration of a known and proven record of performance in a technologically complex and dynamic environment against the assumed advantages of a classic theoretical model -- a model which is based on a static and fragmented view of the telephone network. By this we mean "static" in the sense that it assumes that designs can be frozen and "fragmented" in the sense that it assumes that each piece of equipment may be considered independently of the system of which it is a part.

We have already seen that these assumptions are ill-founded. The network by its nature is dynamic. Designs, therefore, cannot be frozen; they must be constantly changed and adapted to new needs. Moreover, we are not dealing here with the manufacture of products in the usual sense, but with the manufacture of equipment which constitutes the subassemblies, components and piece parts of a complex mechanism which must be developed, operated and maintained as a single system. But let us place to one side the real world of telephony and consider performance for performance sake.

In the absence of an actual model of what performance might be if Western Electric did not exist as part of the Bell System, an obvious approach would be to look at actual performance in related areas of our economy and in the telecommunications systems abroad.

Telephone Company Performance

In view of the general interest in the FCC general rate investigation, we will focus first on interstate services. Interstate telephone rates, of course, have come down steadily. Thirty years ago, the charge for a weekday, three-minute, coast-to-coast call was $6.50. Today, the same call may be made for $1.75 weekdays and for $1.00 nights and weekends. In the aggregate, interstate rates are down by 24% from pre-World War II levels (1940-1967), compared with a 142% increase in the cost of living, while average hourly earnings have gone up by 300%. In the past five years alone there have been major interstate rate reductions of $79 million in 1963, $159 million in 1965, $100 million in 1967 and $20 million in 1968. These reductions, of course, equate to even greater amounts at today's volumes of business.

Overall telephone rates (local and long distance) have gone up by about 10% over prewar levels, only a small fraction of the increase in the cost of living. At the same time, substantial service improvements have been introduced and the usefulness of the service has been greatly enhanced -- calling areas have been expanded, direct distance dialing introduced and the speed and quality of service improved. The hours of work by factory employees, required to pay for one month's individual local residence service with 100 local calls, has declined from six hours to less than two hours. The relative cost of telephone service in terms of the required work hours in the 56 major cities of this country is substantially less than in other countries, with only Stockholm and Ottawa approaching the United States figures.

This did not come about by happenstance. The answer lies in three factors:

> First, the intense and collaborative efforts of Bell Laboratories and Western Electric in bringing on line a rapid progression of technological advances over the entire range of telecommunications, both in the form of new facilities and in the improvement of existing technology.
>
> Second, intensive cost reduction efforts by Western Electric, coupled with its extraordinarily high rate of productivity improvement, which have permitted Western to reduce the prices of its manufactures while the prices for other electrical equipment have risen substantially.
>
> Third, improved productivity of the Operating Companies brought about by the introduction of many automated systems (such as DDD, LAMA, CAMA, ANI and TSP), new low maintenance products (such as ESS, new station apparatus, PIC cable, etc.), and many labor-saving devices and features (such as Ready-Access terminals, B-wire connectors, even count PIC cable, self-supporting cable, D station wire and quick connect terminals) which have all helped to offset substantially increased wage rates.

The impact of the rapid introduction of technological advances may be illustrated by the substantial reduction in the average book cost per circuit mile. The average Long Lines' book cost per circuit mile was about $150 in 1940, whereas it has declined to about $20 today. This certainly is evidence of the rapid pace of technological innovation as well as of the effect of Western Electric's cost reduction efforts, and serves to explain why interstate toll rates have gone down so dramatically.

The effect of the introduction of new technology on productivity in the Operating Companies may be illustrated by a study recently completed by Dr. John Kendrick of George Washington University. ("Productivity Trends in the U.S. Private Economy and in Public Utilities, 1948-1966," a paper read at Iowa State Univ., April 24, 1968.) According to Dr. Kendrick's study, the average annual improvement in total factor productivity in the telecommunications sector from 1948-1966 has been 3.8%, or slightly in excess of electric and gas utility industries. This is well in excess of the national average of 2.4% found by Dr. Kendrick for the private domestic economy for the same period. But this does not tell the whole story since during this period of time a steady flow of new and improved products were introduced and new services offered to the public which are not reflected in improved productivity.

Innovation: New Products and Processes

Since this paper is concerned primarily with Western's role in the Bell System, let us also consider the magnitude of the pace of technology as it relates to Western.

Western Electric is in the crossfire between the increasing demands of the Operating Companies for new and low-cost products and services and the prolific innovative capabilities of the Bell Laboratories. These pressures have had a pronounced impact on Western Electric and its performance and on the volume, quality, speed and low cost of telephone service in the United States.

First. 43% of Western's 1966 Bell sales of its manufactures represented products of a new design since 1961, whereas a recent National Industrial Conference Board survey of 223 manufacturers shows that 20% of their 1966 sales consisted of new products first marketed within the same five-year period. By 1969 it is estimated that 25% of Western's Bell sales of its manufactures will consist of products of new design since 1965, whereas a recent McGraw Hill survey shows that the average for all business will be 15%, with only the aerospace sector exceeding Western's percentage.

Second. In 1967 Western's R & D expenditures amounted to $261 million on its Bell sales. On a National Science Foundation definitional basis, which permits comparisons with other industries, Western spent annually, in the period 1960-1966, 5.2% of its Bell sales on R & D.* This compares with company-

*Taking into account AT&T funded Bell Laboratories' efforts this figure comes to approximately 6.5%.

financed R & D expenditures of less than 2% of total sales for all manufacturing industries, and 3.5% for the communications and electronic equipment industry, excluding Western Electric.

Third. The benefits of this innovation have not been kept closeted for the Bell System's exclusive use, but have been broadly licensed to all comers on a non-discriminatory basis. This policy has opened to others many of the basic inventions underlying present-day electronics, such as the transistor, while at the same time it has permitted the Bell System to incorporate into telephone technology developments which emerge from other sources. The practice then has permitted a diffusion of Bell's knowledge to others and permitted the telephone user to benefit from useful ideas generated by others.

So much for innovation in terms of new products; what about systems benefits from innovation in the manufacturing process itself and in the form of cost reduction?

Fourth. Here again, Western is at the forefront of industry. There is strong and vigorous competition in cost reduction between Works locations, within product lines (e.g., crossbar vs. ESS) and between product lines (e.g., coaxial cable vs. microwave). Western's formal cost reduction program is universally acknowledged for its accomplishments and has been the model for many manufacturing efforts in this field. Its

Engineering Research Center at Princeton is unique among manufacturing enterprises, both in the fact of its existence and in the magnitude of its accomplishments. From this Center and from elsewhere within Western and Bell Laboratories has come a steady flow of major "process" breakthroughs: needle bonding, hydrostatic metal forming, continuous casting of copper, fundamental studies and development of a detailed quantitative model for extrusion processes, high pressure and temperature crystal growing methods, continuous in-line process for the manufacture of thin film integrated circuits, basic processes for the manufacture of Stalpeth cable, the first manufacturing applications of laser.

Fifth. The effect of these efforts, both at Princeton and through the Company-wide cost reduction efforts, may be illustrated by the fact that the first year savings from cost reduction in 1967 amounted to $40 million -- a record high. The significance of this cost consciousness can also be seen in its cumulative effect. The annual effect in 1968 of the engineering cost reductions introduced during the past ten years will amount to some $243 million.

The benefits of these cost reduction savings pervade the entire range of Western's products and have been helpful in driving Operating Company costs down.

Western Electric's Outstanding Price and Productivity Performance

First. Western's prices for its manufactured products are, and have been, on the average, about 50-60% of those available elsewhere. Studies show that this condition exists with respect to the whole cross-section of Western's products, and with regard to high volume as well as low volume products.* The price for its basic telephone set, for instance, is less than the price which electric appliance manufacturers charge their major wholesalers for toasters, waffle irons and percolators -- and this despite the fact that a telephone set is a far more complex and intricate piece of equipment.

Second. On the profit side, Western's profits on its Bell business have averaged lower than other large manufacturers. Western's return on investment in the postwar period (1946-1967) has averaged 9.3% on its Bell investment compared with 12.3% for the 50 largest manufacturers. Its profit per dollar of sales has averaged 4.7¢ compared to 6.1¢ for the 50 largest manufacturers. Western's rate of return on invested capital (equity) in 1967 ranked 341st on the Fortune 500 list.

Third. In the period 1950-67, Western's prices for its total manufactures were down by 10%, whereas its wage rates were up by 110% and the level of its raw material costs were up by 53%.

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*Misleading comparisons have sometimes been made between Bell System tariff rates for Western Electric manufactured data sets and the prices for modems of other manufacturers, overlooking the fact that the tariffs rates include installation, circuit conditioning, maintenance, and other related operating costs.

<u>Fourth</u>. In the period 1950-1967, Western's prices for apparatus and equipment <u>decreased</u> by 16% as compared with an <u>increase</u> of 53% in the Bureau of Labor Statistics price index for electrical equipment prices generally. Western's prices for cable and wire over this period increased by 14%, compared to a 95% increase in the BLS index for cable and wire. Over the period 1950-1965 (after which no published data is available) the level of General Electric's prices was <u>up</u> 13%, while the prices for Western's total manufactures were <u>down</u> 14%.

<u>Fifth</u>. Western's average annual improvement in productivity in the period 1948-1966, using the total factor productivity methodology of Dr. John Kendrick, has been approximately 5.5%, or about twice the annual improvement for the electrical equipment industry, and more than twice that of the private domestic economy and the manufacturing sector. If Western had achieved only the average annual improvement in productivity realized by other electrical equipment suppliers, the Bell Operating Companies would have paid several billion dollars more for the equipment they purchased in the postwar period and rates for telephone service would have been significantly higher.

<u>Sixth</u>. Approximately 60% of this improvement in productivity has gone to labor in the form of higher wages; the remainder has gone to suppliers in the form of <u>higher</u> raw material and component prices and to the Operating Companies in the form of <u>lower</u> prices for Western's products.

The remarkable achievements indicated by these data just did not happen. In large measure they are the result of the coordinated efforts within the integrated structure of the Bell System to achieve maximum efficiency and economy in providing the new and improved telephone plant which the Bell System must have to meet its public undertaking.

Adverse Effects of Divestiture on Telephone Service and Costs

In view of what has already been said, it is obvious that divestiture of Western Electric would forfeit the proven advantages of integration for the speculative advantages of a theoretical competitive model.

There is a wide gap between theory and actuality. As Mr. Justice Holmes has said: "A page of history is worth a volume of logic."* The proof of the pudding must be in the eating and not in speculation. By all objective standards, Western Electric's performance has been more in accordance with the results postulated under the theoretical competitive model than the empirical data indicate for the general market place. Western's basic costs are up but its prices are down, its productivity is outstanding in industry, and it spends more on R & D than companies in related businesses. The rate and effectiveness of its innovation and cost reduction efforts have

*New York Trust Co. v. Eisner, 256 U.S. 345, 349 (1921).

made possible communications services of increasing variety and sophistication at lower cost.

The Bell System's outstanding record of innovative progress has resulted from the continuing exploration and adoption of many diverse technologies, through the wide-ranging work of Bell Laboratories, the cross licenses obtained from other companies under the System's patent licensing program, and the large volume of telephone and other products purchased from outside manufacturers. Scientific, engineering and capital resources are too scarce to permit the luxury of rejecting new ideas from any source that will help increase system revenues, improve service and reduce costs. The System's continuing search for new approaches and ideas is reflected in the impressive and unparalleled diversity of equipment in the network. Moreover, the availability of Bell System patent licenses and technical information to other manufacturers not only helps them supply domestic markets and sell abroad, but contributes further to the ever-increasing pool of knowledge on which continuing innovation depends.

It might be helpful to recapitulate at this juncture some of the major adverse effects that would result from divestiture which have been brought out earlier in this paper. These adverse effects occur in various areas: in research and technical advances, in production and procurement, in the quality and continuity of service, and in the effectiveness and economy of day-to-day Telephone Company operations. They all add up to poorer service to the public at higher rates.

1. In the event of divestiture, the Bell System could not collaborate in research and development with competing manufacturers as it now does with Western and the time span required for the introduction of new equipment would be significantly lengthened. Bell Laboratories' product development engineers would have to be withdrawn from Western Electric plants and Bell Laboratories would have to maintain an arm's length relationship with a number of manufacturers. Manufacturing specifications for thousands of items, including complete dial central offices, would have to be prepared without manufacturing assistance or advance knowledge of the manufacturing facilities to be employed. The whole process of adapting new designs to manufacture, with the inevitable modifications to meet particular manufacturing facilities, would only then commence, fettered by contractual commitments to original specifications. Further, the time-consuming period of designing and producing new manufacturing machinery and tools would not start to run until the contract was actually let.

2. Terminating the close collaboration between Bell Laboratories and Western Electric would eliminate the possibilities for cost avoidance and manufacturing economies which are now so effectively exploited by them during the design development stage. If Bell Laboratories tried to establish a similar relationship with an outside supplier in developing a particular item, it

would give him an unfair competitive advantage; if the Laboratories worked with all potential suppliers, its costs would increase through duplication, its efforts would be scattered and its effectiveness would be diluted.

3. <u>In addition to crippling the development process itself through loss of collaboration with the manufacturer, the rate of introduction of new and better equipment, once it was finally developed, would be greatly retarded</u>. It is to be expected that in many product lines independent manufacturers would resist replacement of existing types of products, which they were already producing in quantity at a profit, by newly developed and more advanced designs. Moreover, the frequent engineering changes in design required during the course of manufacture by Bell Laboratories to meet Telephone Company needs would be difficult and costly to arrange.

4. <u>The ability of the System to respond rapidly to the increased demand for service would be seriously impaired</u>. Upsurges in public demands for telephone service such as those which have been experienced several times in the postwar era could not be met with speed and efficiency. If several manufacturers were competing for the business, and no one of them could be assured of any specified quantity of business over an extended period, they would be unwilling to risk major capital expenditures to meet peak demands. In consequence, not only would there be a seller's market when the System's requirements for equipment were heavy, but the system would be seriously handicapped in fulfilling its obligation to meet public demands for additional service.

The experience of the electric utilities here and telephone administrations abroad with delays in equipment deliveries indicates that held orders and busy conditions would increase substantially. Western Electric anticipates Bell System orders and makes commitments and initiates manufacture well in advance of firm orders from the Operating Companies and, in the case of new products, before final designs are fixed. Unaffiliated suppliers would not have Western's motivation to assume such risk with the result that delivery intervals would be considerably increased. Also, purchase negotiations with unaffiliated suppliers would introduce protracted delays due to the complex nature of orders for telephone equipment.

5. The advantages of standardization of telephone equipment made possible by integration would be lost. If equipment had to be procured from different manufacturers, each promoting its own designs, seeking to substitute its own components, and employing different types of facilities and manufacturing methods, there would be constant pressure to break down the present system-wide standardization. As discussed above, standardization permits opportunities for substantial manufacturing economies, uniform methods and practices in engineering, installation, operation, and maintenance, and greatly reduces the quantities of equipment and parts which must be kept in stock. Standardization also plays a vital part in the speed of restoration of service in times of major disaster since equipment

and labor skills can be effectively mobilized on a nationwide basis. More interruptions in service would result from the breakdown in standardization and because requisite quality levels could not be assured.

6. The proliferation of product designs would increase costs, delay innovations, and create serious problems of coordination. Engineering, field test and related costs to assure compatibility would multiply as the number of suppliers' products in the network increased. The introduction of new services and equipment to meet changing customer needs would inevitably be delayed while negotiations proceeded with each manufacturer to determine whether, when, and at what price it would undertake necessary modification of existing network facilities of its manufacture. This problem would be especially acute where major network innovations and system-wide cutovers are involved.

7. The advantages of Western Electric's efficiency would be dissipated. Western's manufacturing capacity and schedules are geared to the estimated requirements of the Operating Companies. Today it manufactures about 200,000 different piece parts, 30,000 types of apparatus, and more than 100,000 equipment items. Production of this material to meet the varying needs of each Telephone Company is planned and scheduled to achieve maximum manufacturing efficiency. Integration also provides maximum opportunity for cost reduction and economies of scale. Further, by serving all the Operating

Companies and shifting engineering work and installation personnel to meet their fluctuating demands, Western is able to maximize efficiency and realize additional economies. Finally, since Western does not solicit outside business, sales costs and distribution expenses are kept to a minimum.

The economies which are so achieved go to reduce the cost of the telephone plants of the Operating Companies and the investment on which they are entitled to earn a return, and hence to keep down the rates paid by the telephone-using public. The divorcement of Western would inevitably have the opposite result, increasing telephone costs and telephone rates.

8. <u>Production for the benefit of the customer would be replaced by production for profit to the detriment of the Telephone System</u>. Outside manufacturers would tend to schedule production so as to maximize their own profits. The small lot production required for replacement parts would be difficult and costly to arrange and thus leave expensive telephone facilities idle. Contracting for equipment through bids would invite short-cutting of the quality the System needs, with disputes and likely litigation. The present assurance of high quality levels of equipment, gained through Bell Laboratories' assistance and surveillance could not be maintained since outside manufacturers would be reluctant to subject their production processes and output to the veto control of Bell Laboratories. Cost reductions achieved during manufacture would be retained by the supplier

in the form of higher profits and would not be passed on to the Operating Companies in the form of lower prices during the course of the contract.

9. If the Bell System relied upon a multiplicity of suppliers, price levels will reflect a seller's market or an uneconomical duplication of manufacturing facilities. Unless the combined capacity of all potential sources of supply was greater than total Bell System needs, the System would be forced to take the full production of each supplier. A competitive environment would be lacking and the System would be purchasing in a seller's market. On the other hand, if divestiture contemplated a number of suppliers each with adequate production capacity to meet Bell System needs, there inevitably would be a substantial and uneconomical duplication of investment in manufacturing facilities which would be reflected in higher equipment price levels. Realistically, no one would invest in the necessary capacity to meet the System's specialized needs without the assurance of a long term requirements contract. Thus, the European pattern of requirements contracts and allocation, with all of its shortcomings, and not competition, would be substituted for the proven performance of Bell's integrated structure.

IV.

CONCLUSION

In the last analysis, the Bell System integration must be judged by its purpose and its results. The purpose is clear -- to provide first class communications service at reasonable cost. The results are equally well known -- this country has the best and most progressive communications system in the world and the charges are reasonable by any standard. This did not just happen. The Bell System integration has existed since the 1880's and has become increasingly important in advancing communications technology and coping with the ever-growing complexities of the communications system. A decision now to dismember this long-established method of operation can only be justified if that method has failed and service to the public would be better and cheaper under some alternative method or approach. Such a finding must be based on facts and not speculation, for the public interest stakes are very high indeed. We respectfully submit that no such finding can be made in light of any objective analysis of the unique characteristics of the telephone network and Western Electric's proven record of performance as a part of the Bell System.

The relationship between the Bell System's performance and its integrated structure has not gone unnoticed abroad. Here, in conclusion, are the findings of the British Select Parliamentary Committee:

> ". . . regard should be paid to the benefits to be derived from a substantial manufacturing unit under the Post Office's control giving a quick, direct and full feed-back to the Post Office's research and development organization of relevant information regarding technical difficulties encountered in the course of manufacture. Such feed-back might be expected to be more effective than that which can be obtained, under present arrangements from the private manufacturer. Similar benefits might be gained by closer association of manufacturing and operating responsibilities, both from interchange of technical experience and from being able to relate, as closely as possible, supply to fluctuations in demand. <u>In these ways the Post Office could derive similar advantages to those derived by the Bell System from having research, manufacture and operations under a single control</u>."
>
> -- 1st Report, the Select Committee on Nationalised Industries, "The Post Office," Vol. I, Report and Proceedings of the Committee, Feb. 24, 1967, at p. 168 (emphasis added)

7

THE MYTH OF RATE BASE INFLATION

Summary:

Any contention that the Bell System inflates its rate base in order to maximize its earnings flies in the face of the System's demonstrated record of cost reduction and increased efficiency.

Continuing research has produced new and lower cost facilities which have been introduced promptly to care for growth and to replace more costly and less efficient plant. Rates have not increased proportionately to other costs due in large measure to continuous emphasis on efficiency and cost reductions as an alternative to rate increases.

The ability to handle more messages, without comparable increases in circuits or degrading service, through mechanization of the network, improved operating methods and shifting usage to off-peak hours through rate reductions, etc. is one example of greater efficiency in the use of facilities without a corresponding increase in plant and enlargement of the rate base. Another example of the Bell System's efforts to keep its investment base at low levels is in its striving for increased depreciation rates and accruals. In fact, the FCC has granted only about half the amount of depreciation increases requested by the Bell System during the last 15 years.

Overinvestment in plant would work to the disadvantage of the owners of the business. It would saddle a company with the burden of carrying charges and earning requirements which would be a drag on earnings. Prudent investment, however, enhances the rate of growth in earnings per share. Since increases in dividends and market price rest basically on growth in earnings per share, the share owner stands to benefit from such growth. It would be self-defeating to attempt to inflate the rate base since it would have an adverse effect on earnings per share.

In sum, instead of seeking to build up the rate base by maximizing the investment required to provide service, the Bell System has been a leader in introducing new technology and methods seeking to hold down the cost of operation and to minimize the investment required, thus making possible both increases in earnings and reductions in rates.

THE MYTH OF RATE BASE INFLATION

In discussions of utility management, an infrequent but recurring question is whether "rate base" regulation encourages management to add unnecessarily to plant facilities in order to maximize earnings. Those who advance such a contention assume that the paramount motivation of management is to keep earnings at the highest possible level and, therefore, it must logically follow that the rate base will be unduly inflated in order to achieve this goal.

As far as the Bell System is concerned, nothing could be further from the truth. In the first place, such an assumption unfairly questions the integrity of management. Secondly, it ignores the Bell System's demonstrated record of cost reduction and improved efficiency. And finally, it overlooks counter-motivations which actually encourage management to keep the rate base as small as possible, consistent with service needs.

The fact is that even with an ever-growing construction program and greater efficiency in the use of facilities, there is no excess of telephone plant. On the contrary, there has been a shortage of facilities in recent years because of the continuing great demand for communications services.

This paper will discuss briefly how the Bell System, by concentrating on the provision of economical, efficient service, has precluded any inflation of the rate base and, in doing so, has benefited both customers and owners of the business.

Cost Reduction and Increased Utilization of Interexchange Facilities

An underlying consideration in the planning and design of the telephone network has been to achieve the most effective use possible of all facilities. This has been accomplished in two ways: 1) by developing new, more economical systems; and 2) by implementing new, more efficient methods of operation.

Continuing research efforts by the Bell Telephone Laboratories and Western Electric have produced technological developments which have made it possible to achieve dramatic reductions in the cost of interexchange plant, for example. These new and lower cost facilities have been introduced as rapidly as possible to provide for growth and to replace more costly and less efficient facilities.

The principal cost reductions in interexchange plant have been achieved through the use of coaxial cable and radio relay systems, both of which were pioneered by the Bell System. Since 1940, when the first coaxial cable was placed in commercial operation between Philadelphia and New York, the line haul facility cost per circuit mile of coaxial cable systems has been reduced from $15 to $2.35. The costs of radio relay systems, which made their appearance in the Bell System in 1947, have been decreased from $5.30 to $2.60 per circuit mile and will be pushed down to about $2 per circuit mile by 1970, when the new TD2-IB system is introduced. Charts 1 and 2 show the increases in capacity which have been achieved through these new systems, and the accompanying reductions in cost per circuit mile. These and other improvements have produced a dramatic decline in the average investment per circuit mile, as shown in Chart 3.

New systems have been put into service promptly, in order to take full advantages of their efficiencies. This is illustrated by a comparison of the circuit mileages of the various systems as a percent of the total circuit miles for 1955 and 1966.

Equivalent Telephone Revenue Producing Circuit Miles by Type of Facility as a Percent of Total Circuit Miles (AT&T Long Lines Department)

December Year	Paired Cable and Wire	Coaxial Cable	Radio Relay
1955	35.7%	36.8%	27.5%
1966	6.7%	31.1%	62.2%

Concurrent with its success in reducing per-circuit costs of interexchange facilities, the Bell System has also worked toward improving its efficiency in circuit utilization. In the last 10 years, Long Lines messages (telephone, TWX, Data-Phone, and WATS) have increased 214 percent, and the length of an average conversation has risen about 18 percent. During the same period, Long Lines circuits increased only 150 percent.

This ability to handle more messages -- without comparable increases in circuits -- has been achieved by more efficient circuit loading. Moreover, these efficiencies were achieved without degrading service. As Chart 4 shows, the quality of service has not suffered as a result of this increase in circuit loading but has actually improved. In 1958, customers encountered "no circuit" conditions 58 times per 1,000 calls. Last year, NC conditions occurred only 15 times per 1,000 calls.

Several factors have contributed to improved circuit loading during these last 10 years:

> Reduced completion times -- Mechanization of the network, improved operating methods, growth of Direct Distance Dialing, and an increase in the proportion of station calls have reduced the time to complete an average call from 3.1 to 1.9 minutes. (The average completion time for DDD calls, which are included in the above, is 20 seconds.)

<u>Improved network management</u> -- Implementation of alternate routing (high usage and final trunking), to take advantage of the non-coincidence of peak hours throughout the country, has made possible a reduction of nearly 10 percent in high usage trunk requirements.

<u>Shifts in calling patterns</u> -- Rate changes have been introduced in such a way as to shift certain calling volumes to off-peak periods. Wide Area Telephone Service (WATS) has also been introduced, and this has produced a more constant loading during the entire day, thereby relieving busy hours.

The importance of efficient circuit utilization is clearly demonstrated by this fact: if the level of circuit loading in effect ten years ago (1958) had not significantly improved, about 55,000 additional circuits (an increase of almost 40 percent at a capital cost of over $1 billion) would have been required to handle 1967 interexchange message volumes.

<u>Percentage Reduction in Rates, 1958 to Date</u>
(6-minute call)

	Station Day	Station Night
Washington - Chicago	10%	37%
Washington - Miami	11%	44%
Washington - Dallas	21%	50%
Washington - Denver	24%	47%
Washington - Los Angeles	30%	52%

Such rate reductions are concrete evidence that the Bell System has not tried to inflate its rate base or channel capital into less profitable services to preserve a return.

As far as local rates are concerned, there have not been as many opportunities for reductions, but significant progress has been made in mitigating the effects of rising operating expenses. Costs of local telephone service, for example, have risen on the average less than half as much as the cost of living, as shown in Chart 5. Moreover, the value of service has been substantially increased because local calling areas have been expanded greatly.

The fact that local rates have not increased proportionately to other costs is due in large measure to Bell System management's continuous emphasis on efficiency and cost reductions as an alternative to rate increases. Furthermore, the Bell companies have been hard pressed in recent years to keep up with the rapid growth in demand for local telephone service. Last year, 4 million telephones were added to the Bell System network and rather than having excess plant, many companies are now faced with a shortage of facilities. In fact, some locations have the largest number of held orders and regrade requests since the period immediately following the end of World War II.

Considering the factors discussed above, it seems obvious that the objective of the Bell System is to get the maximum possible efficiency out of its plant -- and certainly not to attempt to inflate its rate base.

Increased Depreciation Rates

Another example of the Bell System's efforts to keep its investment base at low levels is in its requests for increased depreciation rates and accruals.

Increases in depreciation rates result in a faster recovery of the cost of the investment in telephone equipment, facilities and buildings. In effect, the larger the depreciation accruals the smaller the rate base.

The Bell System companies have been striving to increase depreciation accruals, not decrease them. Since 1954, for example, 93 of the 98 depreciation represcriptions ordered by the Federal Communications Commission have resulted in increases. The net effect has been to increase the depreciation accruals by $220 million on an annual basis.

As further evidence of the Bell System's interest in keeping its rate base down, it should be noted that the FCC granted only about half the amount of depreciation increases requested by the companies.

Other Incentives to Maintain a Low Investment Base

The inflated rate base "theory" also supposes that when earnings of a regulated company are at or above the top of the objective range, there is an incentive for management to overinvest in order to avoid rate decreases. This a very unrealistic supposition.

In the first place, overinvestment would saddle the company with a burden of carrying charges and earnings requirements which would persist well into the future and which would, therefore, be a drag on earnings in less prosperous times.

Secondly, rate decreases in situations where earnings are above objective levels can work in the interests of the company and its share owners. Judiciously made, rate decreases serve to broaden the market for a regulated company's services, and thus lead to further prudent investment which will enhance the rate of growth in earnings per share.

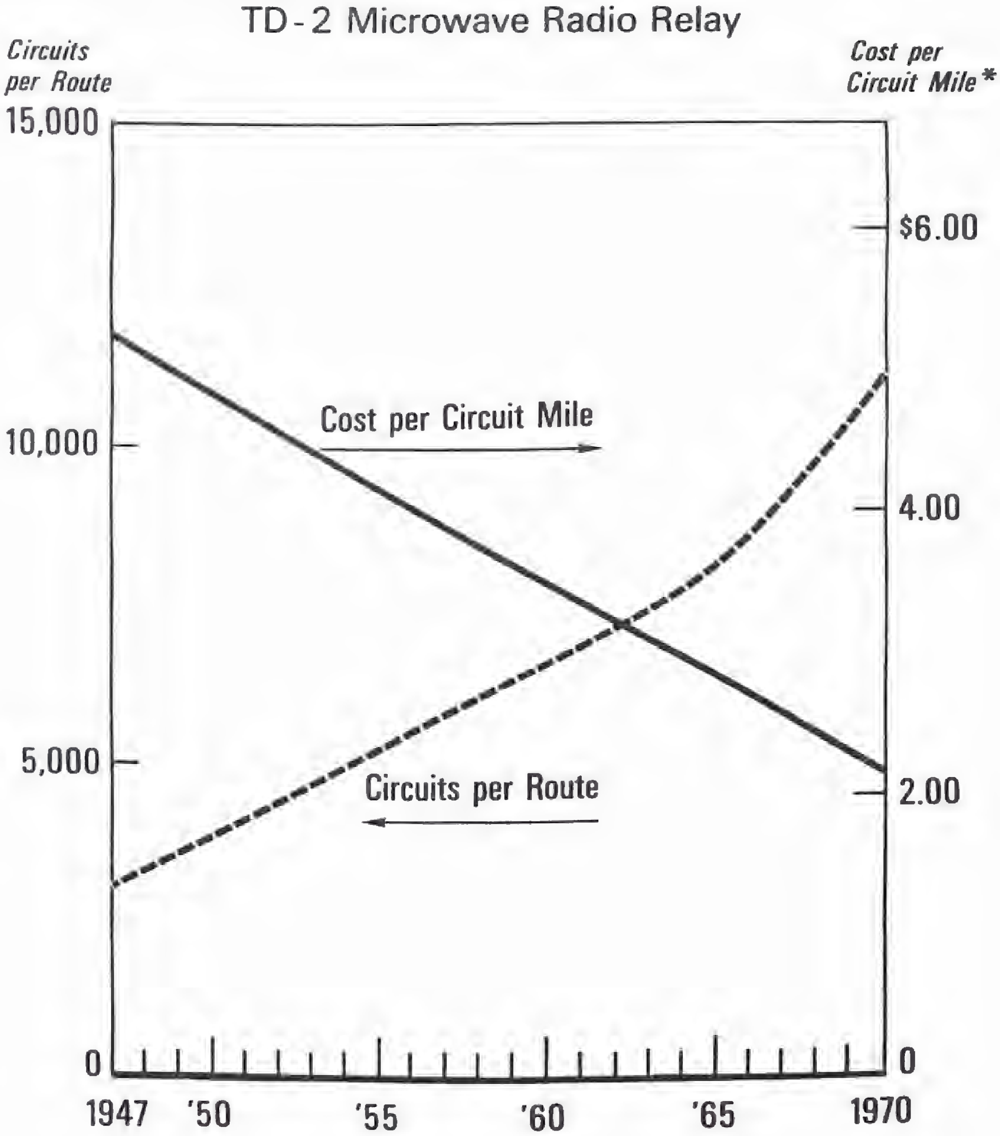
Since increases in dividends and market price rest basically on growth in earnings per share, the share owner stands to benefit from such growth. However, if there is additional investment beyond that required for efficient operation of the business, little if any additional revenue is generated and, at the same time, additional expenses are incurred. Moreover, it requires raising additional capital on which earnings must be generated if the return to exist-ings investors is not to deteriorate. It would, therefore, obviously be self-defeating -- and a dereliction of its obligation to share owners -- for management to attempt to inflate the rate base since it would decrease earnings per share.

In sum, instead of seeking to build up the rate base by maximizing the investment required to provide service, the Bell System has been a leader in introducing new tech-nology and methods that enable it to hold down the cost of operation and to minimize the investment required. This has made possible both increases in earnings and reductions in rates.

Thus an inflated rate base -- while a theoretical possibility -- has no basis in fact or in motivation. Any contention that the Bell System does inflate its rate base, or desires to do so, should be treated for what it is: a myth.

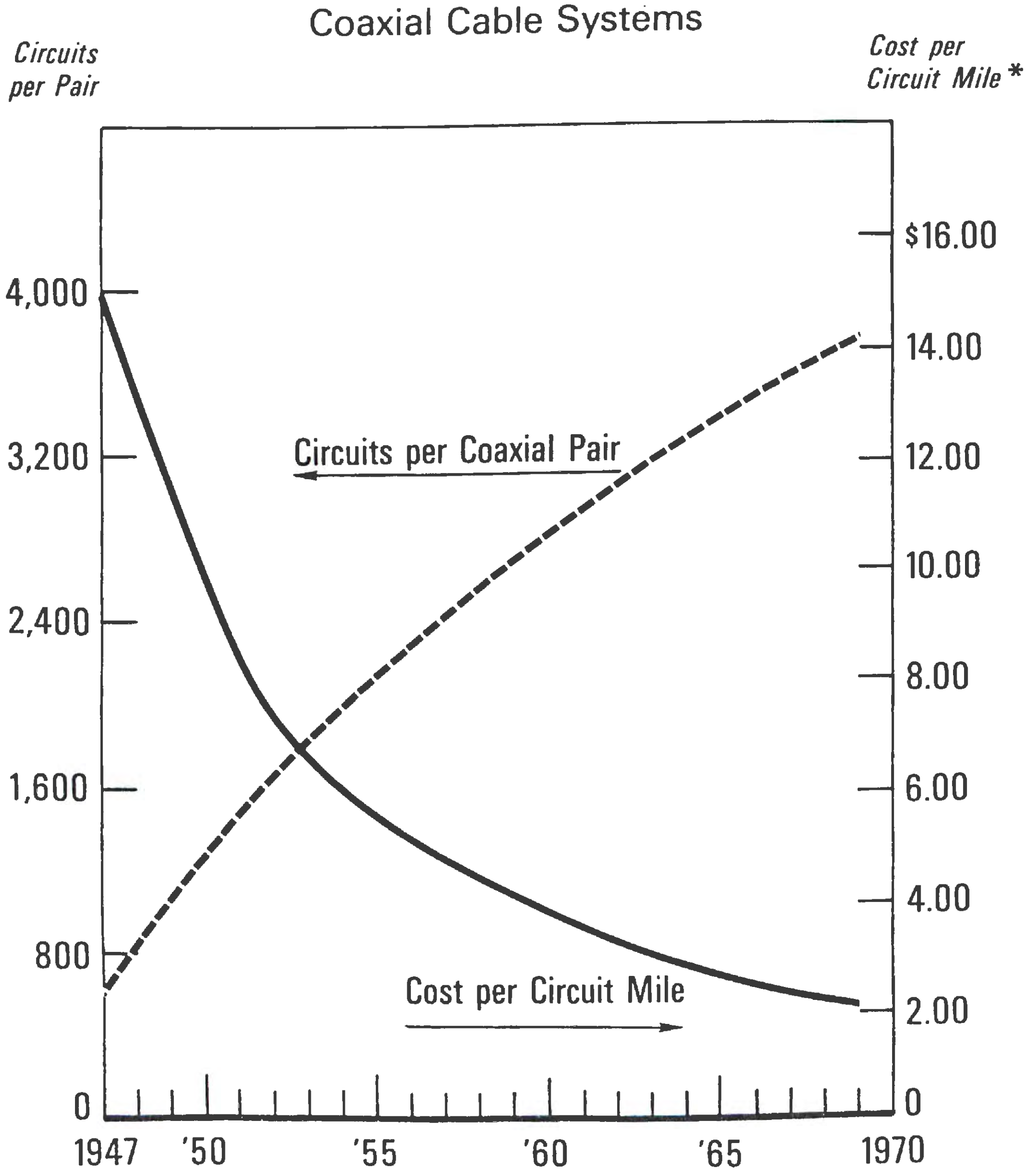
CHART 1

Efficiency of line facilities is increasing with developments in technology . . .



*Line haul facilities only

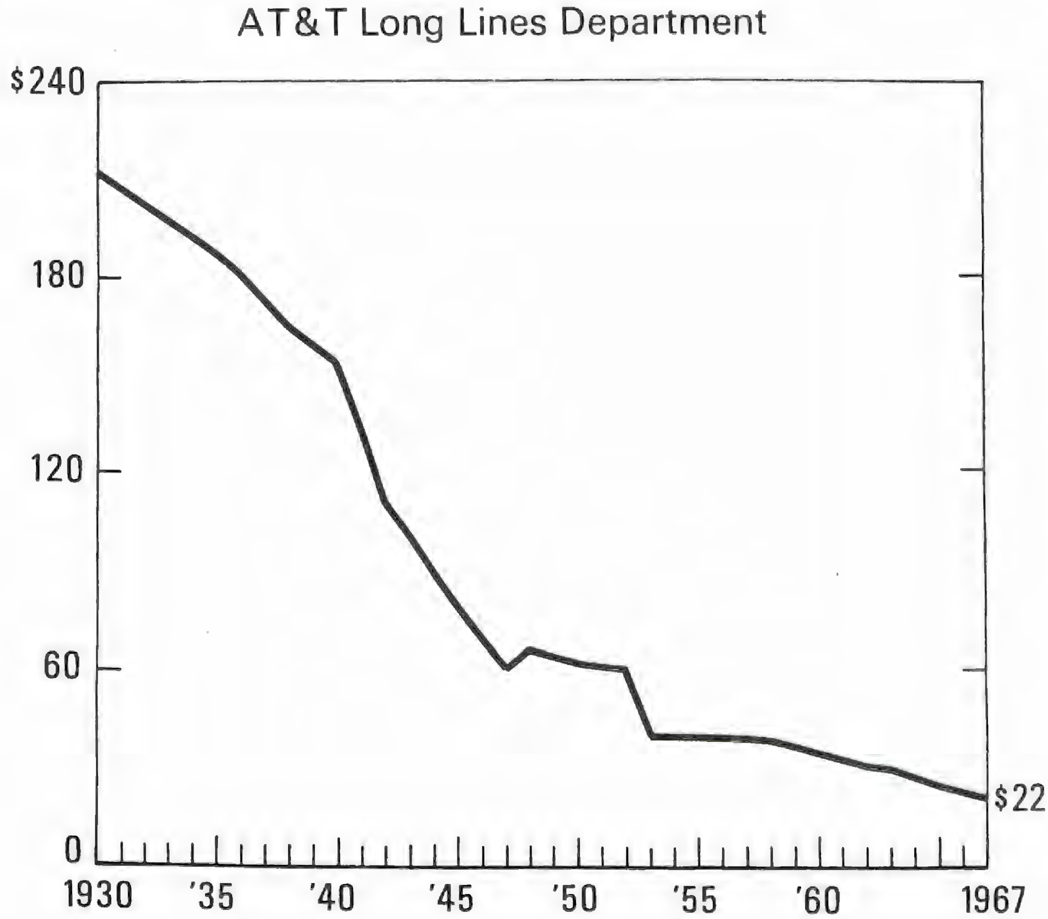
Efficiency of line facilities is increasing with developments in technology . . .



*Line haul facilities only

CHART 3

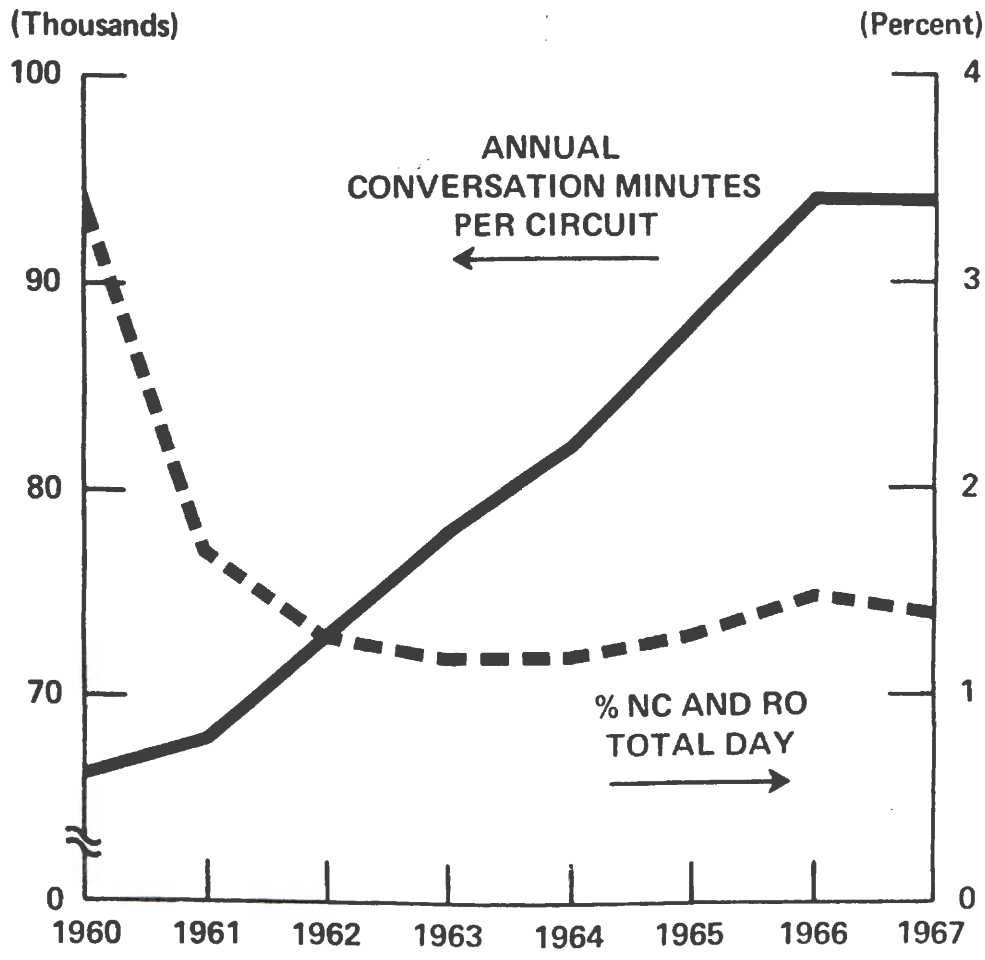
Investment per circuit mile*. . .



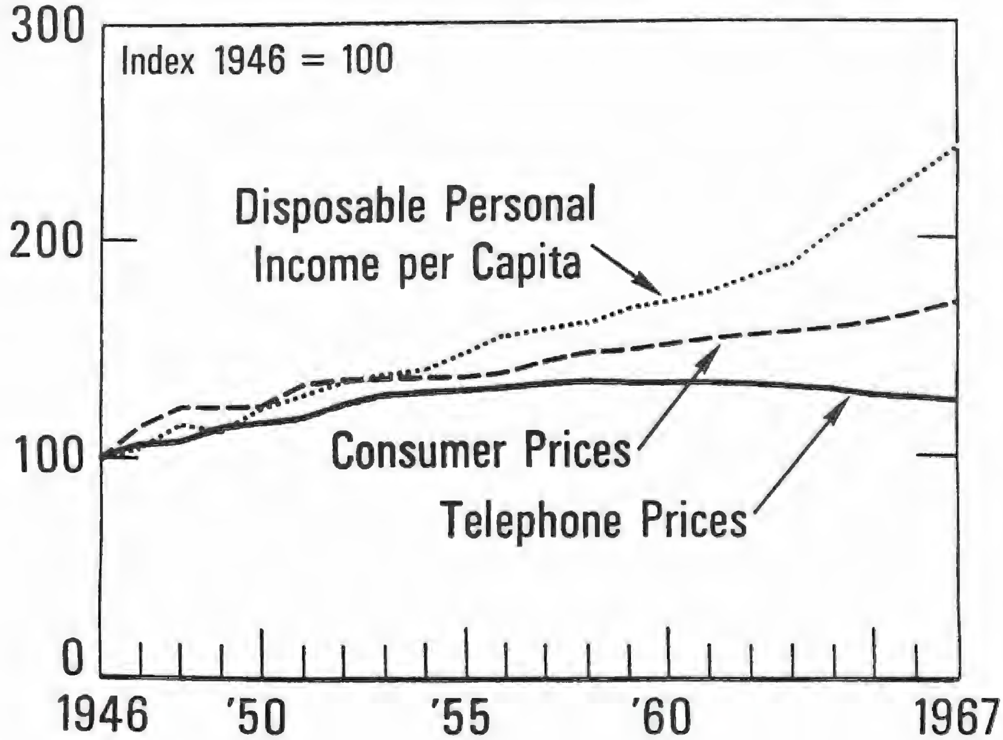
* Total investment including terminal equipment

CHART 4

CIRCUIT LOADING VS PERCENT NC



Bell System rates vs disposable personal income per capita and consumer prices . . .



8

RATE BASE REGULATION

Summary:

Some students of regulation are questioning whether the rate base -- rate of return method commonly used in the regulation of public utilities can meet the needs of society under today's and tomorrow's economic and social conditions. The Bell System's position on this question is that rate base -- rate of return regulation is not obsolete, but there is a real need for a broader concept of the objectives of regulation, with emphasis on productivity and consumer betterment.

There are many conceivable approaches to regulation. Some are variations of rate base -- rate of return regulation; some are distinct alternatives; others are techniques which can be applied to either. But in the final analysis, regulation must be guided by the characteristics and the economics of the industry regulated.

In theory, rate base -- rate of return regulation is simple to administer: (1) calculate the investment being used, (2) establish a fair rate of return, (3) estimate the revenues required to earn that return. In practice, however, there is no universally accepted way of carrying out any of these steps. The same can be said for any other method of regulation.

Investment in plant will remain a fundamental consideration in the regulation of the telephone industry as long as it remains capital intensive. However, it is possible that over the coming years, because of leased plant or other factors, other methods of regulation might be used, giving primary weight to the nature and quality of the service performed.

What is important now is that there is nothing inherent in the rate base -- rate of return method that precludes the provision of incentives for good and improving service, efficient corporate operation and rapid introduction of technological advances. This method has proved to be flexible in the past and there is no reason to conclude that properly administered it cannot continue to serve the public interest effectively for some time to come.

IS RATE BASE - RATE OF RETURN REGULATION OBSOLETE?

A short answer to this question might be that rate base - rate of return regulation is not obsolete. With limited exceptions it is the method currently used by regulatory agencies, federal and state, in determining the level of earnings permitted utilities.

Nevertheless, some students of regulation are questioning whether the rate base - rate of return method of regulation can meet the needs of society under today's and tomorrow's economic and social conditions. Questions such as the following are being asked:

1) Does the rate base - rate of return method of regulation place undue emphasis on property or investment of the utility and too little on its performance?

2) Does it make the ownership of property so dominant that it discourages the replacement by a utility of high-cost plant with newer and more efficient low-cost plant? In other words, does it prevent the introduction of new technology at an optimum rate?

3) Does it make the ownership of property so important that a utility has little or no incentive to lease or make other arrangements for the use of facilities it does not own (e.g., satellite circuits), even if this will result in savings to the users of service?

4) Does it offer management enough incentive for innovation and advances, or does it tend to encourage complacence?

Before attempting to answer these questions, this paper will examine various other approaches to regulation. Some of these upon analysis actually turn out to be variations and adaptations of the rate base - rate of return method; some are distinct alternatives to rate base - rate of return regulation; others are techniques which can be applied to either a rate base - rate of return or alternative methods of regulation. (This discussion will be limited generally to the telecommunications industry, for regulation must be guided by the characteristics and the economics of the industry regulated.)

Exploration of Other Approaches to Regulation

"Bellwether" Method

This is a form of regulation in which one company in an industry is selected as the "bellwether" company, and its authorized rates become the standard in the industry. An example of its use is the action of the FCC in establishing marine radio-telegraph rates.

By an order of September 10, 1952 (Docket 9915) the FCC decided that its primary concern in the marine radio-telegraph field would be directed to the revenue requirements of Radio Marine Corporation of America ("RMCA"). In the order the FCC stated that it was making changes in the rates of RMCA and that such changes should permit RMCA to realize a reasonable rate of return. The FCC also stated that because of the historical rate practices of the industry and because of the existing competitive situation, "it is reasonable to assume that the other marine carriers will file tariff schedules which are no higher than those . . . filed by RMCA." The FCC observed that RMCA was "the largest of the . . . carriers in terms of the number of stations operated and the amount of traffic handled. Also RMCA appears to have the lowest operating expenses in relation to each dollar of revenue . . . received from the public . . ."

This "bellwether" method of regulation is appropriate for a situation, such as the marine radio-telegraph field, where heavy competition exists between carriers, and where operational conditions and technology are similar for all of the carriers. However, such a situation is unusual in the telecommunications field. The telecommunications companies operate for the most part in fields that are not highly competitive, and under varying economic, geographic and other conditions.

In the RMCA situation the "bellwether" method was an adjustment of the rate base - rate of return method. The customary rate base - rate of return principles were applied to RMCA, and the other companies were then advised that they were expected to conform their rates to those of RMCA.

Operating Ratio - Return Margin

Under this method the adequacy of revenues is determined by reference to the operating ratio of the utility. The operating ratio is the percentage relationship of operating costs to gross operating revenues, and the difference between them is the return margin.

This method of regulation has been used by the Interstate Commerce Commission for some time as the basis for regulation of motor carriers. In explaining the reason, the ICC said: "In industries where the amount of investment is large in relation to total costs, the rate of return on investment generally has been accepted as appropriate for determining revenue needs . . . . On the other hand, where the amount of investment is relatively small in relation to total costs, investment is not the primary factor in determining revenue needs . . . . The owners of motor carriers can hardly be expected to look to the return on the amount of their investment as an incentive where the principal risk is attached to the substantially greater amount of expense."

Dr. Joseph V. Charyk, COMSAT's President, has indicated that COMSAT is looking into this method as a possible alternative for the regulation of its business, observing that "where the risk varies primarily with the volume of business done rather than with the amount of investment in plant and equipment . . . it may well be worthwhile to see whether some departure from traditional or conventional rate base - fair return rule might be in order."

Several aspects of the operating ratio method should be observed. First, it has developed in the motor carrier field, where there is heavy competition and where a small investment in capital is required.* Second, there are only a few situations in the telecommunications field where there is heavy competition and small investment in plant. The telecommunications industry has roughly $50 billion invested in plant that is being used to provide service to the public. Not only is the industry capital intensive, but virtually all signs indicate that it will remain so -- billions of new capital will be required in the years ahead. Third, the operating - ratio method is regulation by a mathematical formula which is applied to all operations without regard to different factual situations. It should be noted that even in situations where there is small investment in plant, operating ratios are likely to be quite variable among companies reflecting differing operating characteristics and different risks. It is difficult to see how efficiency and high performance are rewarded under this method.

Regulatory Lag

There may be delays in the functioning of the regulatory process, either when earnings of a utility are inadequate, and a rate increase is in order, or when earnings

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* The CAB has refused to determine return for the airline industry by use of the operating ratio method (General Passenger Fare Investigation E-16068 (1960)). The CAB adopted the finding of the examiner that "No other measure than rate of return on investment . . . provides a direct and positive measure of risk."

are at a level that would indicate that a commission could compel reductions. The term "regulatory lag" is used here to describe a regulatory method in which there is a conscious delay on the part of a commission in reducing rates when it finds good performance on the part of the utility that should be rewarded.

This approach is a desirable development in modern regulation because it provides a relatively simple way for regulation to reward efficient management. In the telecommunications field it has been a useful adjunct to rate base - rate of return regulation. However, even though a utility is operated with the highest degree of efficiency, in periods of rapidly increasing prices and wages, earnings are not likely to be at levels above what has previously been set by the commission as the allowable rate of return. Therefore, the regulatory lag approach serves to hold out incentive only when prices and wages are relatively stable. Also, this approach has the disadvantage of giving the appearance that the regulators, having found that a lower rate of return should apply, are negligent in their responsibilities to the public.

Regulate Competitive Services Separately from Non-Competitive Services

Another method would be to regulate separately the competitive and non-competitive portions of the business of a utility, recognizing that because of the effect of the forces of the marketplace on the competitive portion, prices for competitive services might result in either a higher or lower return than on the non-competitive portion.

It would of course be necessary to determine relevant costs of the two categories of service in order to avoid any charge that the non-competitive services were subsidizing the competitive services. It would also be necessary to determine the amount of competition that would exist before a service was deemed competitive for this purpose.

Price Negotiation - Profit Over Cost

Procedures such as those set forth in the Armed Services Procurements Regulations (3-808.1, dated 29 January, 1965, Revision 9) constitute another possible method. Under this method, rates would be determined in advance, based on a detailed set of weighted guidelines, the intention being that the company would recover its full costs including a factor for profit.

The Department of Defense realizes that the success of its procedures depends upon the degree of judgment and flexibility used in its administration. The guidelines or standards are designed to induce high performance.* If an effort were made to adapt this method to the telecommunications field, guidelines or standards applicable to the telecommunications companies would have to be developed. In the case of telecommunications companies the guidelines or standards would have to recognize the large capital investments of the companies.

Direct Price Fixing

Under this method, rather than determining costs and then specifying prices designed to cover them, the price for each service offered would be determined through an economic study of relevant factors, as is commonly done in the case of fixing milk prices. Where competitive conditions did not prevail, prices might be related to some economic variable or variables. For example, the price of residence telephone

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* For example, the procedures of the Department of Defense state: "It is the policy of the Department of Defense to utilize profits to stimulate efficient contract performance . . . . Negotiation of very low profits, the use of historical average, or the automatic application of a pre-determined percentage to the total estimated cost of a product does not provide motivation to accomplish such performance. Furthermore, low average profit rates on defense contracts are detrimental to the public interest . . . . Consequently, negotiation aimed at merely reducing prices by reducing profits, with no realization of the function of profit cannot be condoned."

service might be related to some per cent of disposable personal income. Or it could simply be decided that a price was fair because the revenues it generates represented a certain proportion of personal consumption expenditures or because it bears a specified relationship to the general level of consumer prices.

The major difficulty with this approach is the practical one of determining a fair price formula to use, particularly where competition does not exist. However, this does not mean that in some areas further study might not evolve a price formula which would produce incentive on the part of the utility and fair prices to consumers.

Management Fee

A variation of the direct price-fixing approach would be an arrangement under which the utility would be permitted rates determined on the basis of its "costs of doing business" plus a profit for its services. Management and consulting firms and service companies often function under an arrangement of this kind. The major difficulty would be in determining an amount to cover the "cost of doing business" as well as an incentive profit. Management, consulting and service fees have a factor of cost which accounts for more than salaries and expenses, and the precise amounts involved must be carefully defined. A favorable aspect of this approach is that the "profit" factor offers an incentive, provided that the "profit" element is used as a reward for efficient operations and provision of high quality of service.

The management fee approach is particularly appropriate when the individual time and skills of a technical or highly specialized group is the principal product involved. While the performance of individuals is vitally important in the telecommunications industry, and utilities should be allowed to realize the rewards of good performance, other factors, including heavy investment capital, are usually so important that regulation of the industry on a management fee basis seems inappropriate.

Marginal Cost Pricing

In theory, the charges for all of the various services offered by a utility might be fixed at marginal costs. Although the marginal cost concept is familiar in ratemaking in the context of determining, as to particular services, levels below which rates will not be permitted to fall, it has never been used as an overall regulatory method in the utility field.

Under such a procedure, the value of service concept would be entirely ignored in ratemaking. Also, since the utility would presumably be a decreasing cost producer, if all rates were based on marginal costs revenues would be insufficient to cover the total costs of the utility. Investors consequently would not obtain a fair return on their capital. Such an approach would not provide incentives for efficiency.

Performance Standard

An additional concept -- which can be an adjunct to or variation of virtually any type of regulatory approach -- permits a wide range of earnings, rather than a specified rate of earnings, with the object of eliciting maximum results by measuring performance. Like virtually every other standard, there is of course the problem of determining the appropriate level and range of earnings to be allowed. However, where a reward is held out for good performance, standards of performance are also required in order to measure efficiency of the utility and determine whether the customer is receiving a high variety and quality of service. It must be recognized, however, that there are no definite formulae or measurements, in the absence of competition under comparable conditions, by which "good" or "bad" performance by a particular utility could definitely be measured.

The Washington Sliding Scale

In 1924 the Public Utilities Commission of the District of Columbia made an arrangement with the Potomac Electric Power Company, under a statute permitting a sliding scale for rates, pursuant to which the rates of the company would be fixed in accordance with a sliding scale formula. Under the arrangement, if the return of the company under the rate formula exceeded 7-1/2 per cent, one-half that excess was to be used as the basis for rate reductions. If the return was less than 7-1/2 per cent for three consecutive years, or less than 6-1/2 per cent for one year, the commission was to adjust the sliding scale formula so that the utility would be in a position to earn at least a 7-1/2 per cent return.

For a number of years the plan resulted in rate reductions for customers and good earnings for the utility. Incidentally, during the period the electric rate in Washington, D.C. fell to one of the lowest in the United States.

With changed economic conditions, the commission, in 1931, and again in 1936, unilaterally revised the formula for rates set forth in the arrangement as well as the formula with respect to return, in both cases making rates and return less favorable to the utility. With the price inflation that followed World War II the revised plan called for higher rates, but efforts on the part of the utility to have rates increased proved unproductive. The plan was abandoned by mutual consent of the commission and the utility in 1955. The commission's order on the matter observed that changed economic conditions caused the discontinuance and stated that "The same factors have resulted in the abandonment of similar plans by those jurisdictions throughout the country which had adopted them." Prominent among such jurisdictions were Arkansas and New Jersey.

Assuming stable price conditions a financial incentive to the utility does exist under such a plan. However, when, because of inflationary or other factors, earnings decrease to a point where rate increases are indicated, it is politically difficult for a commission to raise rates without resorting to formal proceedings. Professor Bonbright ("Public Utility Rates," page 263, note 21), in commenting on the experience in Britain under plans of this nature, observed that "These schemes have been brought to grief by the forces of price inflation."

Some aspects of the above approaches have considerable appeal. Evident in most of the approaches is a conscious effort by regulation to hold out incentives for high performance and innovation on the part of the utility. The difficulties of defining appropriate standards and measurements have undoubtedly prevented the use of these approaches as a substitute for the rate base - rate of return method except in limited areas. This does not mean that the efforts which have been made to develop inducements for performance and innovation should be ignored in the telecommunications field. Quite the contrary. What is called for is increasing emphasis on these factors. However, before explaining how this may be accomplished, it would be appropriate to examine also the conventional rate base - rate of return method of regulation generally applied to telecommunications companies. What are its strengths and weaknesses? If it is to continue to be used, how should it be improved?

Rate Base - Rate of Return Regulation - Theory and Practice

In theory, rate base - rate of return regulation is very simple to administer:

1) Calculate the cost or value of the property or investment being used in providing the service -- rate base.

2) Establish a fair rate of return on that base.

3) Estimate the revenues required to earn that return.

In practice, however, there is no universally accepted way of carrying out any of the steps. Where the regulatory statutes are not specific on a matter, different procedures are followed by different commissions, federal and state. As to what constitutes a proper base, some commissions determine the base entirely in relation to book cost and some give consideration to current values.

As to what expenses are allowable in the determination of net revenue for rate of return computation, the consideration covers a wide spectrum.

In discussing the question, "What is a fair rate of return?", most economists and lawyers in the field, when pressed for a precise answer, agree that no formula exists for determining a fair rate of return. There is no mathematical formula or perfect rule that can be applied. What is called for is fair and enlightened judgment arrived at by an adequate economic analysis.

What is important to our present consideration is that there is nothing inherent in the rate base - rate of return method that precludes the provision of incentives for good and improving service, efficient corporate operations and rapid introduction of technological advances. It does not require that the components of earnings requirements be mechanically determined without consideration of the need to motivate companies to provide ever improving and constantly widening services. Accordingly, if there is a failure to provide the needed incentives the reason lies not in the method itself but in the fact that regulation has not directed itself adequately to these ends. Criticism of the rate base - rate of return regulation, alleging that it is a "cost-plus" method or that it tends to induce the retention of uneconomic investments, is more of an indictment of the way regulation is administered than a failure of the method itself.

Performance Appraisal of Rate Base - Rate of Return Regulation in Recent Years

A review of what has happened in the telecommunications industry in recent years shows that rate base - rate of return regulation is adaptable to changing conditions and still workable. Clearly in this period regulation did not adopt policies so restrictive that progress was impossible. On the contrary, the benefits that have been received by the nation are impressive.

In recent years there has been a continuing heavy demand for communications services. The percentage of American households with telephones was 88.5 per cent at the end of 1967, as compared with 36.9 per cent at the end of 1940. A remarkable number of technological improvements have been made so that the nature and the quality of service has constantly expanded. Many of these technological improvements have "spilled over" to other businesses. The transistor, for example, actually created a new industry.

In the past several years, an expanding array of new products and services was made available to users.

And telephone rates have increased on the average only 10 percent since 1940, while the cost of living was rising almost 140%.

These are but a few examples of the progress that has been made.

Challenge of a Changed Socio-Economic Climate

Even if we are to assume that rate base - rate of return regulation has operated with reasonable effectiveness in the past, this does not necessarily mean that the present methods of administering it are well suited to meet the challenge of the years ahead.

Now national goals are set. Examples are legislation aimed at government-directed economic growth and full employment. To achieve its goals the government takes positive monetary and fiscal action. It stimulates investment. Tax and other legislation encourages the introduction of the latest technological developments.

It is commonly recognized that national goals can be achieved only if the technological advances in industry are continued and accelerated. The scientist and technologist are therefore coming to the fore. Government, as well as business, has come to the realization that the most important invention of this century has been the invention of "the method of invention." Research and development financed by the government have increased in recent years to where expenditures for these purposes now exceed $14 billion a year. The large research and development organizations of industry are also encouraged by government.

Much is being achieved. Technology is advancing at a rapid pace. Unemployment is at low levels. Competition for brainpower is as severe as for capital, and more severe than at any time in the postwar years. More and more goods and services are being produced.

The telecommunications industry plays a big role in this new environment. Communications requirements become more and more extensive as society moves deeper into the age of advanced technology. It is now recognized that businessmen, scientists and governments can function effectively only with communications fitting their various needs.

This point needs some exposition. Years ago many businessmen looked on telecommunications as merely overhead. For instance, such communications as were available were handy but not really essential to the manufacture and distribution of products, even products such as steel. Communications now so permeate all phases of economic activity that they are a vital element in every product and service turned out.

Communications, along with power and transport, now make up the infrastructure of the economy. If this infrastructure is wanting ... if it isn't ready to provide the latest and the best in these services, then all the ideas and efforts to attain the rate of growth (estimated at 4-5 per cent yearly) to employ the millions entering the labor force in the next ten years, and to raise the general standard of living, will be like pouring "nectar into a sieve."

In the telecommunications business (and indeed in most other businesses) the main keys to increased productivity and customer betterment are the introduction of new technology, and other innovations. By increased productivity is meant greater efficiency with a resulting increase in the amount of good, high quality communications available to customers. By customer betterment is meant improving service to all classes of customers, government, business and residential users - and anticipating the needs of all classes of users. This approach will afford the consumer more encompassing protection than ever before - protection to fit the times - as the beneficial effects of increased productivity ripple through the economy.

Emphasis on productivity and consumer betterment could be effected by a variety of means, including the following:

1) Permit a range of earnings that is sufficiently wide to induce management to strive for maximum technological advances.

2) Recognize the effect on utilities of inflation and the resulting changing value of the dollar, so that earnings will bear a reasonable relationship to those of unregulated industry. (This will also help to attract the flow of capital into the industry which will be needed to expand still further the range of services available to the public.)

3) Allow depreciation rates which truly reflect what technology is doing to shorten the life-span of plant, as well as to reflect the effects of inflation. This will permit utilities to recover their investment realistically and make available a flow of funds to provide more of the latest equipment.

Earnings which reflected these factors would not necessarily mean higher overall rates for users. Such a system would reward the risk of innovation. It would hold out inducements to the most socially useful companies, and rewards would be earned by them only through increased efficiency. Thus, they would provide a stimulus for companies to reduce rates to customers.

If regulation were to place more emphasis on productivity and customer benefit it would encourage telecommunications companies to meet the fast-changing desires of customers, to accelerate technological change, and assist the companies in meeting the competition for new capital and brainpower, and further increase the effectiveness of the telecommunications industry in helping to achieve national goals.

Conclusion

The concepts and methods of regulation, mentioned above, other than the rate base - rate of return method, have developed where only a small investment was required, or where, for competitive or other reasons, there were compelling reasons why rate of return on investment was not a principal factor in determining revenue needs. Nevertheless, under each of these approaches the vital issues which face regulators under the conventional rate base - rate of return method are still present, including the following:*

1) How can efficiency and employee morale be stimulated?
2) How can technological innovations and other improvements be stimulated?
3) How can new capital be attracted?
4) What standards and guides will accomplish these objectives?

Consequently, the real need is for a broader concept of the objectives of regulation, with emphasis on productivity and consumer betterment. If there are improvements to be made on the part of regulation, they lie in the need to provide incentives for good and improving service, efficient corporate operations and rapid introduction of technological advances.

The telecommunications industry is, at present, capital intensive and has roughly $50 billion invested in plant. It will require billions of new capital in the years ahead. Consideration of investment in plant will remain a fundamental consideration in the regulation of the industry

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* Also, the constitutional provisions relating to the "confiscation" of property would not be avoided under any of these other concepts and methods, since the constitutional provisions establish a floor to every method of regulation.

as long as it remains so capital intensive. Accordingly, the rate base - rate of return concept still appears to be the most appropriate basic method for its regulation. This does not mean that there are not situations in the telecommunications field where investment should play only a minor role in regulation. This might well be so where large volumes of business can be carried on with only a small investment being involved. Moreover, it is possible that over the coming years, because of leased plant or other factors, there may well be an increasing number of such situations. In all such situations a method, or methods, of regulation might be used, giving primary weight to the nature and quality of the service performed and little weight to the investment involved.

Whether rate base - rate of return or any other method of regulation is employed, however, in the years ahead regulation will have to focus strongly on productivity and consumer betterment in order to bring forth for customers at reasonable prices, the abundance of high-quality services they desire. Also, to achieve maximum results any method used must afford incentives for good and improving service.

The improvements suggested in this paper for achieving customer betterment -- including incentives to performance through a realistic approach toward earnings and depreciation -- are designed to make regulation in the telecommunications field more responsive to the needs of our times. They will enable the telecommunications industry to attract the capital it will need to continue innovation and maximize its contribution to the achievement of national goals. The suggestions are not inconsistent with retention of the rate base - rate of return method. This method has proved to be flexible in the past, and there is no reason to conclude that properly administered it cannot continue to serve the public interest effectively for some time to come.

BASIC RATEMAKING PRINCIPLES FOR BELL SYSTEM SERVICES

This paper is a review of Bell System ratemaking principles. It is based primarily on testimony recently presented to the Federal Communications Commission in its investigation of the Bell Companies' charges for interstate and foreign communications services.

> (A further discussion of the subject is contained in Attachment A, entitled "Bell System Statement of Ratemaking Principles and Factors Relating to the Determination of Proper Rate Levels for the Principal Categories of Interstate Services," which was filed with the Commission in connection with the proceedings. Attachment B, pages 9 & 10 of a brief submitted to the Commission in connection with applications of Microwave Communications, Inc., also discusses ratemaking principles.)

Our rates are designed to achieve in total our overall revenue requirement; also to satisfy customer needs, to promote greater use of our services and to encourage efficient use of our plant. We intend that the revenues from each principal category of service fully cover the costs incurred in furnishing that service, including a return on the related investment, and in addition make a contribution to the coverage of the unallocable common costs.

With respect to the interstate business of the Bell System, since message toll telephone service accounts for more than 80% of our total interstate revenues, it is plain that the most significant indicator of the appropriate rate level for this service is our overall interstate earnings requirement. With respect to the other principal interstate services, our objective is to price them so that each contributes as much to our total earnings as is reasonably practicable, taking into account market conditions, rate relationships and other relevant factors. In this way the contribution which these other services make to our earnings permits us to provide service to message toll telephone customers at rates lower than would otherwise be required to achieve our overall earnings objective. So long as each service covers its relevant costs (including return) and makes some additional contribution, customers using our other services benefit.

Within each state, the application of the principles discussed herein is guided, of course, by the conditions particular to that state, reflecting the population distribution and geographical considerations, the relative development of residence and business areas and, the particular interests of the people dwelling within it. In intrastate service, message toll telephone is a much smaller proportion of the totality of the service than in interstate since much of the message calling is covered by the basic monthly charge which in many cases also includes calling between separate communities. In general, therefore, rates are established on a statewide basis, to produce a coordinated pattern for exchange and toll, taking into account the various non-cost factors discussed herein, and to produce in the aggregate, the earnings needed on the total operations within the state.

In the determination of total revenue requirements, it is necessary to consider costs and also in the case of particular services we assure ourselves that they are contributing to overall earnings. Costs considerations of this type are closely related to the conditions under which we supply our services. In this respect the Bell System is like any other business since the rates for our services must reflect the realities of the market. Therefore, in the design of rates which are responsive to market conditions, factors in addition to cost are critical in shaping our pricing decisions. In this regard, a pricing structure which will encourage customers to buy our services is as much a part of our marketing requirements as the development of the services themselves.

Many of the non-cost factors involve the interplay of market forces and rate relationships. They are, therefore, frequently considered together under the general concept of relative value of service.

It is important in telephone ratemaking to bear in mind two significant characteristics of our business.

First, to a greater extent than in most other industries, the value of our services is directly related to their availability and to the extent of their use. The usefulness of communications service to a particular customer is enhanced by the amount, quality and type of service furnished to others and to other locations.

Second, our service offerings interact and overlap with one another to a substantial degree. The price levels established for one service will usually affect the demand for other services. While these interactions are difficult to measure and to predict with accuracy, they exist and must be considered in pricing our services effectively. These characteristics of our business have several very specific implications for the application of the following ratemaking principles.

Rates and Service Offerings Should Satisfy Customer Needs

We endeavor to design our rate structures to permit customers to select the service arrangements which best meet their particular communications needs. Those needs are continuously changing. Population continues to expand and become more mobile, and localities are changing their characteristics with urban growth. These developments generate new and expanded communications needs. Thus our goal is to offer a wide enough range of services and classifications to reasonably meet the varying requirements of all our customers.

Considering the degree of diversity of our offerings, we must be alert to the difficulties and confusion which could result from an overly complex rate structure. Rate schedules should, when possible, be easy to understand and they should be relatively easy to administer correctly and impartially. It would, for example, be hopelessly complicated and inefficient if we attempted to charge on the basis of the particular cost of providing service to each customer. In order to avoid this situation, our rates are established for service groupings and applied uniformly to all customers. An illustration of this type of rate treatment is found in our Message Toll Telephone, where charges are developed by mileage bands and within each band the price is the same to everyone in spite of variations in the type or costs of facilities used on different routes.

Rates Should Encourage Increased Use of Our Services and Efficient Use of Our Facilities

We are constantly looking for ways to encourage, not only increased use of our services, but also more efficient patterns of use. This dual objective is illustrated in our Message Toll Telephone schedules by the special low rates for evening and weekend calling which are designed to induce customers (1) to increase their usage and (2) to divert calling from peak to off-peak periods. Our efforts to design rates to meet these two objectives serves to achieve the purposes specified in the Communications Act - the maintenance of universally available communications services with adequate facilities at reasonable charges.

As noted earlier, we must recognize that the usefulness of every offering is affected by the amount, type and quality of service which it makes available. Consequently, we believe that services should be priced within the reach of the broadest possible range of customers, and at levels which will stimulate the growth and development of such services.

In these determinations, we give appropriate weight to the dynamic nature of communications technology and to the fact that unit costs are affected by the prices we charge for our services. Continuing technological progress has contributed to a progressive reduction in the unit costs of much of our added plant capacity. In designing rates, we therefore look to anticipated volumes and costs. By doing so, we will be better able to introduce new services at attractive rates, to encourage greater volumes of business and this in turn will result in a more rapid introduction of still newer, lower unit cost facilities which will benefit all services.

Rates Must Take Account of Competitive Alternatives

Rates must be set at levels which take account of the competitive alternatives available to the users of communications services. The competition referred to here comes from other communications common carriers, nonregulated suppliers and from alternative services offered in various Bell System tariffs.

Nonregulated suppliers offer communications equipment over a growing range of the market. In the area of bulk communications, their influence is most apparent because of the availability of high capacity, low cost alternatives to common carrier services. To meet the growing needs for high volume, flexible communications, we offer TELPAK, which serves large, sophisticated buyers who otherwise might turn to the nonregulated suppliers to satisfy their communications needs.

We are convinced on the basis of our experience thus far that we can profitably provide bulk services at rates which are competitive with nonregulated suppliers. If, however, our rates and those of other common carriers are significantly above that range, we will be excluded from a major portion of the market. Such a loss would deny significant benefits to the customers for our other services because it would retard the introduction of technologically advanced facilities into our plant thereby reducing the potential for improved service and lower rates for the general public which uses our basic telephone message service.

Relative Stability of Rates is Desirable

We must also recognize that both the customers and the Company want relative stability of rates and revenues. Customers should be able to make plans without the hazard of frequent, unpredictable wide fluctuations in prices. From the Company's point of view, continual changes in rates can have unsettling effects on both its revenues and its ability to market its services effectively. Thus, changes in rate levels ought to be proposed only when needed to meet changed conditions which are reasonably well defined and are considered to be relatively permanent in nature. Changes in rates should recognize changing technological and economic trends rather than undergoing frequent modifications to meet specific situations.

ATTACHMENT A

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C. 20554

In the Matter of AMERICAN TELEPHONE AND TELEGRAPH COMPANY and the Associated Bell System Companies Charges for Interstate and Foreign Communication Service	)	Docket No. 16258
In the Matter of AMERICAN TELEPHONE AND TELEGRAPH COMPANY Charges, Practices, Classifications, and Regulations for and in Connection with Teletypewriter Exchange Service	)	Docket No. 15011

BELL SYSTEM STATEMENT
OF RATEMAKING PRINCIPLES AND FACTORS
RELATING TO THE DETERMINATION OF PROPER RATE LEVELS
FOR THE PRINCIPAL CATEGORIES OF INTERSTATE SERVICES

Pursuant to the Telephone Committee's Order of January 31, 1968, the Bell System respondents propose the following as the ratemaking principles and factors applicable to the determination of proper rate levels for the principal categories of Bell System interstate services:

1. Rates for the Bell System interstate services are designed to achieve the System's overall interstate revenue requirements, to meet customer needs, to promote greater use and acceptability of communications services, and to encourage efficient utilization of communications plant. The revenues from each principal

category of interstate service should cover the relevant costs incurred in furnishing that service, including return on the related investment, and in addition make a contribution toward the overall earnings of the enterprise. The sum of the revenues thereby derived from all interstate services should cover the total interstate revenue requirements of the Bell System.

2. Rate levels for the various interstate services should be market, as well as cost, oriented; that is, they should be set with reference both to factors relating to the demand for service and to factors relating to the supply of service. Costs alone, without consideration of demand factors, are an insufficient basis upon which to establish rate levels.

3. Determination of relevant costs, however, is of fundamental importance in the process of setting proper rate levels. Such cost determinations provide the valid criterion for minimum rate levels, and permit ascertainment, when measured against expected revenues, of the contribution that a particular service category will make toward the overall revenue requirements.

4. Pricing decisions necessarily look to the future. Therefore, in the process of setting rate levels for particular service categories, current and prospective costs provide the valid cost criteria. Only by reference

to current and prospective cost data can there be an appraisal of the effect that rates under consideration will have on the future contributions to overall earnings from the various service categories.

5. Long-run incremental costs are the costs relevant to the determination of appropriate rate levels for the principal categories of Bell System interstate services. These are the cost data of economic significance in the process of reaching rational ratemaking decisions.

6. Full additional costs are intended by respondents as a reasonable approximation of long-run incremental costs. They are not merely out-of-pocket or short-run marginal costs. Full additional costs are of the long-run variety in that they include the costs related to the additional capital investment, including return on that investment, required to furnish the service. Full additional costs, therefore, include all such capital costs necessary to provide service at the anticipated level of rates over a period of time sufficiently long to permit an adaptation of the plant capacity to the size of the market.

7. In determining the minimum rate level for a service category, the appropriate test is the long-run incremental cost (full additional cost) of furnishing the service. Each service category should be furnished on a going basis at a rate level at which the expected revenues

from the category at least cover its full additional costs.

8. Avoidable costs are relevant in determining whether an existing service category is compensatory, that is, whether continuation of the service at a particular rate level imposes a burden upon the users of other services. The avoidable costs for a category are the total costs that would be avoided, i.e., would not be incurred, if the service were discontinued. Since avoidable costs for the Bell System's interstate service categories are indicated to be no more than full additional costs, the setting of a rate level for each category which provides coverage of full additional costs results in the furnishing of service on a compensatory basis.

9. Computations of fully allocated embedded costs do not provide the relevant cost data needed for ratemaking determinations. Such costs are those derived from an apportionment of the total embedded (sunk) costs of operating the enterprise by distributing this total among the various categories of service in such a manner that the sum of the costs imputed to each category is made to equal the total embedded costs. Such cost allocations are misleading and necessarily arbitrary. Their determination is unrelated to a particular increase or other change in output. It is inherent in such cost allocations that the assignment of a large portion of interstate costs among the various

categories disregards to a significant degree the extent to which each service is the occasion for incurring the costs assigned to it. Furthermore, fully allocated costs of this type necessarily represent embedded or sunk costs, whereas current and prospective cost data are needed for rational pricing decisions.

10. Computations of fully allocated embedded costs therefore have no significance as an economic basis for the establishment of appropriate rate levels for the various service categories. These allocations constitute an invalid criterion in the ratemaking process, a criterion that interferes with pricing decisions designed to achieve more effective utilization of facilities and to foster lower unit costs of providing service to all classes of communications users. Use of fully allocated costs as a standard for setting minimum rate levels would arbitrarily force the maintenance of rates at levels other than those that would yield optimal contributions to overall earnings. Fully allocated costs cannot be relied upon to indicate the need for or extent of any rate changes, nor do they reveal the extent to which a service category is contributing to the overall earnings of the enterprise. Reliance on the results of fully allocated cost studies as the determinant of rates or rate levels, or even as a point of departure or benchmark for such determinations, is likely to lead to results that

conflict with the requirements of economic efficiency and public welfare.

11. Although the concept of a "revenue requirement" has a definitive meaning when applied to the Bell System's interstate business in total, such a concept is inapplicable and misleading when it refers to particular service categories. The dollar amount of revenues which any given service category should be expected to produce cannot properly be determined without reference to a specific schedule of rates and to the estimated market which would be served with such a rate schedule in effect. Moreover, any attempt to determine the revenue requirement for a service category in terms of a ratio purporting to be a rate of return for the category would be inappropriate. In determining full additional costs, a factor for return on the additional capital investment is included, but the concept of rate of return for a service category has only this limited relevance.

12. The rates set for each of the Bell System's interstate service categories affect the size and nature of the market. The determination of appropriate rate levels requires consideration of various market factors, such as the degree of consumer responsiveness to rate changes, the availability of competitive alternatives whether provided by other common carriers or by nonregulated suppliers

of equipment and services, the availability of alternative Bell System services, and the interaction of demands among those services which are closely related.

13. Recognition of competitive market factors is essential to the interests of the communications-using public. Rates set at a level which effectively prevents communications common carriers from meeting competition from nonregulated suppliers would exclude the carriers from an important portion of the market, even though they could furnish competitive service at rate levels above the relevant costs. Such loss of business could retard the introduction of technologically advanced facilities and reduce the potential for improved service and lower rates for the users of common carrier services.

14. In addition to a consideration of the market factors described above, recognition should be given to various other noncost factors in determining appropriate rate levels. Among these factors, the relative importance of which depends upon the circumstances prevailing, are the following: (a) stimulation of greater use of service by means of rate levels that will foster growth and development of the service; (b) encouragement of those patterns of use that make possible more efficient utilization of facilities; (c) selection of service offerings and rate structures that permit customers to choose appropriate service

arrangements best meeting their particular communications needs; (d) promotion of relative stability of rates, so that significant changes in rate levels will be needed less frequently; and (e) recognition of appropriate rate relationships among the various interstate services.

15. The determination of appropriate rate levels for each of the service categories should be based on the principle that long-run incremental costs (full additional costs) for each category provide the valid guide for the minimum level but that actual rate levels should exceed this floor by amounts sufficient in the aggregate to cover total interstate revenue requirements. Demand conditions, other noncost factors, and the regulatory constraint on the Bell System's overall earnings set the appropriate rate level above the floor of relevant costs.

16. Because of the nature of the demand for message toll telephone service and the broad-based public need for this service, it is appropriate for the regulatory determination of the Bell System's overall interstate revenue requirements to limit the rate level for the message toll telephone category. Having established the rate levels for the other service categories as set forth below, the rate level for the message toll telephone service category should be established with reference to overall interstate revenue requirements. WATS (Wide Area Telephone Service) is a form

of long-distance telephone service, closely related to message toll telephone service, and rates for the WATS category should be set on the basis of their relationship to the rates for message toll telephone service, reflecting market factors and cost savings.

17. With respect to the other principal interstate service categories, the rate levels should be set so that each contributes as much to total revenue requirements as is reasonably practicable, taking into account market conditions, rate relationships with closely related services, and other relevant factors (such as those enumerated in paragraph 14 above), _i.e._, so that each produces an optimal earnings contribution to the enterprise. In this way the contributions which these other services make to overall earnings permit the furnishing of message toll telephone service at rates lower than would otherwise be required.

18. With respect to the rate level for message toll telephone service, the overall interstate earnings requirement establishes the upper limit. With respect to the rate levels for other principal service categories, demand conditions, competitive factors, and rate relationships with closely related services effectively set an upper limit. However, if a situation were presented where these factors appeared to be ineffective in setting an appropriate upper limit for a service category, a test

which may assist in determining whether the rate level for that service category calls for special justification or limitation is to ascertain whether the ratio of its revenues to its full additional costs is greater than the ratio of revenues to full additional costs for the message toll telephone service category.

19. In the Bell System's multiservice interstate business, where there are dissimilar demand characteristics for the various services, there will normally be variations from service to service in the ratio between revenues and full additional costs. Even those service categories whose rate levels are close to full additional costs may be making their optimal contributions to total revenue requirements. The optimal rate levels for the various interstate service categories, therefore, can be expected to yield varying contributions depending upon the particular market characteristics for each service.

20. The above statement has set forth only rate-making principles and factors and does not deal with methods and techniques for their application. As the Commission has recognized, when rate revisions are considered, it is necessary to make estimates, based on pertinent available data and on operating experience, to predict the effect of such changes on future operating results. This procedure is a

necessary part of the process of determining appropriate rate levels. No single method of analysis, however, can be applied to all service categories under all circumstances. Depending on the characteristics of the service to be studied, different analytical methods are appropriate. The continued development and refinement of procedures for analysis of supply and demand factors and for implementation of these ratemaking principles and factors should be encouraged.

February 15, 1968

> "... A heavy burden will be upon the applicant for such duplicate facilities to demonstrate that overriding public interest factors favor a grant." *Proposed Global Commercial Communications Satellite System*, 2 F.C.C. 2d 658, 665 (1966).

See also: *Texas and Pac. Ry.* v. *Gulf, Etc. Ry.*, 270 U.S. 266, 277 (1926); *Texas &c R.R.* v. *Northside Ry.*, 276 U.S. 475, 479 (1928); *Chicago & N.W. Ry. Co.* v. *Chicago Etc. R. Co.*, 380 U.S. 448 (1965), *reh. den.* 381 U.S. 907 (1965).

C. Grant Of The Applications Would Threaten The Integrity Of The Nationwide Communications Rate Structure [Issue (h)].

The principle of average rate making is favored by most communications common carriers and has been utilized by them, with the approval of this Commission, for many years. (AT&T Ex. 3, p. 2) This principle has also received widespread approval among state regulatory commissions and is generally in use throughout the United States. Charges for more costly or less heavily used routes have been averaged out with those for the more economical ones. This is a major factor in providing non-discriminatory rate treatment. Such a system promotes nationwide uniformity with respect to rates and greatly simplifies rate administration and understanding thereof by the public. (AT&T Ex. 3, pp. 2-3)

The establishment of limited common carrier systems undermines this basic principle. Such carriers will not apply to serve expensive or rarely used routes. These carriers will be interested only in the most profitable routes. (Tr. 1429-31) If MCI is successful, the existing carriers will have to analyze their rate structures for the competitive routes in isolation from the rest of their business. If a system could be established which would be able to get steady customers on a heavily traveled route, the existing carriers would lose revenues without any concomitant reduction in expenses. (Tr. 2339)* If such a process continued, the existing carriers would retain all of the more costly routes with a lesser total volume of business over which their total costs could be distributed than would otherwise be the case. The result for the existing carriers would have to be lower quality service or higher rates than would otherwise exist, or both.

If the existing carriers ever find that their nationwide rates are not competitive with a limited carrier, they may reluctantly establish a different rate for that one route. (AT&T Ex. 3, p. 6; Tr. 2146-7, 2342, 2363-4, 2421-3) Mr. Chisholm, a Western Union witness, stated that to whatever extent revenues "would be making a contribution in excess of the variable costs," the carriers would be "better off with the business than without it." (Tr. 2423) In response to questions by the Common Carrier Bureau, witnesses for both Bell and Western Union testified that their companies could fix compensatory rates between Chicago and St. Louis at a lower level than MCI if they considered only the cost of facilities used on that route. (Tr. 2146, 2421-3) In view of the economies of scale and the experience available to the existing carriers, these conclusions are reasonable. Such compensatory rates would be lawful if required to meet competition, as shown by the *TELPAK* decision.

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* No one understands the substance of this point better than Mr. Goeken, who testified that he (MCI) would oppose an application for a competing system. (Tr. 1428) See also: F.C.C. Public Notice 3405, July 19, 1967, p. 2.

INTERCONNECTION

Summary:

Telephone companies in the United States are held responsible for the quality of service and the usefulness of the nationwide communications network. The provision of high quality communications service at reasonable costs demands that the publicly regulated telephone companies have full responsibility for, and control over, the facilities used to furnish that service. Adherence to this principle has been an important factor in the development of the outstanding communications system the nation benefits from today.

Telecommunications industry policy governing the use, or "interconnection," of private (customer-provided) communications facilities with the public telephone network furnished by regulated common carriers, is not inflexible. A number of interconnections have been made over the years in situations where it was shown to be desirable in terms of the public interest or where it could be done without jeopardizing service to others. The primary concern is that unlimited interconnection: 1) would seriously degrade the present high quality of telephone service in this country; 2) would lead to both higher costs and lower quality standards in the future; and 3) would seriously hamper innovation and wide scale future improvements in the telephone system.

At the same time, the telephone companies fully recognize the need for flexibility as capabilities and requirements change. The Bell System's approach -- in looking for ways to best serve new communications needs -- is to be open, responsive, and as flexible as possible.

Note: The attached paper was submitted to the Task Force staff in February, 1968. Since that time, the Bell System has taken additional steps to liberalize its tariffs on the connection of customer-provided equipment to the nationwide network.

In a letter to FCC Chairman Rosel Hyde on July 29, 1968, AT&T President Ben S. Gilmer said that the company was "well along in the formulation of new tariff regulations which ... will meet changing customer requirements and at the same time protect the quality of telephone service to the public at large." He pointed out that "our objective in this review has been to open the network to the widest constructive use."

The new tariff proposals to which Mr. Gilmer referred were filed with the FCC on August 29, 1968. A copy of the accompanying letter to the Commission is included in this section. Also included is a summary of the proposed changes.

INTERCONNECTION AND THE BELL SYSTEM

Introduction

The purpose of this paper is to explain, briefly and in general terms, the position of the Bell System with respect to the use, or "interconnection," of private (customer-provided) communications facilities with the public telephone network furnished by regulated common carriers and to outline the principal reasons for that position. For reasons stated below, this paper does not deal with connections between the facilities of regulated common carriers.

Essentially, the Bell System's position is this:

> In the interest of providing high quality communications service at reasonable cost the publicly regulated telephone companies should, as a general rule, have full responsibility for, and control over, the facilities used to furnish that service.

The reasons for this position, a position which we believe represents that of the telephone industry generally, stem from the very nature of telephone service and from the fact that telephone companies in the United States are held responsible for the quality of service and the usefulness of the nationwide communications network. Adherence to the principles underlying this position, which have had the understanding and support of regulatory bodies for many years, has been an important contributory factor in the development of the outstanding communications system the nation benefits from today.

This is not to say that interconnection policies are or should be completely inflexible. A number of interconnections have been made over the years, in situations where it was shown to be desirable in terms of the public interest or where it could be done without jeopardizing service to others. These situations will be discussed more fully in the following pages.

In general, the Bell System companies do, of course, connect with other, non-Bell, communications common carriers that are also fully subject to regulation. Such connections do not involve the problems of quality and cost of service which arise from connections with customer-provided facilities since regulation of common carriers affords protection to the public in these areas.

It also should be recognized that interconnection practices are -- and will continue to be -- subject to pressures for change. It would be surprising if this were not the case, particularly in a period of rapidly developing technology and increasingly diverse communications needs.

The Bell System's intent in this respect is to be as responsive as possible to new communications needs, and to do all it can to accommodate new and worthwhile devices. At the same time, however, the telephone industry and those who oversee it should not lose sight of the basic principles that underlie interconnection policies -- principles that are vital to the optimum performance of the nation's communications system.

Fundamentals Underlying Interconnection Policies

At the heart of the Bell System's position on interconnection is the concern that unlimited interconnection would seriously degrade the present high quality of telephone service in this country, and would lead to both higher costs and lower quality standards in the future.

This is a very realistic concern for a number of reasons:

1) Compatibility - The communications network, unlike a gas or power network, interconnects millions of devices on a two-way basis. These devices don't merely receive energy, as electric lights and appliances do. They also put energy into the network. Hence each item of equipment connected to the telephone network -- from a telephone to a computer -- can affect the operation of other parts of the system.

   A telephone with poor transmission characteristics will adversely affect service quality not only for the particular customer using it, but also for any others who call or happen to be called by that telephone. A faulty telephone can also cause frequent wrong numbers or interfere with the service of others by causing noise and "crosstalk."

In the same way, if an interface or coupling device used as a buffer between a data system and the communications network is inadequate, this can result in power surges that impair transmission quality on dozens or hundreds of long distance circuits that travel the same route.

The sure performance of each part of the complex communications system depends upon the quality and compatibility of every other part. And in order to achieve the close balance required among the billions of these intricate parts which make up the nationwide network, the telephone companies need to maintain an undivided responsibility for the choice and operation of these elements.

2) Innovation - The telephone system is being improved continually, in large ways and small ways, as new and improved equipment and techniques are developed and introduced. The use of customer-provided equipment would hamper such innovation, because many customers would resist accepting changes which would require the replacement or modification of their own equipment.

It is sometimes suggested that the purposes of interconnection policy could be served by establishing specifications for devices to be connected to the network. But even if specifications could be developed, and quality standards somehow maintained, the deterrents to innovation would remain.

A good example of a major improvement which could well have been delayed or even prevented is the 500-type telephone set, which has become the standard of the telephone industry.

Besides improved appearance and usage characteristics, the 500 set offered substantially better transmission capabilities than previous telephone sets. This permitted the use of smaller diameter copper wire, and thus made possible great economies in providing distribution cable. The total cost savings -- to the benefit of all telephone subscribers -- are estimated in the hundreds of millions of dollars.

The introduction of Touch-Tone* dialing, featuring a phone with push-buttons instead of the standard rotary dial, is a current example of an improvement which could be delayed if customers provided their own equipment. The Touch-Tone telephone is faster and easier to use than a rotary dial phone. Moreover, it has great importance beyond that because it offers data transmission capabilities to customers for communicating with computers for banking, shopping, educational, and other purposes.

Other improvements and economies now being introduced or in the development stage are: electronic switching systems for central offices; more efficient receiver units for telephone sets; and an electronic telephone, which promises to be smaller and lighter than present phones and will offer important economic advantages as well as even better transmission characteristics.

*Registered Mark

This electronic telephone is presently projected for introduction in the 1970's. Such developments could be held back or blocked by the widespread use of customer-owned facilities.

3) Maintenance - Because it is so vital to the quality of telephone service, maintenance is included as part of the service provided by the Bell System and independent telephone companies.

High quality depends on a continuing maintenance program, including preventive maintenance, and excellent maintenance, in turn, is furthered by uniformity in training and maintenance procedures.

On the other hand, if equipment were customer-provided, the quality of maintenance could be expected to vary widely. It would depend on many factors, including each customer's ability to maintain his equipment, his financial situation, his promptness in seeking satisfactory maintenance, and the availability of competent maintenance service.

Unlimited interconnection would fragment the responsibility for maintenance of the telephone system. As a practical matter, the regulated telephone industry could not then be held responsible for the overall quality of service.

4) Cost of service - Unlimited interconnection would also have an adverse effect on the costs of providing telephone service.

Major economies -- which flow from the unified approach to the design, installation, operation, and maintenance of the telephone network -- would be lost or delayed as discussed earlier.

> There also would be direct economic penalties. As an example, divided responsibility for maintenance would make the handling of service complaints less efficient and certainly less satisfactory from the customer's point of view. Complaints would have to be investigated, even though it was ultimately found that the trouble was caused by customer-provided equipment. Resulting visits by telephone company personnel to customer premises would be wasteful of time and money, and would impede the overall maintenance job.

These are some of the reasons why the telephone industry believes that reasonable restraints on interconnections should be one of the cornerstones of national communications policy.

It is worth noting that, in the earlier days of telephony, some of the telephone companies experimented with customer ownership of telephone equipment. However, in state after state the public utility commissions ordered the companies to abandon the practice because of the adverse effects on telephone service. Today, the thousands of independent telephone companies in the United States have interconnection practices similar to those of the Bell System companies.

As mentioned earlier, however, the question of interconnection should be approached flexibly. Here are some examples of private communications facilities which are connected with the nationwide network:

-- Right-of-way companies, such as railroads, pipelines, and power companies, may connect their private systems in emergency situations involving their right-of-way locations or in hazardous or inaccessible locations. Military establishments also may connect in cases required by military necessity.

-- Connections are made with a broad spectrum of customer-provided devices or facilities which involve a direct electrical connection, when used in conjunction with telephone company interface or coupling arrangements. (The interface is placed between customer equipment and the network to protect the network and the service of others from harmful signals.)

Some examples thus connected to the network are: voice recording equipment; electrocardiogram equipment; automatic answering and recording equipment; alarm and detection devices; and computers and other data transmitting and receiving equipment.

-- There is a wide variety of other equipment which may be used in conjunction with telephones or other equipment provided by the telephone company. Included are such devices as voice silencers, certain voice amplifiers, telephone holders, shoulder rests, and hard-of-hearing attachments. Such devices, if "privately beneficial, but not publicly detrimental" can be used if they do not damage telephone company equipment or interfere with service.

-- The telephone companies provide channels which connect with customer-owned facilities used for radio broadcasting, television, telephotograph, wired music, voice intercommunicating equipment, and data transmission.

-- As another step in its efforts to be flexible in meeting customer desires, the Bell System has invited makers and sellers of exotic and

> antique "decorator" telephones to design them so that telephone company dials, transmitter and receiver capsules and associated equipment can be put in by telephone installers. These essential parts are then compatible with others in the network, and the telephone companies can maintain them as they would any others.

So today there are, actually, many types of equipment which may be interconnected, provided adequate safeguards are taken to protect the network that many customers use in common.

Interconnection and the Future

Knowledge and skill in communications technology are developing at an unprecedented pace. Customer needs for communications services are becoming more and more diverse. These and other factors will contribute to the continued great expansion of the entire communications industry, both in size and in ability to provide a wider range of services.

H.I. Romnes, AT&T's chairman of the board, noted the great changes in the communications field, and their potential impact on interconnection practices, in a speech at the annual meeting of the American Petroleum Institute last November:

> "The fact is that the common carrier network today is wide open to attachment of all kinds of equipment -- I dare say far more than anyone would have guessed even ten years ago."
>
> He added that "we want to minimize prohibitions and restraints, not multiply them ... We have a task force actively at work reviewing and analyzing all of our practices that bear on the

interconnection of various facilities. We want to make sure that these procedures fit today's technology and today's needs -- your technology and your needs ...."

In summary, the Bell System believes that reasonable restraints on interconnection are essential to sound national communications policy. The basic interconnection policies have served the public well and have helped provide the nation with the finest communications system in the world.

At the same time, there is full recognition of the need for flexibility as capabilities and requirements change. In the years ahead, the Bell System's approach -- in looking for ways to best serve new communications needs -- will be open, responsive, and as flexible as possible.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

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AREA CODE 212 393-1000

D. E. EMERSON
VICE PRESIDENT

August 29, 1968

Mr. Ben F. Waple, Secretary
Federal Communications Commission
Washington, D. C. 20554

Dear Mr. Waple:

Application is hereby made for permission to file, to be effective November 1, 1968, the attached revisions in A.T.& T. Tariff F.C.C. No. 263. Permission is requested in view of the circumstances involved in the proceedings pending before the Commission in Docket Nos. 16942 and 17073.

The attached tariff pages contain proposed changes in the regulations relating to connection of customer-provided equipment and systems to the message telephone network. As stated in Mr. Gilmer's letter of July 29, 1968, to Chairman Hyde, the Bell System Companies have for some months been reviewing the tariff regulations relating to this matter. Our objective in this review has been to open the network to the widest possible constructive use. The tariff regulations attached to this application are the result of this review and, in our judgment, will meet changing customer requirements and at the same time protect the quality of telephone service to the public at large.

These revised regulations provide for the connection of various kinds of customer-provided data and voice transmitting and receiving terminal devices through service-protecting arrangements. Thus, provision is made for the direct electrical connection of customer data transmitting and receiving equipment either through a DATA-PHONE data set which is currently furnished by the Bell Companies, or through a new Data Access Arrangement under which the customer equipment performs the data signal conditioning normally performed by the DATA-PHONE data set. Direct electrical connection of customer voice transmitting and receiving equipment is provided for through a connecting arrangement furnished by the telephone company. The use of customer data or voice transmitting and receiving equipment which involves acoustic or inductive connection to telephone company facilities is expressly provided for under the revised regulations.

For protection of the network, the regulations specify certain minimum criteria for customer transmitting and receiving equipment. In addition, in order to protect the functioning of the network, network control signalling (i.e., the transmission of signals into the telephone system which perform supervision, number identification, and control of switching machines) will continue to be performed by facilities furnished by the telephone company.

As Mr. Gilmer's letter to Chairman Hyde pointed out, the matter of general interconnection of customer-provided communications systems involves serious and complex public interest problems which go beyond those involved in the connection of terminal devices. We believe that these problems require much more consideration and exploration on the part of both industry and the regulatory agencies. For this reason, the revised regulations provide for the retention of the existing regulations relating to the connection of customer-provided communications systems together with an additional section providing for the connection of private mobile radio systems with the network. Meanwhile, we are pursuing the study of further possible changes in regulations relating to the connection of customer-provided communications systems.

We submit that, in the interest of making the nation-wide network increasingly flexible and useful in a manner that will produce the most effective service to all its users, permission to file the attached tariff revisions as requested in this application should be granted.

Copies of this application and of the attached tariff regulations are being sent to each Commissioner and to all parties in Docket Nos. 16942 and 17073.

Respectfully submitted,

Emerson

Vice President

Attachment

SUMMARY OF CHANGES IN TARIFF REGULATIONS

(1) Provisions are made for connecting various kinds of data and voice transmitting and receiving devices provided by others than the telephone companies. Network control signalling, (i.e., the transmission of signals into the telephone system which perform supervision, number identification, and control of the switching machine), will continue to be furnished by the Telephone Company. The major changes are:

A. Direct electrical connection of customer-provided data transmitting and receiving equipment under either of two options:

(a) By means of telephone company provided DATA-PHONE data sets, or

(b) Through a data access arrangement which provides a protective connecting arrangement for use with the network control signalling unit. Minimum network protection criteria are specified for the protection of the network and its users.

Thus a customer may decide to subscribe to service through DATA-PHONE or select the data access arrangement and provide his own modulating devices. Under this latter arrangement business machine manufacturers may incorporate such modulating devices in their products if they wish.

B. Direct electrical connection of customer-provided voice transmitting and receiving equipment through a connecting arrangement provided by the telephone company. Minimum network protection criteria are again specified for the protection of the network and its users.

C. Acoustic and/or inductive connections of customer-provided voice or data transmitting and receiving equipment. Minimum network protection has been established for such connections as well as for those enumerated above.

(2) The matter of general connection of customer-provided communications systems involves serious and complex public-interest problems. These problems require much more consideration and deeper exploration on the part of both industry and Commissions. For this reason the proposed tariff regulations at this time retain the existing regulations relating to the connection of customer-provided communications systems, with the addition of a provision for connection of private mobile radio systems either through an acoustic-inductive device provided by the customer, or through a connecting arrangement provided by the telephone company. Both means of connection are subject to certain minimum network protection criteria as enumerated in the tariff. Meanwhile, we are pursuing the study of further possible changes in regulations relating to the connection of customer-provided systems.

8/29/68

10

VOICE/RECORD COMMUNICATIONS

Summary:

There is no technological distinction between voice and record communications service today. The nationwide communications network is presently used to handle not only voice communications but all types of record and alternate voice/record service as well. Neither the transmission facilities nor the switching system distinguish between the two.

The creation of two dedicated, segregated networks would result in massive cost penalties. Such a separation would be both impractical and contrary to the public interest for a number of technical, economic, and service reasons. In addition to substantially increasing the cost of communications service to the public, it would restrict the availability of communications service to the public; it would be detrimental to national defense needs; it would deprive the public of the benefits from continued research and development in all fields of communications.

In sum, there are no valid technical distinctions between voice and record communication modes. Proposals to restructure the industry according to such artificial lines are technologically unsound, economically wrong, and contrary to the interest of communications users in general.

VOICE AND "RECORD" COMMUNICATIONS: SHOULD ANY DISTINCTIONS BE MADE?

Introduction

A question that comes up from time to time in the communications field is whether there could be any valid reasons for distinguishing between or creating a separation of voice and non-voice ("record") services. This paper will explore the nature of voice and record communications and discuss what distinctions, if any, should be made between these modes for technical or for economic and service reasons.

Looking first at technical aspects, there is virtual unanimity of opinion among communications experts that no technological basis exists for making a distinction between voice and record communications services today. Factors that contribute to this consensus include:

1) The comparability of communications signals -

   In the early days of electrical communications, the telephone and telegraph generally were looked upon as two distinct inventions. But as the technologies advanced, the distinctions between them became more and more vague. To a large extent, the separation of the two forms of communications reflected the limitation of primitive hardware.

   Under today's technology, of course, the fact that an electrical communication takes a particular form or originates in a particular manner is of little consequence. Rather than being divided, such communications are united by the fact that they can be transmitted electrically.

Dr. John R. Pierce of Bell Telephone Laboratories discussed overall progress in the communications art in a technical paper presented in October, 1966. Dr. Pierce observed that:

"... our intellectual conception of communication has finally caught up to what has always existed in the nervous system -- a common sort of communication for all modalities of sense. Our conception of communication has also come to fit what has increasingly existed in communications systems -- circuits that can be used interchangeably for telegraph, voice, or picture signals. We are now achieving, both conceptually and practically, something approaching the universality in electrical communication that was built into the communicating senses of man even before he had learned to read and to write."

2) <u>Capabilities of the nationwide communications network</u> -

The nationwide communications network, provided by the Bell System and independent telephone companies, is presently used to handle not only voice communications but all types of record and alternate voice/record services as well.

Neither the transmission facilities nor the switching system distinguish -- or need to distinguish -- between electrical signals which originate with the human voice and those which originate otherwise. These facilities make no more distinction between human language and machine language than they do between spoken English and spoken French or Russian.

The use of the nationwide network for record communications is constantly expanding. For example, there is a rapidly increasing use of Data-Phone* service, which permits the transmission of data over regular telephone lines. And the introduction of Touch-Tone* telephone service, with inherent flexibility for alternate voice/data use, offers additional data transmission capabilities and advantages to subscribers.

Systems are now coming into use that enable customers to transmit banking, credit, inventory, and production information -- or even to order groceries or draw checks on their personal bank accounts -- by means of the signalling capabilities of their Touch-Tone telephones.

And, in the newer, digital transmission systems (such as PCM, or pulse code modulation), there is absolutely no distinction made in the handling of signal pulses that represent information originating as voice, data, facsimile, or pictures.

Other capabilities of the telephone network for non-voice transmission are increasingly being recognized. Business equipment manufacturers are marketing equipment to transmit a variety of forms of information over regular telephone lines. Newspaper photographers for years have transmitted photographs over telephone lines. Other arrangements make it possible for data to be recorded on magnetic tape for retransmission. A recent and important development enables the family doctor, using simple, portable equipment, to transmit electrocardiograms from any patient's home telephone.

*Registered Mark

> Present day capabilities of the telephone network emphasize the fact that any distinction between one form of communication and another is an artificial one.

Communications experts therefore agree that, in light of technological developments in the communications art, no distinctions should be made between voice and record modes.

This conclusion was reached as far back as 1951 by the President's Communications Policy Board. In its report transmitted to the President on February 16, 1951, the Board said: "We have looked carefully into the proposal that the telecommunications industry should be divided clearly into two parts, one dealing exclusively with 'record' communications, the other with communications by 'voice.' Our examination of this question has shown that such a dividing line is very difficult to draw, and we have concluded that the attempt to reorganize the telecommunications system on the basis of such a distinction might result in effects on the system going far beyond the initial intention of any such division...."

General Sarnoff, in addressing the Armed Forces Communications and Electronics Association in May, 1965, observed that: "... today the electronic pulses which we use to transmit information make no distinction between voice and data, words or images. They are all so many bits of energy. The broadband channels through which they flow can accommodate them all."

Former FCC Chairman Newton Minow, in his May 31, 1963, letter to President Kennedy, said: "The distinction between voice and record communications is being blurred, and there is a growing need for the broadband channel; this pattern is certain to continue, as computers become increasingly important."

E. William Henry, who succeeded Mr. Minow as FCC Chairman, noted the artificiality inherent in such a separation in his August 14, 1963, address to the Standing Committee on Communications of the American Bar Association: "But the distinction between voice and record communications, from a technical, operating standpoint, has become blurred. For example, in what category does television belong? The same circuitry used for voice can be used for digital computer information. New broad-band services now offer the customer communications channels which he can use for voice or record communications as he chooses....

"...The possibilities of intermixing voice and record services are almost limitless. New technology, and the needs of modern business and modern government have made the old distinction between voice and record communication more and more artificial...."

Even in the face of the technological realities, however, there have been suggestions on some occasions in the past that the communications industry of this country could be restructured to create a separation between voice and record services. Basically, these proposals would limit telephone companies (Bell System and independent) to the provision of voice services only. The telephone industry would not be allowed to offer record services alone or even to offer voice and record services alternately or in combination.

Such a separation would be both impractical and contrary to the public interest, for both economic and service reasons:

1) <u>A voice/record separation would substantially increase the cost of communications services to the public</u>.

A separation of voice and record services would undoubtedly require the creation of two separate communications networks, not only for interchange facilities but for local exchange plant and switching equipment as well. The creation of two such dedicated, segregated networks would result in massive cost penalties. (The facilities of Bell System and independent telephone companies which comprise the nation-wide network represent an investment of about $40 billion.) The practical effect of such unnecessary duplication would be an inevitable escalation of the cost of communications services.

A separation also would result in costly losses of efficiency in design, construction, operation, and maintenance. Because of the technological similarity of all communications services, communications plant can be provided most efficiently and economically if no attempt is made to segregate and dedicate facilities on the basis of the use ultimately made by the subscriber. Capital costs of design and construction can be minimized if requirements for <u>all</u> types of service can be included in the initial design phase and combined facilities can be constructed to accommodate the total requirements. In short, the ability of the communications network to handle both voice and record services permits the achievement of high load factors and economies of scale.

Moreover, utilization of the inherent flexibility of the telephone network reduces testing and maintenance expenses. The basic instruments and personnel needed to maintain and test facilities are largely the same, regardless of whether the traffic carried by such facilities is voice or record. Thus, an enforced separation of services would add considerably to these expenses, and would result in increased communications charges to the public. And as a practical matter, it would be virtually impossible to enforce such a separation if subscribers utilized acoustical coupling devices.

2) <u>A voice/record separation would restrict the availability of communication service to the public</u>.

In addition to its effect on costs as a result of unnecessary and uneconomical duplication of facilities, a separation of voice and record would restrict subscribers in their use of communications service and curtail the availability of service both in the private line and exchange service fields.

The users of communication services, both large and small, have made clear the need for combinations of voice and non-voice service. There has been rapid growth in communications use of voice-data services by business as well as government users. For example, many businesses program their computer work so that circuits used for voice communication during the day are used for the transmission of data at night when the facilities would otherwise be idle.

As recognized by the General Services Administration: "Separation of voice and record traffic would not accommodate customer needs for an integrated communications system nor recognize advances in communications technology. It would create artificial obstacles to the realization of fundamental economies through joint and interchangeable use of common plant."*

Adoption of any proposal to separate voice and record would, as a practical matter, deprive a large segment of the communications-using public of non-voice service. For example, smaller users might be deprived of the opportunities to use the Data-Phone and Touch-Tone features of telephone service. These features make it possible even for users whose requirements are too small to justify dedicated private line systems to transmit data over their telephone facilities as frequently or infrequently as their needs dictate.

Another example is the use of telephone facilities for data transmission in cases where highway counters, electrical meters, gasoline or water supply meters are in remote locations. Services of this nature are valuable to the users, and it would be detrimental to the public interest to prohibit the use of the telephone network for these services.

*Brief of the General Services Administration before the Federal Communications Commission in the Domestic Telegraph Investigation, Docket No. 14650, pp. 6-7.

3) <u>A voice/record separation would be detrimental to the national defense needs</u>.

The Department of Defense has emphasized that adoption of any proposal to separate voice and record service "would seriously and detrimentally affect the defense effort and the national security."* The Department of Defense further stated that:

"A complete separation of voice and record communications would not only be contrary to the public interest but would be detrimental to the national security.

"The essential communication needs of the military require complete flexibility in the use of communication channels irrespective of the type of input, voice or record, at any given moment....There must be a capability of instantaneous selection and alternate use of communication paths."**

4) <u>A voice/record separation would deprive the public of the benefits from continued research and development in all fields of communication</u>.

Record communications services have substantially benefited in the past from the research and development of the nation's telephone companies. It is questionable whether communications services would be as far advanced as they are today if these companies had been arbitrarily precluded from furnishing record services. Basic research, applied research and development, and

* Brief of the Department of Defense in the Domestic Telegraph Investigation, FCC Docket No. 14650, p.3.

** Ibid.

design for production, carried on by the telephone industry, have found application in all fields of communications -- telephone, telegraphy, facsimile, data communications, television program transmission, and others.

Continued telephone industry participation in providing communications services other than voice will undoubtedly result in further improvements in the communications art. Pulse code modulation (PCM), developed as a means of transmitting voice signals, promises to be a most efficient method of high-speed data transmission. The development of Data-Phone service and the Touch-Tone telephone set has stimulated the introduction of many new systems, including systems in which digital inquiries can be manually directed to electronic machines which in turn send back voice replies.

The public should not be denied the potential of similar contributions in the future for the sake of an artificial separation of communications modes. If the nation's telephone companies were prohibited from offering non-voice services, in the long run the public would be deprived of the benefits from the continuing participation of the telephone industry in all areas of communications research and development.

In summary, there are no valid technical distinctions between voice and record communication modes. Proposals to restructure the industry according to such artificial lines are technologically unsound, economically wrong, and contrary to the interests of communications users in general.

If there is one thing that experience in communications service has taught, it is that duplication of facilities is unsatisfactory and unacceptable to the public, as well as uneconomic. Customers, both large and small, want flexibility in communications -- including simple access to a multiplicity of service offerings. These needs can best be served through the versatility offered by a communications network with multipurpose capabilities.

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AREA CODE 212 393-4664

WILLIAM R. STUMP
EXECUTIVE ASSISTANT

FEB 21 1968

Mr. Don Mackin
Environmental Science Services Administration
Department of Commerce
Boulder, Colorado 80302

Dear Mr. Mackin:

Your request for information, concerning the growth of data services and estimates of bandwidth for data use in the future, has been referred to us because of your interest in interstate aspects. John Shepherd, Mountain States Telephone, tells me that you are thoroughly knowledgeable about our service offerings -- so I'll omit the standard descriptions and attempt to answer your specific questions.

(1) Growth of data services compared to voice services on the message network.

- One measurement of growth in data services which may be helpful to you is the increase in the number of Data-Phone data sets. Attachment 1 shows the growth since 1962, with projections through 1969. (The growth of sets in service continues to be strong; the year-to-year percentage increase is expected to continue for the next few years at near present levels, although down somewhat from the very high initial yearly percentages.)

- Statistical information showing the message growth on the interstate network also may be useful.

  - Attachments 2 & 3 list the volume of interstate messages for long distance telephone and Teletypewriter Exchange Service (TWX) respectively.

  - Attachment 4 shows the growth in Wide Area Telephone Service (WATS) access lines, rather than messages. Records of WATS messages are not maintained, since customers are not charged for individual calls.

- We have no separate statistics for the number of data calls vs. voice calls. This is because data service is not a service which is separate from our other services. A data call is established like any other telephone call -- by dialing on the local or long distance networks. We do not distinguish between a telephone call used with voice and one used for data, and the charges are exactly the same.

(2) Estimates of type of bandwidths necessary, or which will be offered, for data use on the message network, in the future.

- Present estimates of bandwidth requirements in the future are tentative, at best, because so much depends upon the changing needs of our customers. We maintain an active liaison with about 250 manufacturers of business equipment to assure that we are able to provide a full range of services to satisfy customer requirements.

  Generally, we anticipate: a continually growing need for voice grade services, like Data-Phone data service, and an emerging need for wideband services, primarily for computer-to-computer connections and for transmission of high speed facsimile.

- In addition to our present data service offerings, with which you are familiar, we are doing some developmental work on wideband switched services.

  . On February 15, 1968, we filed a tariff revision with the F.C.C. to provide for an offering of a 50 kilobit switched message service. If permitted by the F.C.C., this service, DATA-PHONE 50, would be offered on a trial basis beginning April 1, 1968, in 4 cities (Washington, New York, Chicago, Los Angeles).

  . We are also planning to conduct a Product Trial of PICTUREPHONE service (1 mHz bandwidth) later this year. Our market estimates for these services are somewhat sketchy -- but we expect to learn a good deal more from the trials.

As you probably know, the F.C.C. has launched a broad inquiry into the interdependence of computer and communications services and facilities (Docket 16979). For this inquiry, we are currently developing detailed information, which may also be useful to you. When it is available, we'll send you a copy.

Sincerely yours,

W.R. Stump

Attachments
cc: J.M. Shepherd, Mountain States Telephone

Attachment 1

DATA-PHONE Data Sets

End of	DATA-PHONE Data Sets	Percentage Increase Over Previous Year
1962	5,698	
1963	8,802	54.4%
1964	13,989	58.9
1965	20,472	46.3
1966	30,333	48.2
1967 (estimated)	45,000	48.4
1968 (estimated)	65,000	44.4
1969 (estimated)	86,000	32.3

Attachment 2

Interstate Message Toll Telephone (MTT)

	Messages (Millions)
1962	1,173
1963	1,266
1964	1,392
1965	1,569
1966	1,780
1967	1,945
1968 (estimated)	2,100
1969 (estimated)	2,260

Attachment 3

Interstate Teletypewriter Exchange (TWX) Service

	Messages (000)
1962	30,313
1963	32,771
1964	33,941
1965	33,559
1966	32,859
1967	32,176
1968 (estimated)	34,280
1969 (estimated)	35,650

Attachment 4

Interstate Wide Area Telephone Service (WATS)

	Outward* Access Lines	Inward* Access Lines
1962	5,147	-
1963	8,408	-
1964	11,106	-
1965	13,967	-
1966	16,497	-
1967	21,924	1,200
1968	29,500 (estimated)	2,600 (estimated)
1969	35,500 (estimated)	3,900 (estimated)

* Separate services: the same WATS line cannot be both Inward and Outward.

11

QUALITY VS. COST CONSIDERATIONS

Summary:

While costs and quality must be balanced, they are not necessarily conflicting objectives. Lower quality does not necessarily mean lower costs. In fact, the reverse is true. Lowering standards leads to increased customer complaints, higher maintenance costs and reduced usage.

Telephone service objectives in the Bell System reflect several factors including the state of the art, rising customer expectations and new service demand -- all tempered by a delicate balance between costs and appropriate levels of quality. These factors often influence each other dynamically. Quality service and customer acceptance go hand in hand. Service in the end must be satisfactory according to customer standards.

Telephone service has improved steadily over the years. The speed at which calls are established has been reduced to seconds, transmission is better than ever, and savings to customers have been just as dramatic as improved performance. Through the years the Bell System has been able to offset the inroads of inflation through continuous advance in technology and operating methods.

In sum, Bell System service objectives have developed in response to the nation's fast-changing communications needs. They have been spurred by advancements in telephone technology, influenced by new demands from industry, government and the public in general, and tempered by a continual regard for balancing improved performance with reasonable rates for all users. These are all factors in the Bell System's undertaking to provide the best service possible and to make it continually better, more abundant, and more economical.

SERVICE OBJECTIVES IN THE BELL SYSTEM

Introduction

This paper discusses the service objectives of the Bell System and their relation to quality standards. It also considers the question of the extent to which quality standards can be lowered in order to achieve economies. Our conclusion is that lowering standards will not achieve overall economies. In fact, the reverse is true. Lowering of standards leads to increased customer complaints, higher maintenance costs and reduced usage.

General Service Objectives

1. Availability

   - Trunks, circuits and switching facilities must be capable of handling busy hour call volumes with delays falling within acceptable limits.

   - Calls to operators and to information bureaus and intercepted calls must be handled promptly in accordance with carefully defined standards.

   - Service repair calls and requests for newly installed service must be handled with dispatch and in conformance with the understanding between service representatives and customers.

2. Speed and Simplicity

   - Calling anywhere in the country should be convenient and simple. It should be as easy for a customer to call across the country as it is to dial someone across the street.

3. Dependability

   - Users should be able to count on telephone service at all times for regular use or emergency. Calls should go through as dialed, or as requested by customers when placed with operators.

   - Telephone call connections should remain free of interruption, cutoffs and crosstalk.

4. Clarity

   - A prime consideration in voice communications is the ability of the customer to hear and be heard clearly. Similarly, data communications must be unimpaired by transmission imperfections.

5. Courtesy

   - Service by operators, installers and repairmen and other representatives must be rendered courteously and in a helpful manner.

How Service Objectives Are Established

Service objectives in the Bell System must reflect several factors including the state of the art, rising customer expectations and new service demand - all tempered by a delicate balance between costs, on the one hand, and appropriate levels of quality on the other. These factors often influence each other dynamically. New technology has fostered new demand, which in turn has given rise to higher customer expectations in terms of improved services and more economical rates. An example is direct distance dialing, which has led to increased volume and more stringent customer expectations with respect to the speed with which calls are completed.

Quality service and customer acceptance go hand in hand. Continuous analysis clearly demonstrates this. Over the years the Bell System has used various measures to evaluate service quality. From the early beginnings, for example, to assess performance, we have used many internal measurements of efficiency and service. But internal measurements are just part of the service story. Service in the end must be satisfactory according to customer standards. Therefore the System has also evaluated service quality from the customer's point of view. As far back as 1929, for instance, AT&T established a unit in its Chief Statistician's Division to apply survey techniques to obtain customer opinion. The Bell companies have always given substantial weight to surveys of this kind in setting new service objectives.

In recent years these techniques have become increasingly sophisticated through use of random sampling methods. The latest program - Service Attitude Measurement (SAM) - was started in 1966.

Though SAM can supply important information on companywide and nationwide trends, its major aim is to furnish management with needed facts about local service. Telephone users are asked how they feel about their experience with the telephone company, not only in their daily use of the service, but when they order phones installed or are in contact with the company for some other reason. From the findings come not only new service objectives, but more meaningful interpretations and use of existing objectives. For example, in one plant district a substantial percentage of customers were commenting that when they reported trouble they were not told when the trouble would be fixed. By analyzing the manner in which repair clerks, plant craftsmen and other departments were handling such reports, an effective program for correcting the difficulty was designed. The traditional objective of attempting to restore service within a specified number of hours was expanded to emphasize not only flexible commitment times but also keeping the customer informed - when work was started, of any unforeseen delays, and of the fact that the repairs had been completed. As a result, later surveys showed a marked decrease in customer adverse comments with regard to this aspect of their service. The experience in this district prompted the System to emphasize generally the significance to customers of being kept informed of the status of repair work when telephones were reported out-of-order.

Customer Reaction and Economy

By staying in touch with customers through opinion surveys, the Bell System has been able to effect savings while providing service deemed satisfactory by users. Special studies have been especially useful here. Before World War II, for example, the service objective for dial tone speed was set so that customers would experience a delay of more than three seconds on only 0.5% of calls. This meant that when a customer attempted to dial a call, he received a dial tone within three seconds for 99.5% of the calls during the office's busy hour in the busiest calling season. During the war, in an effort to conserve critical war materials, the service standard was lowered to 1.5% over three seconds. Study of customer reactions then showed that this new standard was generally acceptable to users. After the war, therefore, the objective was continued at 1.5%. The savings from this enabled the Bell System to divert needed capital to other services and improvements.

To answer the question whether an even lower objective for dial tone speed, say 3.0% over three seconds, might be satisfactory to customers, a comprehensive study was made in the 1950's. This provided conclusive evidence that the objective of 1.5% over three seconds for dial tone delay accurately reflected a level of service which was acceptable to the customer, but that levels poorer were unacceptable.

Special studies reveal other information that enables the company to balance costs and quality. For example, periodic assessments of customer reaction to such transmission characteristics as loudness, noise, echo and distortion enable Bell System engineers to set quality standards that are both satisfactory to users and economical to the business.

Can Quality Standards Be Reduced to Achieve Economy?

While costs and quality must be balanced, they are not necessarily conflicting objectives. The introduction and expansion of dial service, for instance, produced operating economies which resulted in substantial savings to users as well as marked improvements of quality and performance in local and long distance telephoning. Continuing with manually handled telephoning would have been prohibitively expensive if not technically impossible in the larger cities. If we had the same number of operators per 10,000 telephones today that we had when dial service started, we would need about a million operators now or five times as many as we now employ. But this couldn't happen, because we couldn't sell 1920-type service to today's public at the price we would have to charge to pay our wage bill. In short, we wouldn't have the customers we have today and the public would not have the service it has today.

Similarly, lower quality does not necessarily mean lower costs. When there are sufficient trunks, labor costs per unit go down as operator work units decrease. When operators respond to dial "O" calls promptly, and when dial tone is not delayed, customers call repair centers less frequently. When the opposite is true, manpower costs go up while quality of service goes down.

It has sometimes been suggested that the telephone companies institute a "delayed message" service. Under this concept, the customer could place a call with the operator who would hold the call until a circuit was available and then notify the customer. Such a plan contemplates the use of fewer circuits than would be necessary for the prompt handling of all calls; this supposedly would result in reduced circuit costs and cheaper service. However, such an approach would actually produce poorer service without any real savings; indeed, it would probably result in <u>increased</u> costs. The expense of the additional operator time necessary to handle the call twice, once to take and record the customer's call and then later to set it up and notify him when it is ready, would offset any economies in circuit costs. This effect will become even more pronounced in the future due to continually rising labor costs while circuit costs continue to trend downward.

Telephone companies today provide a variety of services which offer customers the kind of savings envisioned in a "delayed message" service. Evening, night, weekend and holiday rates are lower than business day rates, for example, to encourage customers to spread their calling into less busy hours. Wide Area Telephone Services (WATS), which encourages customers to queue their calls over a single access line at a fixed monthly rate, also tends to spread customer usage of circuit facilities over a wider time period.

Chart A shows how improvements in service actually produce operating savings. More adequate provision of circuits means better service to the customers, in that calls go through promptly without the need for operator assistance and with a minimum of trouble reports. Reducing operator work time, in turn, results in lower costs.

A further illustration of this effect lies in the provision of switching equipment. As the time a customer must wait for dial tone increases (a result of providing less switching equipment in a central office), experience has shown that trouble reports go up. This results not only in customer dissatisfaction but in increased and unnecessary labor costs in investigating such reports.

Another pertinent factor is the fact that as the quality of service improves substantially, usage of the network tends to increase with a resultant increase in the economies of scale which benefit all users.

Improved Service, Lower Rates

Telephone service has improved steadily over the years. It took about ten minutes for operators to set up a cross-country connection in the 1920's. Today a cross-country call through an operator takes less than a minute to establish, and direct dialed calls go through in seconds.

Transmission is also better than ever. Nobody shouts to be heard on the telephone today.

Savings to customers have been just as dramatic as the improved performance. In 1940, the average telephone user worked six hours to pay for one month of local residence service. Now (Chart B) he works one-third that time and is able to reach more telephones. Also, rates for long distance service have dropped substantially. The cost of a three-minute daytime call from coast to coast was $16.50 in the 1920's. This compares with $1.75 today and the lowest rate of 75 cents for calls dialed by customers after midnight.

Through the years the System has been able to offset the inroads of inflation through continuous advances in technology and operating methods. The cost of service has declined in relation to the cost of living and personal income levels (Chart C) and this has broadened the market for our services.

In sum, Bell System service objectives have developed in response to the nation's fast-changing communications needs. They have been spurred by advancements in telephone technology, influenced by new demands from industry, government and the public in general, and tempered by a continual regard for balancing improved performance with reasonable rates for all users. These are all factors in the Bell System's undertaking to provide the best service possible and to make it continually better, more abundant, and more economical.

Chart A

Service improvements produce operating savings . . .

More liberal provision of toll circuits provides better service to customers and reduces operator work time

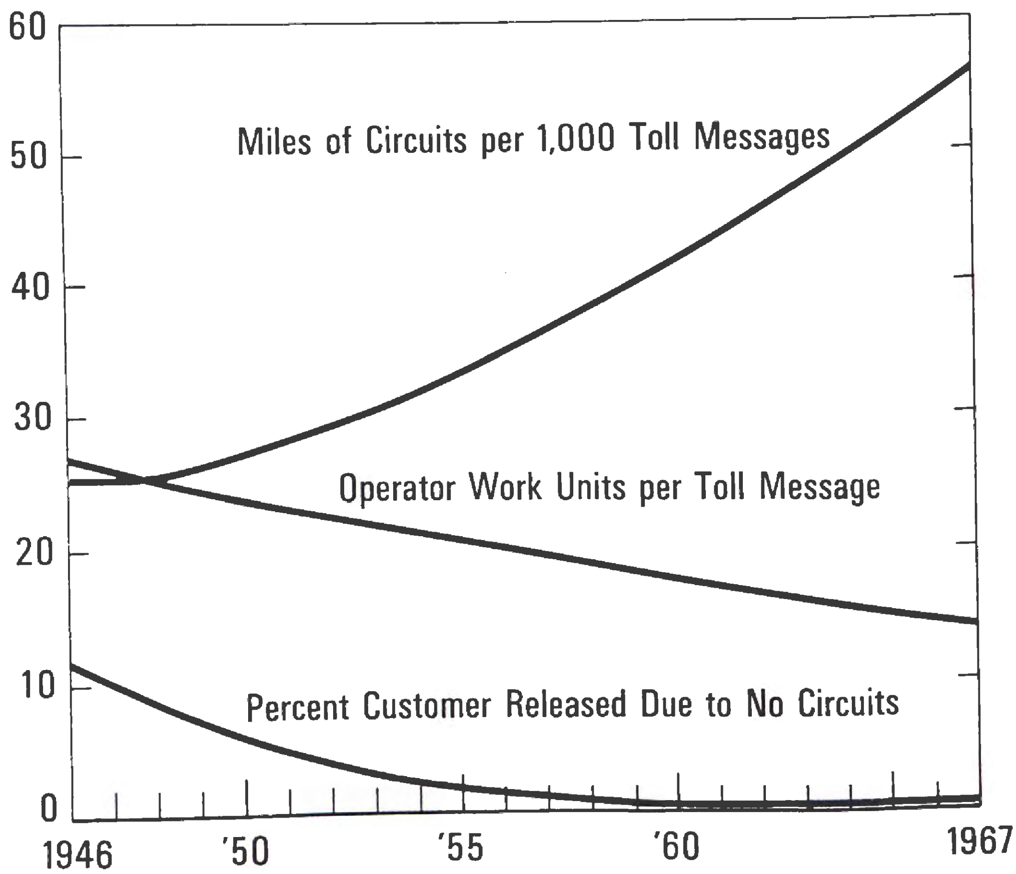
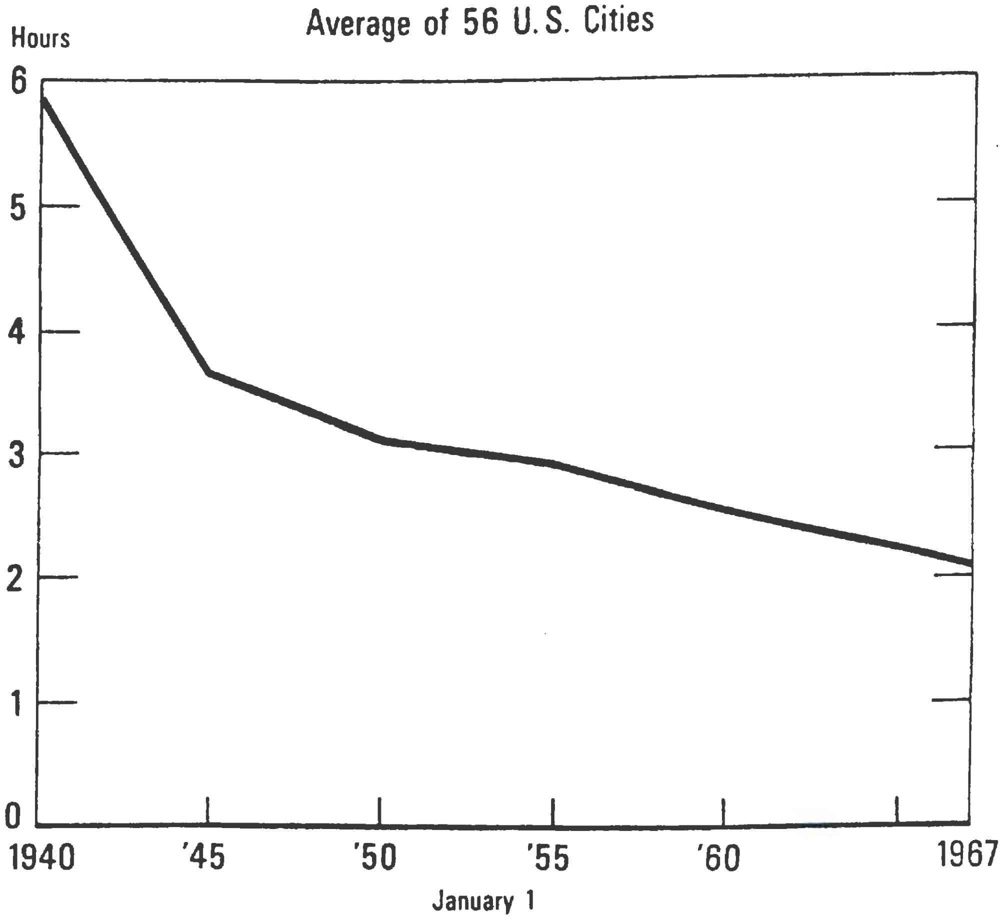


Chart B

Hours of Work Required to Pay for One Month's Individual Residence Service, with 100 Local Calls

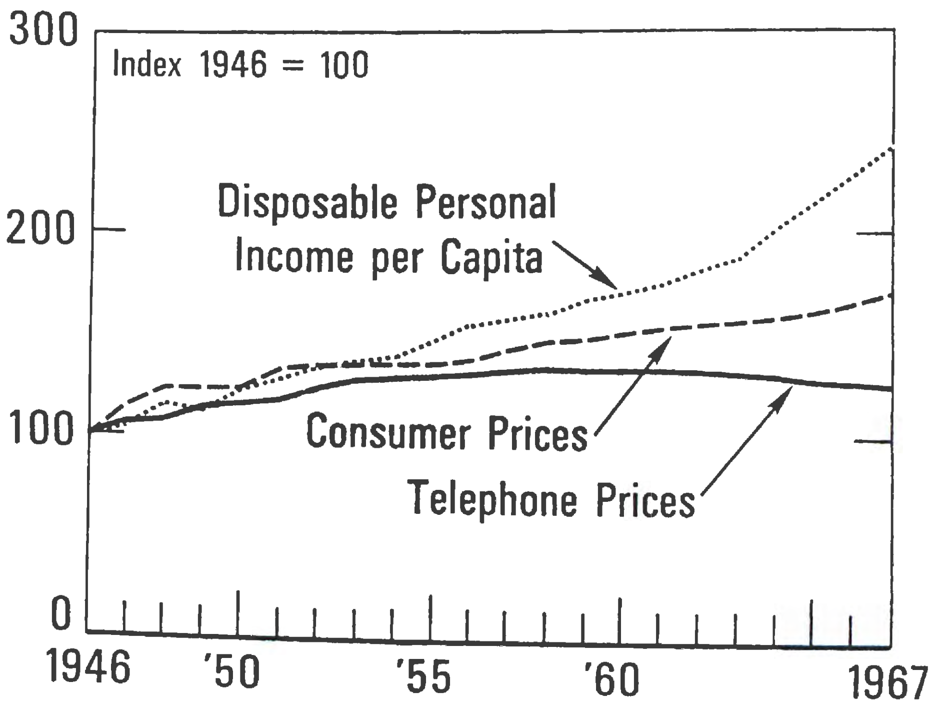
Average of 56 U.S. Cities



American Telephone and Telegraph Company
Business Research Division
May 1967

Chart C

Bell System rates vs disposable personal income per capita and consumer prices . . .



12

FORECASTING FOR NEW SERVICES

Summary:

Within the Bell System the drive toward service innovation springs from a basic goal - to provide constantly improving services to stay ahead of both current and emerging communications needs of the nation.

The basic ideas for new communications service flow from innovations made possible by new technology such as the transistor, electronic switching, and the laser and the needs and demands of society. The Bell System's objective is to provide a broadening range of services that are genuinely responsive to what individuals want. Meeting this objective requires market research and development programs which attempt to match technical capabilities with the communications needs of the nation.

The Bell System uses a variety of methods to develop forecasts for new products and services. Market study activities vary from limited, exploratory samples of potential customer interest through elaborate market research surveys and complex mathematical techniques. Market studies often lead to some form of product or service trial to assess the performance and to evaluate further the market for a new service or product. In addition, the Bell System maintains a close liaison with manufacturers of business equipment to assure that a full range of services are provided to satisfy customer requirements.

Much of the Bell System's success in developing new technology and resultant new services can be credited to its commitment to a continuing major program of research and development, both pure and applied, and to its market research ranging from long-range studies of special areas of communications to regular quantitative forecasts of local and long distance facility requirements.

Forecasting for New Communications Services

Introduction

The drive toward service innovation in the communications industry is a strong and constant one. Within the Bell System, this motivation springs from a basic goal of the organization -- to provide constantly improving services to stay ahead of both current and emerging communications needs of the nation.

Managing the innovative process -- in a time of rapidly changing technology -- is a demanding task. Planning for the timely introduction of new and improved communications services has become a continuous activity, occupying the talents and abilities of many hundreds of Bell System people.

Such planning is also an increasingly complex undertaking. The ultimate use of a new product or service concept being considered today, for example, will depend on the interaction of many factors. These include technological developments and the developing desires of society in general, as well as competitive and economic forces.

In considering some of the specific methods the Bell System employs in forecasting for new services, it is important first to take a broad look at the sources of most new service possibilities. Essentially, the basic ideas or concepts for new communications services flow from two directions:

1) Innovations made possible by new technology

New developments within the industry -- such as the invention of the transistor by the Bell Telephone Laboratories -- have a revolutionary effect on future directions in communications and in other fields.

The transistor breakthrough made possible the fundamental development of the electronic computer industry. Progress in semi-conductor research also opened the way for space communications, and has led to the practical development of electronic switching systems (ESS) and other evolving dimensions of telephone service such as TOUCH-TONE* dialing, DATA-PHONE* and PICTUREPHONE* service.

Much of the Bell System's success in developing new technology and resultant new services can be credited to its commitment to a continuing major program of research, both pure and applied. More than $2 billion has been spent on research and development in the past 15 years.

Technological achievements in other fields also can have a profound influence on communications requirements. A classic example is the computer. Computer systems present a challenging set of service needs -- in terms of both the volume and variety of information to be communicated and increased versatility called for in transmission and switching systems.

More and more, technology is a moving target ... and this makes decisions as to the timing of the introduction of new technology all the more difficult. On one hand, it is essential that the benefits of technical advances be made available as quickly as possible. On the other, there are major risks in premature commitments to promising new developments.

The unprecedented pace of change requires the telescoping of research and development

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into almost simultaneous activities. In this and many other respects, communications users benefit substantially from the close coordination made possible by the organizational integration of Bell Laboratories, the Western Electric Company, and the operating units of the Bell System.

2) <u>Needs and demands of society</u>

The state of the communications art is approaching the point where virtually any service is technically possible but not necessarily economically feasible. While technology makes new services possible, it is society that makes them necessary or desirable.

The Bell System's objective is to provide a broadening range of services that are genuinely responsive to what individuals want. Meeting this objective requires market research and development programs which attempt to match technical capabilities with the priority communications needs of the nation.

These programs range from broad, long-range studies of special areas of communications ... such as the rapidly developing data communications fields ... to regular quantitative forecasts of local and long distance facility requirements (on which annual construction programs are based).

Included is an informal but important activity in which close liaison is maintained with various classes of users -- ranging from business equipment manufacturers to handicapped groups, from the military departments to medical associations -- in order to anticipate their particular needs.

This work and other study activities are watched closely by a New Products Board at AT&T headquarters. This is an interdepartmental group of officers with responsibility for appraising the feasibility of new products and coordinating their introduction.

For the most part, the considerations and activities described above precede any formal efforts to forecast specific services. As new service concepts move from the exploratory to practical stages of development, the need for information on competitive and economic influences, such as accurate estimates of potential markets and the extent of customer acceptance, grows in importance. The techniques the Bell System uses for gathering such information are described in detail in the sections that follow.

Forecasting Methods

The Bell System uses a variety of methods to develop forecasts for new products and services. Selection of the most appropriate method or methods depends upon the stage of development of the product or service, the facilities to be used in furnishing the service, and the anticipated market, in terms of size and stratification, for which it is designed. From the idea stage to the introduction, there is no predetermined course for all products to take.

1) Studies

Bell System market study activities vary from limited, exploratory samples of potential customer interest through elaborate market research surveys and complex mathematical modeling techniques. Market studies usually precede and often lead to some form of product or service trial.

- A Market Probe is a limited study, used primarily to determine general customer interest in and reaction to a possible product or service. A probe attempts to define general characteristics or parameters and to uncover evidence to help guide the company toward further studies or trials. Not all probes are conducted by company personnel; professional market research organizations also are used.

- The broader Market Study attempts to determine the degree of customer interest in a product or service, the relative value of it and an optimum price level. In a Market Study, the company seeks more detailed information concerning customer reaction to specific features. These studies are often limited to a particular industry or segment of a market. Statistical sampling techniques are nearly always used. Results of personal interviews with customers, usually conducted by a professional research agency, coupled with other study data provide the company with a basis for estimating future market demand.

- A Mathematical Model is employed to analyze the interaction of dependent and independent variables. Modeling techniques, which utilize a computer for calculation, permit the rapid evaluation of the effects of changing selected variables through a broad range of possible circumstances.

2) Trials

The Bell System conducts trials, or tests, to assess the performance and to evaluate further the market for a new product or service. Trials, unlike studies, always involve the actual use of the product or service.

- In some cases, particularly in the earliest stages of a product's development, trials are conducted internally (in employees' homes or on company premises). In addition to these experiments, three different types of external trials are conducted -- each designed to produce specific information needed before proceeding with the development or introduction of a new product or service.

- A Technical Trial attempts to determine whether a product meets technical and performance requirements. The Bell Telephone Laboratories conduct these trials, coordinating as needed with AT&T Engineering, Marketing & Rate Plans and other departments.

  Small numbers of units are tested in customer locations. No additional charge is made to the customer, which permits closer control of the statistical sample of users and of the overall experiment.

- The primary purpose of a Product Trial is to determine customer reaction to the operation features, color, size, etc., of a particular product.

  As in the Technical Trial, customers do not pay charges for installation, nor do they pay additional monthly recurring charges for use of the new product. A Product Trial usually runs for a three or four month period. All equipment is removed at the conclusion of the trial.

  Cost and maintenance information is compiled during the trial. Professional market research agencies usually conduct the customer interviews, following guidelines established by the AT&T Management Sciences Division.

Analysis of trial results often dictates changes in the product or service before it is standardized. In product trials, the company also seeks indications of potential market size and structure, although this is not a primary objective.

- Market Trials introduce new products or services on a controlled basis to determine: a) optimum rate levels and structure (for both the Bell System and the customer); b) customer buying characteristics; and c) the most successful promotional techniques. Customers pay for the product and generally are allowed to retain the equipment in service after the trial is over. Market Trials, conducted concurrently in several locations, test the effects of varying rate levels to gain information on the optimum price/development relationship.

  The AT&T Marketing and Rate Plans Department coordinates these trials and analyzes results. Interviews with customers (and non-buyers) are often conducted by professional market research agencies.

3) Associated Market Research Activities

In addition to Market Research Activities associated with the trial and study activities mentioned above, the Bell System continually analyzes the effects of changing market conditions and estimates future conditions. While such activity can be generally classified as study work, it is important enough and significant enough to deserve a special mention.

- We analyze the interaction between alternative products and services offered by the Bell System as well as by others. Analysis of alternative services offered by us provides needed information to insure a balance of service features and rate levels among our various products and services.

Analysis of alternative services offered by others attempts to relate price and features to present and proposed Bell System offerings.

- We maintain a close, two-way liaison with manufacturers of equipment who, with the Bell System, jointly offer customers a complete capability. Data-Phone data communication service is an excellent example. The Bell System maintains liaison with about 250 manufacturers, apprising them of our development efforts and soliciting ideas from them for new services and compatible data sets.

Examples of Current and Completed Projects

Attachments 1-13 describe some actual Bell System projects where the various market research methods are being or have been used. These condensed descriptions illustrate a particular approach and provide added detail from specific cases.

Product or Service	Attachment Number
Touch-Tone Service	1
Message Toll Telephone Calling Plans	2
Teletypewriter Exchange Service	3
Picturephone Service	4
Electronic Private Branch Exchange	5
Portable ECG Data Service	6
Trimline Telephone	7
Princess Telephone vs. Trimline Telephone	8
Wide Area Telephone Service vs. Private Line	9
Private Microwave	10
Computer Time-Sharing	11
Bulk Communications	12
Data-Phone Service	13

Attachment 1

Touch-Tone* Service

From Market Study to Market Trial

Description of Service

The Touch-Tone telephone features electronic push-buttons that allow calls to be made more quickly and conveniently than with rotary dials. Pushing the buttons generates musical tones which identify the digits. Special telephone office equipment receives these tones and converts them into electrical pulses which process the call like a regular dial pulse signal.

* * *

Research, both technical and Market, for Touch-Tone services goes back a number of years and includes a number of steps - each designed to determine specific characteristics about the service and the market for it. This attachment summarizes the highlights of the developmental process to illustrate various Bell System study methods.

Technical Trial

In 1948, Bell Telephone Laboratories conducted a limited experiment with special, mechanical, pushbutton phones. Trial participants were 35 Bell System employees, living in Media, Pennsylvania. Customer interest in pushbutton calling was established but much more technical development was necessary before any customer tests could be conducted.

Product Trial

With the advancement of the art during the next ten years, it was possible to conduct a product trial in 1958. At that time, the trial was held in Elgin, Illinois and Hamden, Connecticut. Main objectives were: to evaluate the customer's dialing performance, his opinion of pushbutton service and to obtain some indication of possible rate levels for the offering.

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Approximately 500 phones were tried by residence and business customers during a four month period. Personal customer interviews were conducted at the completion of the trial.

Results indicated that almost all (98%) of the customers preferred pushbutton to rotary dialing because it was faster and easier to use. About half made suggestions concerning the buttons: make the tops of the buttons concave, provide more space between them. Almost everyone (98%) wanted Touch-Tone service when perfected; about one fourth indicated a willingness to pay $1 - $1.50 per month for the service. Technical results indicated excellent dialing performance; dialing irregularities were within acceptable limits, time to dial (pulse) the call was cut in half.

The operation of Touch-Tone telephones required special central office equipment, which was designed and tested also. In 1960, the Bell Telephone Laboratories conducted a trial of improved central office equipment in Hagerstown, Maryland and Roanoke, Virginia. Two types of central office switching equipment were tested.

Market Study

The trials proved that Touch-Tone service worked and customers liked it. However, the question of styling and appearance was not settled. The experimental Touch-Tone telephones were regular phones with the rotary dial removed and large buttons mounted on the round faceplate. In contrast, the designers proposed a new faceplate with a square design. In both models, the buttons were arranged in a nearly square pattern, numbering left to right, top to bottom.

The market study to determine which direction the styling should take was conducted in Cleveland, Ohio. Two hundred customers examined both models (round and square faceplates) and were asked to indicate their preference.

Results of the study indicated that both models were reasonably acceptable:

- Considering styling alone, the square faceplate was preferred.
- Because of a preference for the type of buttons on the earlier model, it was slightly preferred in the overall.

In essence, customers preferred the new styling but wanted the larger, easier to read, buttons of the earlier experimental models.

With this much testing completed, the remaining questions required a market trial. Introducing the new service on a controlled basis produced much-needed information concerning customer buying characteristics, the best promotional techniques and proper rate levels.

Market Trial

The market trial for Touch-Tone service began in November 1960 in Findlay, Ohio and February 1961 in Greensburg, Pennsylvania. These two closely matched cities satisfied major requirements and were chosen as trial locations because they:

- Were removed from large metropolitan areas and had high local radio and newspaper coverage.
- Had similar statistical relationships for: average family income, telephone extension development, individual line rates, extension rates and color charges.
- Were served by the same type of central office equipment, Number 5 Crossbar. (The cities contained about the same number of main stations, 11,000-14,000.)
- Had been selling the Princess telephone for at least 6 months. (We wished to measure the effect of Touch-Tone sales on Princess sales.)

Fifty-eight hundred Touch-Tone telephones - in all standard colors and models - were provided for the trial cities. In addition, the central office equipment in each city was converted for Touch-Tone operation.

The major phases of the trial program, reached through several months of pre-trial planning and discussion of detailed research methods, included:

- A customer attitude and market survey before and after the introduction of Touch-Tone service.
- An advertising recall study to determine the effectiveness of newspaper and radio coverage.
- Interviews with buyers and non-buyers about every four months to determine the characteristics of the various segments of the market.
- A complete accounting record of all service order activity, from which detailed station movement reports (including Touch-Tone station development data) were prepared at frequent intervals.
- A disconnect study to determine the extent of and reasons for the loss of Touch-Tone stations.

Both Findlay and Greensburg were assumed to be reasonably typical of the Bell System, based upon a thorough analysis of data on income, employment, bank debits and related telephone development. (Economic items slightly favored the trial cities over the Bell System average; offsetting these were lower levels of telephone development and less expressed willingness to pay for Princess or Touch-Tone service.)

After approximately 21 months, a complete report of Touch-Tone trial results was prepared in mid-1962. Trial data projected for 10 years ahead, based on a continuing favorable economic climate, <u>in the trial cities</u> showed:

	1 Yr.	2 Yrs.	5 Yrs.	10 Yrs.
% of Total Telephones	5%	7%	11%	16%

These trial results then were projected to the Bell System as a whole to estimate total development.

When the service was introduced by Bell System Companies, lower rates were used. The rate level in most companies is $1.50 per month for each customer line and includes all telephones on that line. Trial rates were $1.50 for the first telephone and 75¢ for each additional one.

Actual results more than justified the decision to proceed with the Touch-Tone program. Because of favorable economic conditions and the lower rates, actual experience has been about 40% better than originally forecast.

Message Toll Telephone (MTT) Calling Plans

Market Study

Description of Service

A message toll telephone call is simply the interconnection of telephones located in different local calling areas using the long distance - or toll - network. Approved long distance rates apply.

Message Toll Telephone (MTT) Calling Plan is the term applied to a plan designed to provide a customer with more economical calling options - tailored to meet his specific telephone calling needs.

Market Study Activity

The objective of this study was to determine if a new long distance pricing arrangement could be devised which would:

- better meet the needs of residence and small business customers,
- encourage the use of Direct Distance Dialing (DDD), and
- utilize the network during off-peak hours.

The market study evaluated three possible approaches in terms of: customer understanding, reaction, preference and inclination to buy, patterns of usage, household and other demographic data and promotional techniques.

Basic features of the three plans considered were:

Plan A . The customer received a discount if he subscribed to a plan for dialing interstate DDD calls within a pre-determined geographic area during specified off-peak hours. Minimum subscription was 1 hour per month; additional usage was billed in one minute increments.

Plan B . The customer received a discount if he subscribed to a plan for dialing interstate locations <u>anywhere</u> during specified off-peak hours. The discount applied to all interstate calls when the charges exceeded the minimum billing of $10 per month.

Plan C . The customer, for a flat monthly charge, had unlimited dial calling to a selected central office prefix (first three digits of a local telephone number) during specified off-peak hours.

A professional consulting firm conducted personal interviews, of about one hour in length, with 2,400 residence and 1,200 business customers. Scientific sampling techniques were used so that the results could be statistically projected to represent the total Bell System market.

Plans A and B met with much greater customer acceptance than Plan C. In addition, Plans A and B were accepted, generally, by both business and residence customers; Plan C was limited, mainly, to residence customers. The study was only recently completed. Customer trials are being considered.

Attachment 3

Teletypewriter Exchange Service (TWX)

Market Study: Mathematical Model

Description of Service

Teletypewriter Exchange Service (TWX) is an automatic switched service using teletypewriters which enable any TWX customer in the country to reach (by dialing) any other TWX customer.

TWX service has been evolving from man-to-man to man-to-machine communications as businesses and government make more and more use of computers and other business machines. Shorter, more highly formatted, messages are coming into use which intensify the need for faster service and a more responsive companion rate structure.

Market Study Activity

The 1963 TWX Market Study was conducted to estimate market reaction to various proposed rate plans and to provide a basis for selecting the optimum one. The study design provided usage and station information for developing the serving arrangements and appropriate costs.

The study was based on a sample of TWX stations and messages for one month, May, 1963. The econometric model required a large scale computer to perform the mathematical calculations necessary to analyze the combined effects of different types of station equipment, different speeds of service, different rate schedules and other variables. The model determined the most economic overall service for each of approximately 2,700 teletypewriter installations; the monthly billing, computed by this means, was compared to the customer's existing service arrangement and rates to determine if he would experience a rate increase or decrease, and the percentage (if an increase).

The model classified all stations with an estimated increase in billing of 100% or more as potential drop-outs and excluded them from the total market estimate. Information on the stations classified as remaining in the market was expanded to represent the total TWX market then and projected two years into the future.

In November, 1964, one of three rate plans processed. through the model was selected and presented in connection with F.C.C. Docket 15011. In July, 1966, the F.C.C. issued an order in which they suggested interim rates having about the same structure, though at slightly lower levels, as those proposed by the Bell System. These became effective on September 1, 1966.

Studies since then have shown development to be generally as forecast. Small differences are attributed to the slightly modified rate plan now in effect and uncertainties influencing the TWX market since the Bell System announced its intentions to revise rates in 1964. It was not until 1966 that the rates (which are still interim in nature) went into effect.

PICTUREPHONE* Service

Market Probe, Product Trial

Description of Service

Picturephone service permits the calling party to see as well as to hear the person with whom he is talking on the telephone. Introduced experimentally to the public at the New York World's Fair in 1964, limited commercial "booth-to-booth" service is available between centers in New York, Chicago and Washington, D.C.

Market Probe

The Bell System engaged a professional research agency to conduct a probe of the potential market for Picturephone service. The objective of this very limited exploratory study was to determine customer reaction to, and interest in, a possible see-as-you-talk service. Specifically, we hoped to learn how business customers might actually use it and to obtain some indication of the demand.

Small groups of businessmen, at various levels of management from a broad base of industries, were contacted. They provided some realistic overviews and insights into present and future business applications for a Picturephone service. As development continues, it may become appropriate to conduct a much wider study to provide more detailed information on this evolving telephone communications market.

Product Trial

Development of Picturephone station apparatus as well as related transmission techniques and central office switching equipment has been underway for some time. In addition to the 1964 World's Fair installation and the "booth-to-booth" limited commercial operation, a trial was conducted

*Registered Mark

in 1965 between Union Carbide Corporation locations in two cities to determine service performance and customer satisfaction, and to gain installation and maintenance experience. While the concept was well received, the need for another trial was evident.

Some of the areas which must be explored are:

- What is the best method for introducing the service, consistent with customer requirements?
- What features do customers want?
- What is the optimum rate level?
- When will Picturephone service reach a level of maturity which will make the service more beneficial to the telephone user?
- What effects will the service have on existing central office and intercity facilities?

To examine these areas more closely, a Product Trial, employing an improved station set and central office equipment, will be conducted in late 1968 with Westinghouse Electric Corporation in Pittsburgh and New York City.

Attachment 5

Electronic Private Branch Exchange (PBX)

Technical Trial

Description of System

The 800A Electronic Private Branch Exchange (PBX) is a small switching system, located on the customer's premises, designed for a maximum of 80 extensions. The PBX processes incoming and outgoing calls and interconnects office extensions. An attendant, or operator, assists in processing some calls.

The system uses solid state electronic components, and expands readily to handle light to heavy calling volumes, from a small to a large number of telephones. The cabinets housing the equipment are compact and styled to fit into most office locations.

Trial

Two systems were tested: one in New York, the other in Philadelphia. Purpose of the trial was to:

- evaluate overall technical performance.
- obtain detailed information on installation and maintenance characteristics.
- determine customer reaction to appearance, features and operation.

The trial ran from May, 1965, to January, 1966. As a result of the trial, various adjustments and changes were made to correct technical and operating difficulties.

The system now has been standardized for manufacture.

Portable Electrocardiogram (ECG) DATA-PHONE* Service

Product Trial

Description of Service

Data-Phone medical data sets work with regular Electrocardiogram (ECG) machines to transmit ECG information instantly from a patient to a remote receiving point over regular telephone lines. This unlimited access opens the telephone network to the medical profession for graphic communication.

Three different medical data sets are available:

- The stationary transmitter set is designed for sending ECG graphic data from locations where permanent installations are desired, such as offices or hospital examining rooms. The set connects easily to regular ECG machines. A built-in telephone used to establish data calls also functions as a regular desk telephone and permits discussion of the material transmitted.
- The portable transmitter set permits a doctor, or specialist, to take the ECG machine to a patient who cannot get to a hospital or office. This light transmitter unit works with any regular telephone to transmit ECG data without special connections.
- The data receiver set converts ECG information, received from both stationary and portable transmitters, into the proper input for the remote ECG machine. A signal device permits communication with the sender during ECG transmission. When not used for communicating diagnostic data, the built-in telephone functions as a normal telephone. If needed, the data receiver is capable of automatic answering and recording of ECG data.

*DATA-PHONE is a registered mark; see Attachment 13 for description.

Trial

Inquiries from the medical profession for a means of transmitting electrocardiograms reliably and rapidly from a number of different locations, coupled with Bell System development of Data-Phone data communications service, prompted this trial in 1963-64. Thirty-three data sets were installed in hospitals and clinics in New York, Washington and three other cities. The objective of the trial was to determine the customer reaction to the design, features and operation of these medical data sets.

Overall reaction of most doctors and technicians using our trial equipment was very favorable. Asked for specifics, they mentioned the following as particularly favorable features:

- Immediate service of an expert (28%)
- Time-saving (24%)
- Versatility (20%)
- Simplicity of operation (15%)
- Good fidelity of reproduction (13%)

Thirteen of the seventeen trial participants using the portable transmitter reported they felt a real need for this type of medical data set. Reasons given were:

- ability to transmit from patients' homes
- ability to use any place in a hospital
- emergency capability.

Since any long distance transmission requires paying the usual tariff rates for such service, the company was interested to learn if this was of any great concern. Three-fourths of the trial participants who used the service for long-distance transmission stated that the effect of toll charges on usage was "very little or almost none."

After making design changes based upon trial results, these medical data sets were put into production and are now offered throughout the United States.

TRIMLINE* Telephone

Market Trial

Description of Product

The Trimline telephone is a telephone instrument with the dial in the handset. (The handset also houses the transmitter unit, the receiver unit and a recall button -- which connects or disconnects the phone, like the switchhook of a standard telephone). Both desk and wall models are available.

Trial

The first trial of this telephone was conducted in 1958. Customer interest in the concept led to design changes, subsequent product trials, and to a market trial in 1963. This market trial provided necessary information on market size and structure as well as indications of the effect on alternative Bell System offerings (such as the Princess telephone).

The two trial locations were Jackson, Michigan, and Janesville, Wisconsin. Twenty-six hundred Trimline telephones, in all standard colors and in both wall and desk models, were made available - primarily to residential customers. An advertising and sales promotion program supported the sales effort. The Trimline phone, at a trial rate of $1.00 per month, competed directly with products of our own line.

After 5 months:

- Trimline development was 3.1% of total residence telephones
- Total extensions sales increased 18%
- Princess telephone sales decreased 79% from pre-trial sales rates. (See Attachment 8 for further analysis.)

*Registered Mark

Trial customers liked the Trimline. Ninety-four per cent were "very well" or "quite well" satisfied with the new telephone. Reasons given were: size, convenience, style and novelty. In addition, 69% felt it was "reasonable" in cost.

Of the non-buyers, 51% reported they didn't buy because of the cost, 17% because they were satisfied with the telephone they had.

Sales results data provided the basis for projecting initial production requirements and eventual Bell System development levels. In the nearly three years since the Trimline telephone -- modified slightly as a result of the trial -- was introduced in the Bell System on a company-by-company basis, estimates for production requirements have been quite accurate.

Attachment 8

Princess* Telephone vs. Trimline* Telephone

Study of Market Interaction

Description of Products

The Princess telephone, introduced by the Bell System in 1959, is smaller, more compact and lighter than regular desk phones. It features an illuminated dial. The Trimline telephone, introduced in 1965, is a compact dial-in-handset instrument which can be used as either a desk or wall model.

Market Study Activity

Generally, the introduction of a new product affects the market for related products that are already available. The impact of Trimline telephone sales on Princess telephone sales is an example of such interaction. Market Trials provide a means of predicting the relative impact.

Analysis of such things as the number of phones installed, removed, substituted one for the other, etc., indicates:

- The total number of Princess phones in service is still growing. However, the percentage of Princess telephones to total telephones in service is declining slightly.
- Percentage of Trimline telephones to total in service continues to increase considerably.
- The percentage of premium-type telephones is 37% greater than before the introduction of Trimline.

*Registered Mark

Effect of Wide Area Telephone Service (WATS) on Private Line Services Study of Market Interaction

Description of Services

Wide Area Telephone Service (WATS) is a form of long distance service designed to meet the needs of customers who make many long distance calls to many points. Within six selected wide areas -- up to nationwide -- the customer may place as many calls as he likes for a fixed monthly charge. WATS is available on a full-time or measured-time basis.

Private Line service is a private point-to-point arrangement. Customers who make many calls to the same locations, or who prefer to have rapid, direct, connections without dialing, subscribe for this service.

Market Study Activity

This 1966 study produced useful estimates of the effect of WATS on Private Line services. Over 1,000 detailed questionnaires were completed for customers selected through scientific sampling. The questionnaire was designed by A.T.& T.'s Management Sciences division. Distribution of customers surveyed was nationwide, throughout the serving areas of Bell System operating companies.

Results of this study showed that WATS had only a slight effect on Private Line services, either on revenue or on numbers of lines. Specifically:

- WATS replaced 0.9% of annual Private Line services revenue.
- WATS lines replaced 1.9% of Private Line facilities.

Analysis of the study data also produced certain general conclusions about factors influencing customers in the selection of the interstate communication service best suited to their needs. Briefly, the major factors were:

- Geographic Dispersion and Size

  . Larger communications users buy Private Line Services because of: volume, long distances between major population or industrial centers and the associated calling charges.

  . Smaller companies, with smaller calling volumes and fewer out-of-state branch locations, found the regular message toll network more economical, until the advent of WATS.

- Convenience

  . Customers subscribing to Private Line Service for convenience rather than communication economics, generally were not candidates for WATS. Some wanted to originate calls from either end of the Private Line; others needed a conference calling or multiple point broadcasting arrangement; others required the fast response time (without dialing) available with Private Line Service.

- Diversity of Operations

  . Most of the WATS customers in the sample operated in broad regional or national areas and had insufficient concentrations of communications requirement to make Private Line Service economically attractive.

Attachment 10

Privately Owned Microwave Systems

Study of Market Interaction

Description of Product

A microwave communications system is a high-frequency radio relay system, using electro-magnetic waves. Each system requires essentially the same elements: a transmitter, a transmitting antenna which radiates and directs the energy produced, a receiving antenna that intercepts a maximum of this energy after its transmission through space, and a receiver.

Microwaves, like light waves, travel in straight lines. They can be focused sharply and aimed from point-to-point. Along a relay route, a small amount of power (less than one watt) boosts the signal to required levels between stations.

The Bell System uses microwave systems to handle a large portion of various communication services. The term "privately owned microwave systems" refers to systems owned and operated by organizations other than communications common carriers for point-to-point communications in connection with their own business activities.

Market Study Activity

In 1966, the Bell System retained a consulting engineering firm to make a study of cost levels of existing privately owned microwave systems. The consultants selected 142 systems, of approximately 330 private systems, which represented a good cross-section in terms of size, length, quality and reliability.

Cost guides were developed for different components of the system -- including land, buildings, towers, radio, multiplex (to transmit several messages simultaneously over the same channel), and test equipment.

Investigation of catalog prices of a number of equipment manufacturers led to calculation of representative component prices used in the cost guides.

The consultants developed separate factors for "toll grade" systems -- those having noise and reliability characteristics generally equivalent to Bell System objectives -- and "sub toll grade" systems. Each system was classified in terms of length, density (size of cross-section) and reliability.

The factors appropriate for the specific user classification were applied to produce detailed information on total first cost (investment) and annual carrying charges (expenses).

Analysis of the study data revealed little significant variation in monthly carrying charges between systems with different cross-section sizes and length. The number of terminal locations and reliability did affect, substantially, both investment costs and expenses. Long haul systems, with a greater number of terminal points and a high degree of reliability, were at the high end of the range; the simple systems, with fewer terminal locations, at the low end.

The information provided by this study is useful to the Bell System in assessing the market potential in this competitive area.

Computer Time-Sharing

Market Study

Description of the Service

Time-sharing is a method of operation in which a computer facility is shared by several users for different purposes at (apparently) the same time. Although the computer actually services each user in sequence, the high speed of the computer makes it appear that the users are all handled simultaneously.

The Bell System furnishes communications links for time-sharing systems and, therefore, is keenly interested in obtaining accurate estimates of projected market characteristics. This comprehensive Market Study is divided into four phases.

Market Study Activity

- Phases I and II, completed within the past few months, involved interviews with selected providers and users of computer time-sharing systems. Results provided useful information concerning:
  - operating policies of the companies offering computers on a shared basis.
  - terminal and communications requirements.
  - calling traffic characteristics of those subscribing to time sharing systems.
  - growth trends of a representative group of existing systems and users.
- Phase III is underway. The objective of this phase is to estimate the total market for computer time-sharing systems. The A.T.& T. Management Sciences

Division has retained a consulting firm to conduct a mail survey. Three thousand of the 9,000 questionnaires mailed have been returned; almost 37% of these indicate present use of or plans for data communications in these time-shared systems. Magnetic tapes containing the survey results only recently have been delivered and this phase will be completed in 1968.

- Phase IV will probe deeper into the communications characteristics of selected time-sharing systems. Objectives are to collect sufficient data to develop any new systems, features, services, and engineering practices which may be required to better satisfy the customer's communications needs.

  This phase of the study is divided into two parts: systems with long holding time connections and those with short holding time connections. (Holding time is the total time the communication channel is in use.) So far, five systems with long holding times have been measured. Identification of required Engineering and Traffic practices is expected this year. Also, measurement of systems with short holding times will begin during the early part of 1968.

Attachment 12

Bulk Communications

Market Study

Description of Service

Bulk Communications is a term used to describe large capacity communication service between specified points. The needs of government and industrial customers for large capacity facilities have steadily grown as a result of the postwar economic expansion. Trends toward organizational decentralization, coupled with the rapid development in data processing applications, produced a demand for rapid transmission of operational and accounting information between geographically separated points. Flexible communication facilities of large capacity evolved as a strong customer requirement.

Market Study Activity

In late 1960, A.T.& T. hired a consulting firm with substantial experience in the design and evaluation of data processing and industrial communications systems, to estimate the future size and structure of the bulk communications market. The consultants interviewed 58 companies plus agencies of the federal government, all large users of communications services. They also interviewed 12 manufacturers of business equipment. The personnel growth estimates of 60 major users, broken down into a geographical distribution, were also included in the study.

Projections considered that bulk communications requirements would be affected by:

- Growth in industrial and governmental management and professional activity.
- New developments in communications and information processing technology.
- Stimulative effect of availability of privately owned microwave systems.

- Stimulative effect of TELPAK (a Bell System private line service which offers large communications capacities for transmission of voice, teletypewriter, facsimile, or data produced by business machines).

The study results indicated a large potential demand for bulk communications by broad market segments for 1965 and 1970 as follows:

	Millions of Dollars Annually	
	Calendar Years	
	1965	1970
Total Government	$128	$192
Transportation Industries	11	34
Other Industries	26	46
Total	$165	$272

The study concluded that a competitively priced common carrier service would give potential customers a realistic choice (between private systems and service furnished by common carriers) and would promote the growth of the bulk communications market, particularly for transportation and other industries.

The Bell System used the results of this study to assist in making estimates of the TELPAK market. Four TELPAK services were offered - "A," "B," "C," and "D" which were equivalent to 12, 24, 60 and 240 regular telephone voice channels, respectively.

The estimates of the Bell System TELPAK market composition, or mix, made in 1960 were not realized. Customers, the Federal Government in particular, did not use the various TELPAK services as the company anticipated.

Attachment 13

DATA-PHONE* Service

Market Liaison Activity

Description of Service

Data-Phone service provides for the transmission of data using regular dialed-up telephone service. This is accomplished using data sets and the same dial telephone network that is used for local or long distance voice communications. A Data-Phone data set has a telephone associated with it and the data set is connected to a business machine terminal. The data set may be connected electrically or acoustically to the telephone network. The data set converts the electrical signals from the compatible business machine into tones suitable for transmission over the telephone network and provides the means for dialing the call.

To place a data call, the user lifts the telephone receiver associated with the Data-Phone data set, receives dial tone, and dials the telephone number associated with the Data-Phone data set at the receiving business machine terminal.

At the receiving terminal, the call is answered at the Data-Phone data set either automatically or manually by an attendant. When answered by an attendant, the sets are in the normal "talk" or "voice" mode. The operators then talk and confirm with each other that the business machine terminals are ready to transmit or receive data.

When all is ready, the operators switch the established telephone connection from the "talk" mode to the "data" mode by pressing the "data" button on the Data-Phone data set. This action transfers control of the line to the business machine terminals, enabling the machines to transmit and receive data.

At the completion of transmission, the operators press the "talk" buttons and hang up the telephones, thereby disconnecting the call.

*Registered Mark

There are also Data-Phone data sets available that automatically establish calls for the transmission of data between business machine terminals without the aid of any operators. This is possible by using a device called an Automatic Calling Unit. When directed by the associated business machine, this device automatically dials the telephone call. These units are capable of dialing telephone calls by using the conventional rotary dial technique or the new Touch-Tone dialing system.

Data-Phone data sets are also arranged to automatically answer calls. This unattended answer feature permits an unattended location to have its machine turned on automatically by the calling Data-Phone data set.

Market Liaison Activities

The Bell System Data-Phone data set is an example of a product which does not stand alone in providing a communications service, but does so only in conjunction with a business machine or teletypewriter product, many of which are frequently provided by other companies. For that reason, development of new data sets or improvement of older ones requires close coordination and cooperation with business equipment manufacturers.

At A.T.& T. Headquarters, in the Engineering and Marketing Rate Plans Department, a sizeable organization maintains a continuing program of liaison with about 250 manufacturers of business equipment. The aim of the Bell System is to keep these manufacturers continually apprised of our development efforts. Our program includes: scheduled and other meetings; lending experimental model shop prototypes of data sets and auxiliary equipment. This enables us to obtain their suggestions and affords them ample opportunity to consider compatible equipment.

We also solicit ideas for new services and compatible data sets from them. This two-way program enables each of us to maintain the ability to meet expanding and varying needs in the rapidly evolving data communications field.

Since 1958, about 45 different types of Bell System Data-Phone data sets have been developed and used. About 30 of these are still in general use; 15 are obsolete (in just 10 years).

The 30 types of Data-Phone data sets in use today are compatible with about 200 different types of business machines. These machines range in size from simple card readers to large computers. In addition, about 20 additional types of data sets are under development or under trial.

PROJECTIONS OF TELEPHONE GROWTH

(THRU 1980)

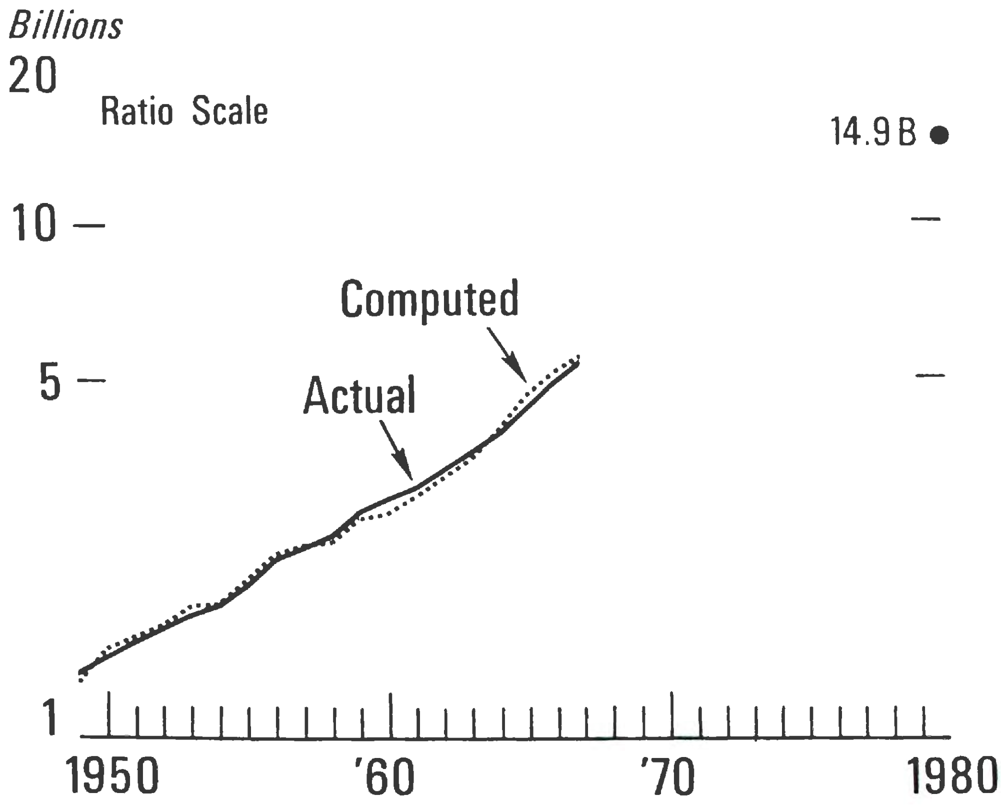
JANUARY 1968

COMMENTS ON PROJECTIONS

The accompanying charts show projections - not forecasts - of Telephones in Service and Long Distance Messages for 1980.

These projections are based on relatively simple trends and/or relationships during the post-World War II period. These trends and relationships can change unexpectedly and thus invalidate the projections. Even the definition and basis of measurement of telephones and messages may change by 1980, as can also the proportion of messages that are measured. Moreover, growth in the number of telephones and messages may be significantly affected by new types of service offerings, such as customer service packages, special pricing policies, and technological advances. Such developments cannot be quantified and adequately reflected in these projections.

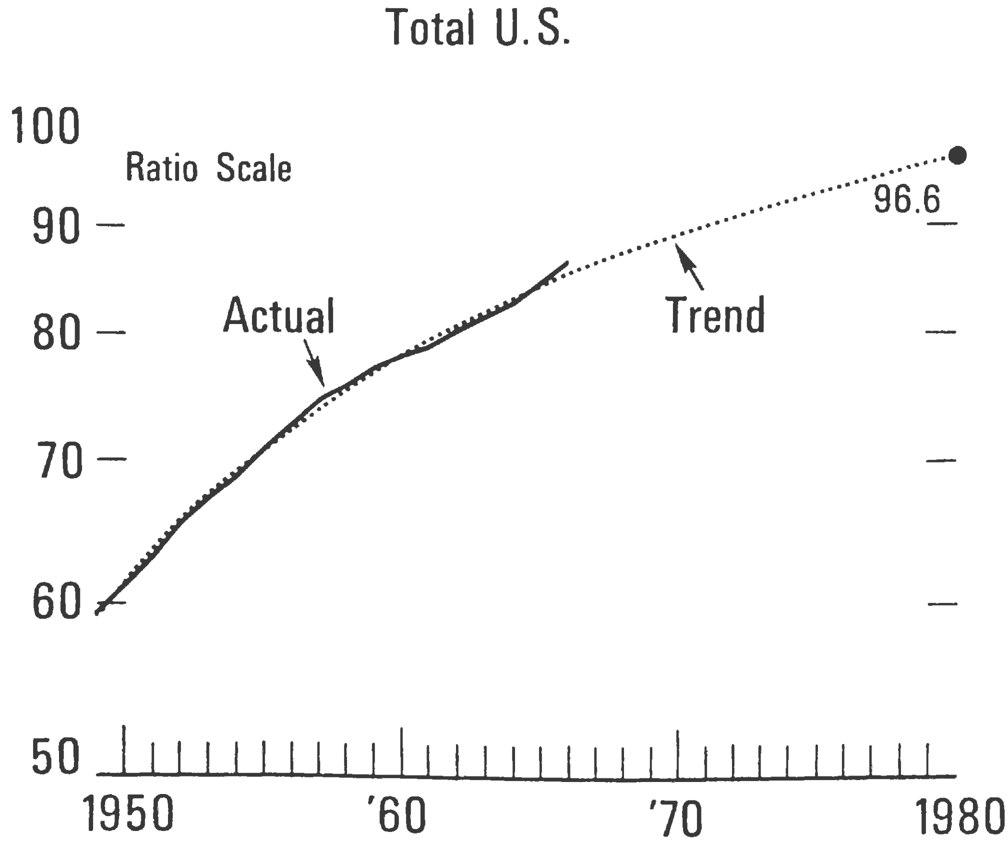
Projection of
Total long distance messages . . .



1-1-67 basis of classification

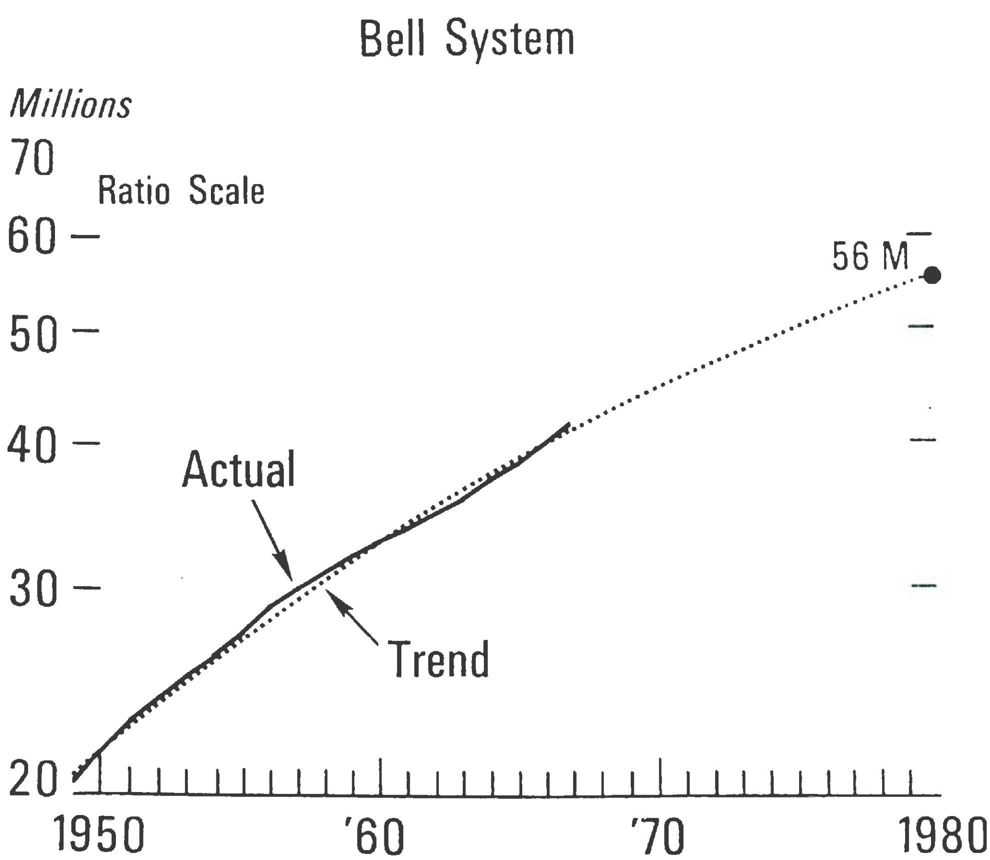
PROJECTION OF

Per cent households with telephone service . . .



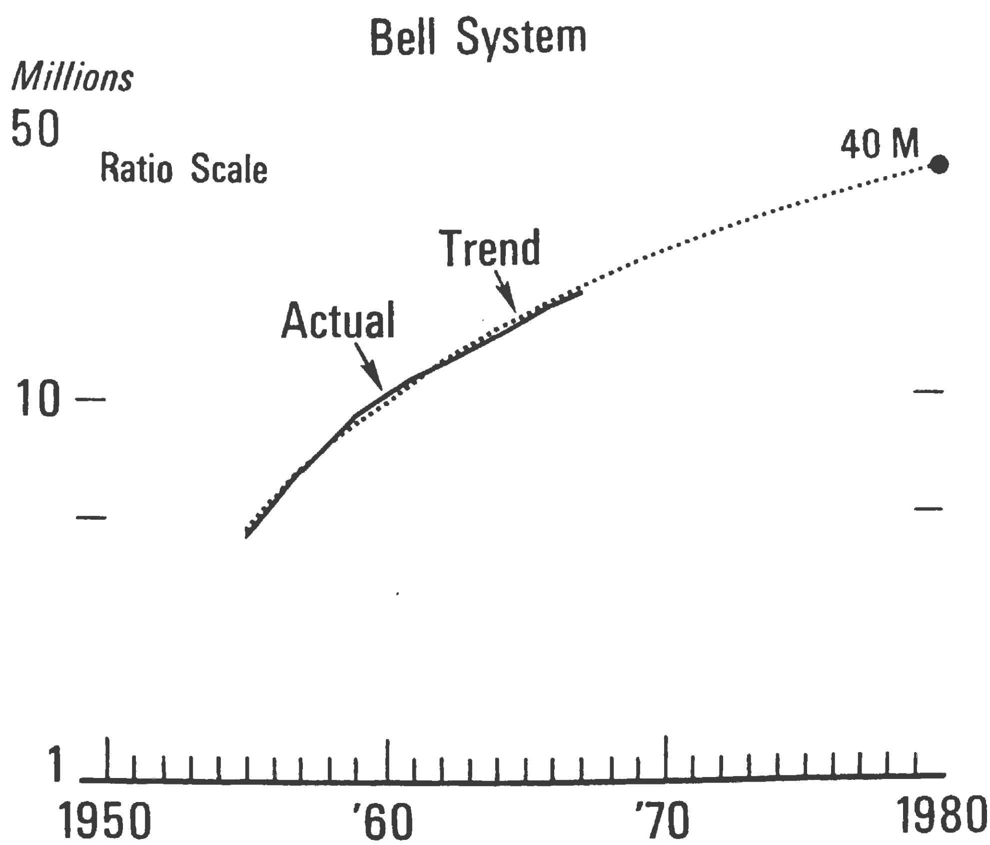
PROJECTION OF

Residence main telephones in service . . .



PROJECTION OF

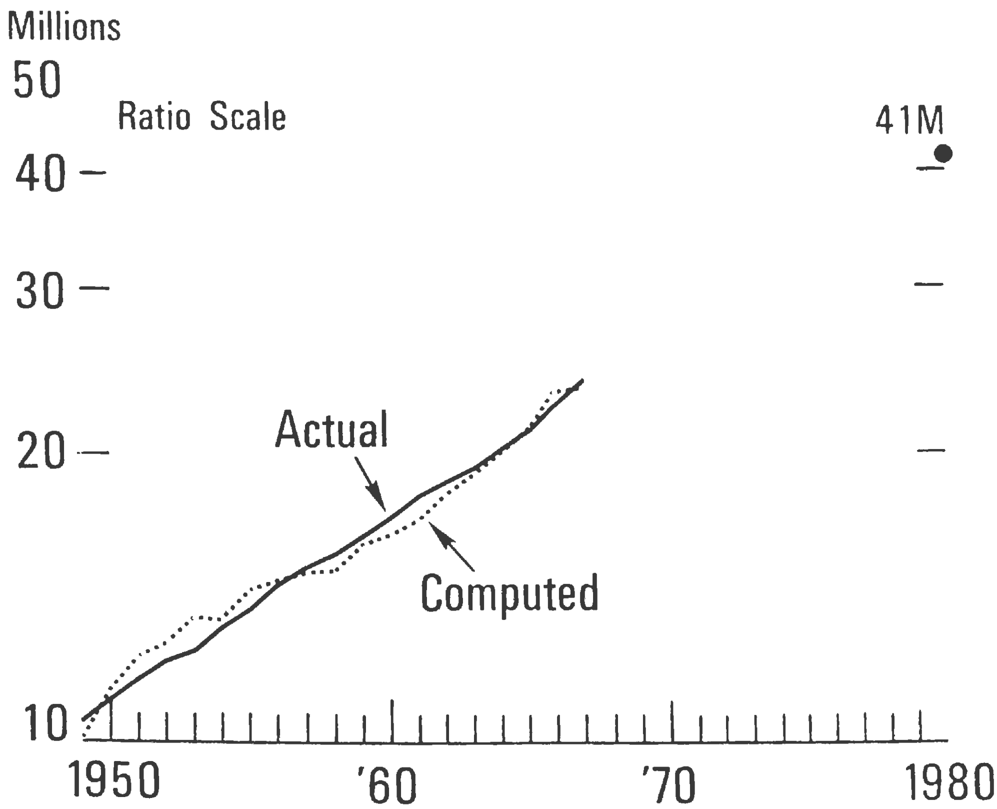
Residence extension telephones in service . . .



PROJECTION OF

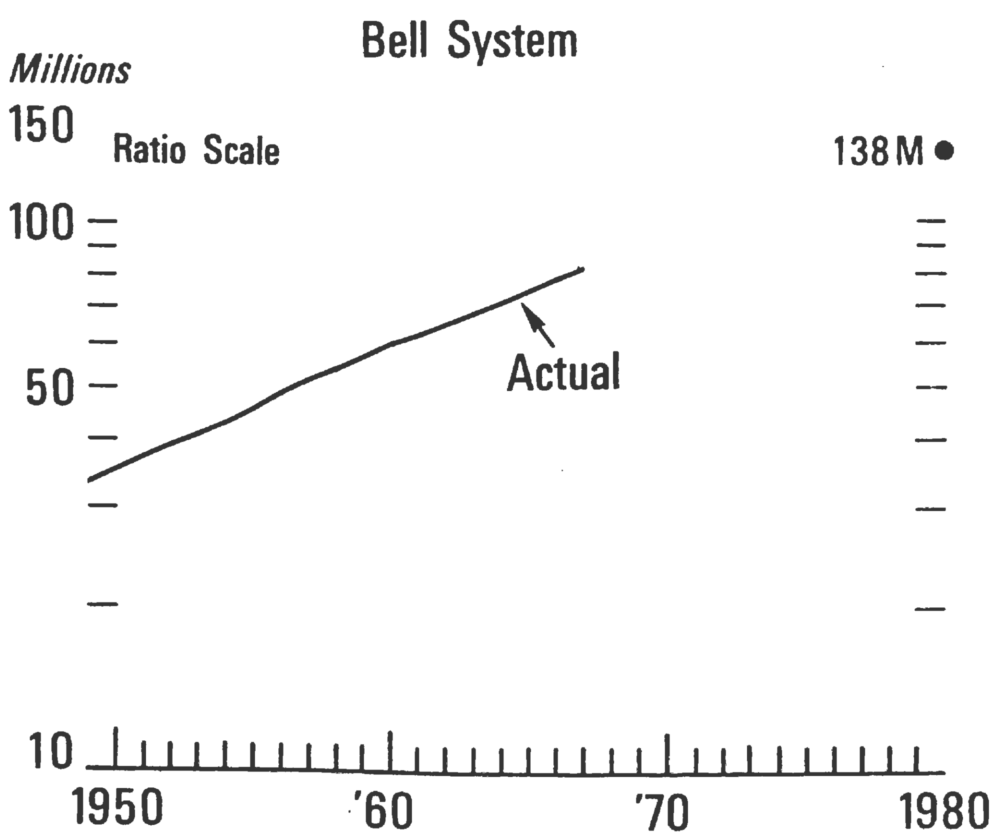
Total business telephones in service . . .

Bell System



PROJECTION OF

Total telephones in service . . .



Appendix

90TH CONGRESS } HOUSE OF REPRESENTATIVES { DOCUMENT
1st Session } { No. 157

GLOBAL COMMUNICATIONS SYSTEM

MESSAGE

FROM

THE PRESIDENT OF THE UNITED STATES

TRANSMITTING

RECOMMENDATIONS RELATIVE TO WORLD COMMUNICATIONS

AUGUST 14, 1967.—Referred to the Committee on Interstate and Foreign Commerce and ordered to be printed

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To the Congress of the United States:

Man's greatest hope for world peace lies in understanding his fellow man. Nations, like individuals, fear that which is strange and unfamiliar. The more we see and hear of those things which are common to all people, the less likely we are to fight over those issues which set us apart.

So the challenge is to communicate.

No technological advance offers a greater opportunity for meeting this challenge than the alliance of space exploration and communications. Since the advent of the communications satellite, the linking of one nation to another is no longer dependent on telephone lines, microwaves or cables under the sea. Just as man has orbited the earth to explore the universe beyond, we can orbit satellites to send our voices or televise our activities to all peoples of this globe.

Satellite communications has already meant much in terms of human understanding.

—When President Lincoln was assassinated, it took twelve days for the news to reach London. Britons watched and grieved with us at the funeral of John F. Kennedy.

—Europeans watched Pope Paul speak to the United Nations in New York—and Americans saw his pilgrimage to Fatima.

—The peoples of three continents witnessed the meeting of an American President and a Soviet Premier in Glassboro.

The future of this new technology stirs our imagination.

85-011

In business and commerce—

—Commercial telephone calls will be carried routinely by satellite to every part of the globe.

—Rapid and universal exchange of data through satellite-linked computers will encourage international commerce.

—Productive machinery can be operated at great distances and business records can be transmitted instantaneously.

In education and health—

—Schools in all lands can be connected by television—so that the children of each nation can see and hear their contemporaries throughout the world.

—The world community of scholars can be brought together across great distances for face-to-face discussions via satellite.

—Global consultations, with voice and pictures, can bring great specialists to the bedsides of patients in every continent.

—The art, culture, history, literature and medical science of all nations can be transmitted by satellite to every nation.

Who can measure the impact of this live, direct contact between nations and their people? Who can assess the value of our new-found ability to witness the history-making events of this age? This much we know: because communication satellites exist, we are already much closer to each other than we have ever been before.

But this new technology—exciting as it is—does not mean that all our surface communications facilities have become obsolete. Indeed, one of the challenges before us is to integrate satellites into a balanced communications system which will meet the needs of a dynamic and expanding world society. *The United States must review its past activities in this field and formulate a national communications policy.*

U.S. Activities to Date

The Communications Act of 1934 has provided the blueprint for federal involvement in the communications field. That Act, and the Federal Communications Commission it created, have served our national interest well during one-third of a century of rapid communications progress.

The Communications Satellite Act of 1962 established a framework for our nation's participation in satellite communications systems. Congress weighed with care the relative merits of public and private ownership of commercial satellite facilities. The Act authorized creation of the Communications Satellite Corporation (ComSat)—a private corporation with public responsibilities—to establish a commercial satellite system.

In 1964 we joined with 10 other countries in the formation of the International Telecommunications Satellite Consortium (INTELSAT). 58 nations are now members. Each member contributes investment capital and shares in the use of the system. ComSat, the U.S. representative, is the consortium manager and now contributes 54% of the total investment. All satellites managed by ComSat are owned by INTELSAT—so that commercial satellite communications has from its beginning been a product of international cooperation.

Progress has been rapid. Early Bird was launched in 1965. Now the INTELSAT II series serves both the Atlantic and the Pacific. Twelve ground stations—the vital links for sending and receiving messages—have been constructed over the world. 46 are anticipated by the end of 1969.

Today, just five years after the passage of the Communications Satellite Act and three years after the INTELSAT agreement, developments have exceeded our expectations:

—The synchronous satellite, which rotates with our globe and thus maintains a stationary position in orbit, has been developed well ahead of schedule.

—Those responsible for U.S. international communications—with ownership divided among a number of surface carriers and ComSat—now look forward to an integrated system which will utilize satellite technology.

—Proposals are being discussed for the establishment of a domestic communications satellite—either limited to TV transmission or servicing a variety of domestic communications uses.

Because we have been the leaders in the development and use of satellite communications, other countries are deeply interested in our country's position on the continuation of INTELSAT, and in the importance we assign to international cooperation in the field of satellite communications.

On February 28, 1967, I declared in a message to Congress:

> Formulation of long range policies concerning the future of satellite communications requires the most detailed and comprehensive study by the executive branch and the Congress. I anticipate that the appropriate committees of Congress will hold hearings to consider these complex issues of public policy. The executive branch will carefully study these hearings as we shape our recommendations.

A number of important communications issues are presently before the Federal Communications Commission for consideration. Some of them have been discussed in the Senate and House Commerce Committee hearings on the Public Television Act of 1967. ComSat and the State Department have opened discussion of the international questions with our foreign partners and their governments.

In order to place this important policy area in perspective, I want the views of the President to be clear. This message includes a report of the past, a recommendation for the present, and a challenge for the future.

Global Communications System

Our country is firmly committed to the concept of a global system for commercial communications. The Declaration of Policy and Purpose of the Communications Satellite Act of 1962 set forth Congressional intent:

> The Congress hereby declares that it is the policy of the United States to establish, in conjunction and in cooperation with other countries, as expeditiously as practicable a commercial communications satellite system, as part of an improved global communications network, which will be responsive to public needs and national objectives, which will serve the communications needs of the United States and other countries, and which will contribute to world peace and understanding.

The INTELSAT Agreement of 1964—to which 58 nations have now adhered—left no doubt as to its purpose. Its preamble expressed the desire:

* * * to establish a single global commerical communications satellite system as part of an improved global communications network which will provide expanded telecommunications services to all areas of the world and which will contribute to world peace and understanding.

Of course, these agreements do not preclude the development and operation of satellite systems to meet unique national needs. The United States is developing a defense system—as will others. But INTELSAT members did pledge that commercial communications between nations would be a product of international cooperation.

Today I reaffirm the commitments made in 1962 and 1964. We support the development of a global system of communications satellites to make modern communications available to all nations. A global system eliminates the need for duplication in the space segment of communications facilities, reduces the cost to individual nations, and provides the most efficient use of the electro-magnetic frequency spectrum through which these communications must travel.

A global system is particularly important for less developed nations which do not receive the benefits of speedy, direct international communications. Instead, the present system of communications—

—encourages indirect routing through major nations to the developing countries,

—forces the developing nations to remain dependent on larger countries for their links with the rest of the world, and

—makes international communications service to these developing nations more expensive and of lower quality.

A telephone call from Rangoon to Djakarta must still go through Tokyo. A call from Dakar, Senegal, to Lagos, Nigeria, is routed through Paris and London. A call from American Samoa to Tahiti goes by way of Oakland, California. During the recent Punta del Este conference, I discovered that it usually cost Latin American journalists more than their American colleagues to phone in their stories because most of the calls had to be routed through New York.

Such an archaic system of international communications is no longer necessary. The communications satellite knows no geographic boundary, is dependent on no cable, owes allegiance to no single language or political philosophy. Man now has it within his power to speak directly to his fellow man in all nations.

We support a global system of commercial satellite communications which is available to all nations—large and small, developed and developing—on a non-discriminatory basis.

To have access to a satellite in the sky, a nation must have access to a ground station to transmit and receive its messages. There is a danger that smaller nations, unable to finance or utilize expensive ground stations, may become orphans of this technological advance.

We believe that satellite ground stations should be an essential part of the infrastructure of developing nations. Smaller nations may consider joint planning for a ground station to serve the communications needs of more than one nation in the same geographic area. *We will consider technical assistance that will assist their planning effort.*

Developing nations should be encouraged to commence construction of an efficient system of ground stations as soon as possible. When other financing is not available, *we will consider financial assistance to emerging nations to build the facilities that will permit them to share in the benefits of a global communications satellite system.*

Continuation of INTELSAT

The 1964 INTELSAT agreement provides only interim arrangements—subject to renegotiation in 1969. Our representatives to the consortium will soon begin discussions for a permanent arrangement.

We support the continuation of INTELSAT. Each nation or its representative contributes to its expenses and benefits from its revenues in accordance with its anticipated use of the system. The 58 members include representatives from the major nations who traditionally have been most active in international communications. It has been a successful vehicle for international cooperation in the ownership and operation of a complex communications system.

We will urge the continuation of the consortium in 1969. The present arrangements offer a firm foundation on which a permanent structure can be built.

Some nations may feel that the United States has too large a voice in the consortium. As heavy users of international communications, our investment in such an international undertaking is exceptionally large. The early development of satellite technology in the United States and the size of our investment has made it logical that ComSat serve as consortium manager.

We seek no domination of satellite communications to the exclusion of any other nation—or any group of nations. Rather, we welcome increased participation in international communications by all INTELSAT members. We shall approach the 1969 negotiations determined to seek the best possible permanent organizational framework.

—We will consider ceilings on the voting power of any single nation—including the United States—so that the organization will maintain its international character.

—We will support the creation of a formal assembly of all INTELSAT members—so that all may share in the consideration of policy.

—We favor efforts to make the services of personnel of other nations available to ComSat as it carries out its management responsibilities.

—We will continue the exchange of technical information, share technological advances, and promote a wider distribution of procurement contracts among members of the consortium.

It is our earnest hope that every member nation will join with us in finding an equitable formula for a permanent INTELSAT organization.

Domestic Communications Satellite Systems

Communications satellites have domestic as well as international applications. Satellites that can beam telephone calls or television programs between New York and Paris can do the same between New York and Los Angeles. Daring proposals have already been made to tap the vast U.S. domestic market.

Our awareness of the social and economic potential of this new technology is met by similar excitement around the globe. Each nation will be making decisions about how domestic communications needs can best be met. The position taken by the United States is particularly important because our domestic market is so large and our role in international communications is so extensive.

There are important unanswered questions concerning the operation of a domestic system. Assuming these questions are answered favorably, we still must make the decision to move forward with such a system consistent with our international obligations.

The space segment of a communications satellite system is international by its very nature.

—A synchronous satellite occupies a permanent orbital position in the international domain of outer space.

—All satellites radiate electro-magnetic energy potentially capable of interference with other communications systems.

—All satellites use the internationally regulated frequency spectrum.

In view of the international nature of satellite communications and our commitments under the INTELSAT agreement of 1964, we should take no action in the establishment of a domestic system which is incompatible with our support for a global system.

This does not mean that the United States—or any other nation—will give up vital sovereignty over domestic communications. The flow of satellite communications—both domestic and international—is to and from ground stations owned by the individual nation or its representatives. Each country will have to determine for itself whether it wants to use communications satellites for domestic purposes. It must be prepared to bear the expense of such satellite use, just as it will derive any revenues.

It is the space segment—not the ground station—that is of legitimate international concern. How should a nation utilize satellites for domestic communications purposes?

There are several possible choices:

—A nation can lease circuits from an international INTELSAT satellite.

—It could elect to operate a separate satellite for its own domestic use.

—It could join with neighboring countries to operate a separate satellite.

Logically, this decision should be based on economic grounds—whether domestic requirements can be met most efficiently and economically by a satellite owned by INTELSAT, or by a separate satellite. Present studies indicate that a high volume of domestic traffic is necessary for a separate satellite to offset the cost advantage of sharing the use of an international satellite. The same considerations apply if domestic needs are to be met by a satellite shared by several nations.

If the regional satellite is to carry international traffic as well, INTELSAT—the international communications consortium—has an important stake in the result. Adequate provisions must be made so that any international traffic which is diverted will not jeopardize the economic efficiency of the INTELSAT system or limit its extension to developing countries.

INTELSAT members should adhere to INTELSAT supervision in any use of domestic or regional satellites.

Such supervision should include coordination of design so that all communication by commercial satellite is compatible with the global system. We must not sacrifice our goal of direct communications links among all nations. Domestic and international traffic should be able to flow freely through the entire global system, limited only by the technology itself.

Technical regulation is also necessary so that positions in orbit can be assigned, frequencies can be allocated, and energy from satellites does not interfere with other communications systems.

The alternative to this type of coordination is international communications anarchy—lack of inter-connections, needless expense, pollution of frequencies, radio interference, and usurpation of orbital spaces. Nations should have no hesitation in choosing the route of nternational cooperation.

Participation by Other Nations in INTELSAT

I urge the Soviet Union and the nations of Eastern Europe to join with the United States and our 57 partners as members of INTELSAT. INTELSAT is not a political organization. It holds no ideological goal except that it is good for nations to communicate efficiently with one another. It seeks no diplomatic advantage. It is quite simply a cooperative undertaking of many nations to finance an international communications system which is of advantage to all.

In 1963, this invitation was extended by the governments of those nations which joined in the creation of INTELSAT. Today, I renew that invitation on behalf of our government.

I have stated many times my hope that our commercial activities with the Soviet Union and Eastern Europe will grow, that our contacts will increase, and that we will emphasize those matters in which our interests are common rather than dwelling on those issues which divide us.

Here is a rare opportunity to join in an activity to bring benefits to all nations and loss to none. Recently the Soviet Union ratified the treaty for the peaceful uses of outer space. Nothing could better symbolize the truth that space belongs to all men, than an international undertaking that permits the free flow of communications. I earnestly hope that the Soviet Union and the nations of Eastern Europe will join in this historic action.

The Soviet Union is a leader in satellite technology. I am advised that there is no insurmountable technical obstacle to an eventual linking of the Soviet MOLNIYA system with the INTELSAT system. The peoples of the world could rightfully rejoice if our advances in satellite technology were accompanied by this act of global cooperation.

Of course, this participation would require a revision of investment and voting ratios based on Soviet anticipated use of the system. Our representatives in INTELSAT are ready to participate in immediate discussions to make that membership possible.

International Communications Ownership

Most nations handle their international communications through a "chosen instrument"—generally, a government owned entity. The United States has no chosen instrument. Several record carriers and one voice carrier handle international traffic. In addition, ComSat provides satellite circuits to these carriers.

Our normal instinct is to favor the existence of multiple companies in each commercial field. We believe that competitive pressures—among technologies as well as companies—will usually generate lower prices for the user. Congress recognized in the 1962 Act that ComSat would be required to deal with several international carriers.

Yet, there is a legitimate question as to whether the present division of ownership continues to be in the public interest. Critics argue that:

—International communications are provided by an industry which is regulated in its rates and practices. Price competition, as we usually use that term, does not exist.

—Divided ownership has resulted in the construction and maintenance of expensive, duplicating communications facilities which increase operating costs and result in higher rates for the user.

—Our nation is in a relatively poor bargaining position on communications matters with foreign counterparts since we do not speak with a single voice.

—Disputes have existed between ComSat and the surface carriers over who should own the ground stations in the international system.

—Defense communications in the future could be subjected to delay.

Several proposals have been advanced which would affect our international communications posture. Legislation has been proposed to permit a merger of one or more of the international carriers. It has been suggested that ComSat should be permitted—in certain circumstances—to contract directly with users other than the international common carriers.

Questions have been raised whether additional communications capacity should be developed through surface cables, utilization of satellites, or other technologies.

A continuation of the review of these issues is desirable.

TASK FORCE ON COMMUNICATION POLICY

I am appointing a Task Force of distinguished government officials to make a comprehensive study of communications policy.

It will examine a number of major questions:

—Are we making the best use of the electro-magnetic frequency spectrum?

—How soon will a domestic satellite system be economically feasible?

—Should a domestic satellite system be general purpose or specialized, and should there be more than one system?

—How will these and other developments affect COMSAT and the international communication carriers?

These are complex questions. Many of them are being presently weighed by the Federal Communications Commission. But a long, hard look must also be taken by all parties with responsibility in this area—for the ultimate decisions will work a revolution in the communications system of our nation.

This Task Force will examine our entire international communications posture. It should investigate whether the present division of ownership in our international communications facilities best serves our needs, as well as which technology can meet new communication requirements in the most effective and efficient manner.

The task force may establish working groups of government and non-government experts to study various technical, economic and social questions.

The task force should also determine if the Communications Act of 1934 and the Communications Satellite Act of 1962 require revision. I am asking the task force to report to me from time to time and to make its final report within one year.

Government Organization

Our government must be organized to carry out its responsibilities in the communications field. Present authority is widely dispersed. The Federal Communications Commission has heavy responsibilities under the 1934 and 1962 Acts. The President and many agencies have responsibilities under these Acts, various Executive Orders, and as part of their general duties.

Communications is a vital public policy area—and government organization must reflect that challenge.

I have asked the Bureau of the Budget to make a thorough study of existing governmental organization in the field of communications and to propose needed modifications.

Conclusions

This message does not create a new communications policy for our nation. Rather it proposes the foundation for that policy.

—It reaffirms our intentions as a partner in INTELSAT.

—It considers the need for modifications in our international communications posture.

—It sets in motion the necessary studies for a better understanding of policy needs in domestic and international communications.

The challenge of this new technology is simple—it is to encourage men to talk to each other rather than fight one another.

Historians may write that the human race survived or faltered because of how well it mastered the technology of this age.

Communications satellites now permit man's greatest gifts—sight, expression, human thoughts and ideas—to travel unfettered to any portion of our globe. The opportunity is within our grasp. We must be prepared to act.

Lyndon B. Johnson.

The White House, *August 14, 1967.*

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