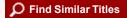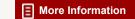## FROM THE ARCHIVES

Review of Electronic Mail Service Systems Planning for the U.S. Postal Service (1981)

Pages
65

Size
8.5 x 11

ISBN
0309330254

Committee on Review of U.S. Postal Service Planning for Electronic Mail Service Systems; Board on Telecommunications-Computer Applications; Assembly of Engineering; National Research Council

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Review of Electronic Mail Service Systems Planning for the U.S. Postal Service

A Report to the
U.S. Postal Service by the

Committee on Review of U.S. Postal Service Planning
for Electronic Mail Service Systems
Board on Telecommunications-Computer Applications
Assembly of Engineering
National Research Council

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CONTENTS

PREFACE

This report is the product of a committee convened by the National Research Council (NRC) at the request of the United States Postal Service to review emerging Postal Service concepts and plans for electronic mail services. It is the second NRC study for the Postal Service on electronic mail systems, and it builds on the earlier study, issued in 1976 (see Chapter I).

The committee's deliberations began in April 1980 and were completed in April 1981. The committee included members with expertise and experience in law, economics, communications technology, and business management. It would be expected that such a diversity of membership would generate a diversity of views on the particular issues addressed. However, though some differences did appear from time to time in our deliberations, they were remarkably small relative to the consensus achieved on major conclusions presented in this report.

Our basic task was to review Postal Service plans for electronic mail as those plans were presented to us, and not to undertake separate and independent research into the subject of electronic mail. Our comments on these plans deal with technological and managerial aspects of general planning direction and design. The committee was limited in its ability to probe deeply into details of either the technology or the management of Postal Service plans.

The committee met as a group six times for briefings and discussion. Between meetings, individual members reviewed materials, conducted interviews, and drafted comments as their regular, full time responsibilities and other professional commitments permitted. We hope that the judgments that resulted from this process will be useful.

Several members of the committee asked colleagues to assist with this study. Accordingly, the committee wishes to thank Messrs. Charles Skibo of the MCI Telecommunications Corporation and Richard L. Snowden of the American Telephone and Telegraph Company.

The committee received very useful information on electronic mail developments abroad, for which it expresses its great appreciation to J. Kanzow, of the Ministry of Posts and Telecommunications in the Federal Republic of Germany; S. L. Goron, of the British Post Office;

CONCLUSIONS AND RECOMMENDATIONS

The United States Postal Service has committed itself to promoting
and developing electronic mail services. In so doing, it has decided
to limit itself to providing so-called Generation I and Generation II
services, which involve partial use of electronic methods in the
handling and transmission of messages while retaining the Postal
Service's unique physical delivery network capable of reaching almost
any point in the country. Provision of an electronic end-to-end
delivery system, the so-called Generation III system of "mail," is
deemed to depart too much from the basic character of the Postal
Service and to approach privately supplied communications services too
closely.

The present commitment of the Postal Service with regard to
electronic mail services is justified.

Recommendation 1: The Postal Service should actively promote
and develop electronic mail services insofar as they enhance
present mail services involving ultimate physical delivery of
messages.

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Until recently, plans to develop electronic mail have suffered from
confusion over long-range and near-term objectives. To a significant
extent, this situation results from an organizational schism within the
Postal Service, which in turn reflects insufficient direction from top
level Postal Service managers. The organizational problem appears to
have been solved by a new management direction that has integrated
electronic mail initiatives. However, the plans for electronic mail
are still somewhat confused as to how near-term program development
meshes with long-term planning objectives. For example, it is unclear
how the near-term development of an electronic computer-originated mail
(E-COM) service will relate to the longer range conception of an
electronic message service system.

Recommendation 2: Because of the imprecision inherent in
forecasting markets over long time periods, the Postal Service
should implement discrete services like E-COM and use them to

test and develop the market. The Postal Service should continue long-range planning, looking ahead to future service needs and options for meeting them. However, the evolution of services arising out of near-term services such as E-COM should not be forced to conform to long-term system designs drawn in advance of market and operating experience.

* * * * *

The Postal Service created a handicap for itself initially by splitting organizational responsibility for electronic mail planning and development. Though this problem appears to have been solved, there remains a question of how the Postal Service should organize itself with respect to electronic mail services. For the present, the Postal Service has established a special unit to handle electronic mail, but has not made it financially independent. Detailed plans as to how this unit will be organized and how it will function have yet to be developed.

Recommendation 3: The Postal Service should establish an independent unit for electronic mail with an appropriate degree of managerial and financial independence from regular mail operations. To this end, all services provided by other postal units should be fairly charged to the electronic mail unit.

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The new electronic mail unit must be given sufficient financial, managerial, and technical capability to be an active participant in the electronic message field. The Postal Service has relied heavily on outside contractors for assistance in developing electronic message concepts and services. In the future it should develop greater capability to manage these activities within its own organization.

Recommendation 4: The Postal Service should acquire greater in-house expertise to manage both the financial and technical aspects of developing electronic mail.

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An essential element of managerial capability is knowledge of the market and how it can be developed to serve customer needs. The Postal Service needs to know more about the market for electronic mail services and then to devise flexible business strategies for developing that market. For example, needed flexibility for evolutionary development could be provided through separate offerings of the various functional components of an electronic mail service, rather than only one monolithic service.

Recommendation 5: The Postal Service should give priority
attention to market research to determine customer needs and
how they can be met by different electronic mail service
offerings, singly and in combination. The Postal Service
should also develop flexible marketing and pricing strategies
for these offerings.

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Electronic mail's greatest impact on postal operations will be to
cut labor costs. Electronic sorting and distribution will displace
labor-intensive methods of mail handling. Both labor unions and
management recognize and accept this development, although neither has
very reliable estimates as to exactly how electronic mail will affect
postal workers. However, the postal unions have not been as closely
consulted on the development of plans for electronic mail as they could
have been.

Recommendation 6: Postal Service managers should attempt to
involve labor representatives in a planning partnership to
develop electronic mail services. Together, both management
and labor should monitor the effect of electronic mail on the
workforce, with a view towards ensuring a cooperative
implementation of electronic mail.

* * * * *

Electronic mail presents potentially serious problems of security
and privacy protection. The processing, storage, and transmission of
large amounts of data, which are functions central to electronic mail,
offer an attractive target for anyone seeking access to individual and
corporate information. A secure system must include precautions
against two distinct threats: unauthorized use of private information
by those who handle and process messages and intrusion by outsiders who
gain access to the messages during processing or transmission.

Recommendation 7: The Postal Service should establish strong
internal security procedures for handling electronic
messages. These procedures should be designed to prevent any
employee or group of employees from browsing through the
mails, from aggregating the mail to any one user, or from
extracting mailing lists. If the Postal Service markets
communications links as part of electronic mail, it should
offer to encrypt messages as a special service option.

Chapter I

ORIGINS AND EVOLUTION OF ELECTRONIC MAIL

Before discussing the specific concerns of this report, a few
general comments on the United States Postal Service are in order. We
can begin by noting that the Postal Service serves a 36-million-square-
mile area, delivering mail to locations from Attu, Alaska, to San Juan,
Puerto Rico, and all points in between. The Postal Service delivered
over 100 billion pieces of mail to more than 80 million delivery stops
in fiscal year 1980.

After a period of relatively slow growth, the volume of mail grew
by more than 6 billion pieces in the past year alone. The number of
new addresses increased by about 2 million, and another 26 million
addresses changed. In addition, the Postal Service has launched
services like Express Mail and Presort in recent years.

The scope and magnitude of the service gives some measure of the
operational challenge; the financial size indicates the extent of the
management challenge. Viewed as a business, the Postal Service would
be ranked as one of the largest U.S. enterprises: in fiscal year 1980
it employed more than 650,000 workers, maintained more than 39,000 post
offices, branches, and stations, managed total assets of nearly $4
billion, generated $17 billion in annual revenues, and incurred
operating expenses of more than $19 billion.

These data suggest the magnitude of the operational and managerial
tasks facing the Postal Service but say nothing about how well those
tasks have been performed. The occasional complaints about the quality
of the service and the rising costs of stamps imply a negative
appraisal of Postal Service efficiency. Yet the general indicators are
more positive than critics suppose. This is true, certainly, if one
compares U.S. postal services with those in other countries.

For example, U.S. postal employees handle more pieces of mail per
employee than any other major postal service in the world. At a rate
of more than 156,000 pieces per employee-year in fiscal 1980, the U.S.
Postal Service far exceeded that of the next most productive,
Switzerland, which serves a tiny area and population compared with the
United States. Despite complaints about rate increases, U.S. postal
rates are among the lowest in the world. For example, the cost of
sending a letter in the United States in fiscal year 1980 was less than
half of that in France, the Federal Republic of Germany, and Sweden,

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and slightly more than half of that in Great Britain and Japan. Even Switzerland had rates half again as high as those in the United States.

Data for comparing delivery efficiency are not readily available. Given the greater size of the delivery area, one would not expect the U.S. Postal Service to match the delivery performance of, say, Switzerland. But the general indicators are quite positive--certainly more positive than some of us who have waited for overdue mail might suppose. For example, in fiscal year 1980 about 95 percent of first class mail sent within a local or metropolitan area was delivered overnight, 86 percent of the mail addressed to locations within a 600-mile radius was delivered within 2 days, and 87 percent of the mail sent more than 600 miles was delivered within 3 days.

Nonetheless, there are valid concerns about the efficiency of the service and of the organization that provides it. The past decade has seen some noteworthy efforts to make the U.S. Postal Service more efficient than was characteristic of the old Post Office Department. The latter seemed oriented more to political patronage than to efficiency.

In response to the recommendations of the President's Commission on Postal Organization (the Kappel Commission), established in 1968 to consider reorganization of the Post Office, Congress created the U.S. Postal Service in 1971 as an independent agency of the U.S. Government. The Postal Service was mandated to operate in accordance with good business practices. Congress intended certain mail services to continue to be explicitly subsidized through appropriations, but in general expected that the Postal Service would become self-sustaining by 1985.* However, there is reason to doubt that the goal can be met if past trends continue. Since it began operations in 1971, the Postal Service has operated with deficits every year except 1979. Without question, much of the problem stems from political factors that, in our

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*There are currently two separate subsidies. The first (Public Service subsidy) supports service in rural areas and small communities; the second (Revenue Forgone subsidy) supports reduced rates for special users--newspaper and magazine publishers, certain nonprofit organizations, and the blind. While the Public Service subsidy was scheduled to be reduced by ten percent annually beginning in fiscal year 1980 and ending in fiscal year 1984, the Omnibus Budget Reconciliation Act of 1981 (Public Law 97-35, signed on August 13, 1981) further reduces the Public Service funds available to the Postal Service. The law permits Public Service appropriations of $250 million (vice $644 million) in fiscal year 1982, $100 million (vice $532 million) in fiscal year 1983, and no Public Service appropriation (vice $460 million) in fiscal year 1984. The Postal Service is entitled to request $460 million in Public Service appropriations in fiscal year 1985 and thereafter. The Revenue Forgone appropriation for fiscal year 1981 was $789 million, up very slightly from the $782 million appropriated for fiscal year 1980. The Omnibus Budget Reconciliation Act limits such appropriations to $696 million for fiscal year 1982, $708 million for fiscal year 1983, and $760 million for fiscal year 1984.

system, are inevitably overlaid on the goal of strict economic viability. For example, Congress has often decided in favor of Saturday mail delivery and the continuation of small post offices. The Postal Rate Commission has often decided in favor of lower rather than higher rates.

This story has been well documented in previous studies of the Postal Service, such as that of the 1977 Commission on Postal Service (the Freeman Commission). It is neither necessary nor appropriate that we review those studies here, except to call attention to the fact that costs associated with matters of national policy will still exist despite the 1970 Postal Reorganization Act and its mandate for a more efficient postal service.

The inability to eliminate uneconomic services and facilities means that the Postal Service must look to improved methods and equipment for handling and delivering mail to achieve greater efficiency. Over the years, the Postal Service has made some notable strides in this respect--mechanized mail processing and sorting, presorting, ZIP code, and computer-aided forwarding--that have boosted productivity to the high levels mentioned earlier.

Unfortunately, such productivity-enhancing techniques have not matched the inflationary trends that have beset the entire economy in recent years. For one thing, the improvements have their own rising development and capitalization costs. For another, labor costs account for 85 percent of the total operating budget of the Postal Service, so that it is particularly vulnerable to inflation-adjusted wage costs. Current labor contracts give postal employees an automatic cost-of-living adjustment linked to the consumer price index. Compensation increases since 1971 (even after adjusting for productivity increases) have exceeded increases in the consumer price index in order to attain better comparability with the general level of salaries and wages. The data in Table I.1 illustrate this trend.

Given the strong regulatory and public resistance to increased postal rates,* the task of coping with escalating costs is daunting enough. It is made all the more so by the growing prospect of competition for message delivery from private delivery firms and telecommunications companies. There has always been, of course, some competition between mail and private delivery, and between mail and electronic telecommunications; but each service has been sufficiently distinctive in price and characteristics to be somewhat independent of the others.

This situation is changing regarding telecommunications. Advances in electronics, electronic data processing, and computer-controlled

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*The Postal Rate Commission (PRC) found a Postal Service request for a 5-cent increase for the first ounce of first class mail in March 1981 unwarranted, but allowed a 3-cent increase. In June 1981, the Governors of the Postal Service rejected the Commission's decision and requested the Commission to reconsider. Subsequently, the Governors decided, contrary to a further 18-cent recommendation by the PRC, to raise the rate to 20 cents, effective November 1, 1981. This action is being challenged in the courts.

TABLE I.1 Average U.S. Postal Service wage compared to consumer price index, for various years.

Year	Average Wage*	Wage Ratio to 1971 Level	Consumer Price Index**	Index Ratio to 1971 Level
1971	7,913	1.00	121.3	1.00
1972				
1973	9,329	1.18	133.1	1.10
1974				
1975	11,739	1.48	161.2	1.33
1976				
1977				
1978	14,757	1.86	193.5	1.60
1979				
1980				
1981	19,915	2.52	265.2	2.19

*Adapted from U.S. Postal Service. 1981. The Postal Leader 11(13). July 14.

**U.S. Department of Commerce, Bureau of Economic Analysis. 1978. 1977 Business Statistics, 21st Biennial Edition. Washington, D.C.: U.S. Government Printing Office. And U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business. Washington, D.C. (various issues).

communications have sharply diminished the convenience of physical mail, particularly for business communications. Such advantage as there is has become increasingly sensitive to relative prices, which are driven by handling and delivery costs. Here the advantage may be rapidly shifting to electronic message systems. Thus, the Postal Service has found itself threatened by both blades of the demand-supply scissors: the rising costs of a still labor-intensive operation from one side, and competition from a more cost-effective, technologically advanced electronic message service from the other.

It is this dual threat that led the Postal Service recently to renew its consideration of electronic mail. In 1969, the Post Office Department began to study the use of electronic technology in processing and transmitting mail. A report issued by the Department in 1970 concluded that the construction of a nationwide electronic mail service system was technically feasible. In the same year, the Post Office instituted MAILGRAM, a service that combined aspects of telegrams and letters. MAILGRAMs are transmitted electronically by Western Union and delivered manually by the Postal Service.

In 1973, the Board of Governors of the Postal Service decided to study fully the possibilities of an electronic mail system. In August 1973, the Office of Advanced Mail Systems Development was established within the Research and Development Department of the Postal Service to manage the study. An initial plan for an Electronic Mail Service System (EMSS) program was completed in 1974. The plan outlined a systems approach to begin electronic mail service in 1985 and to have it fully operational by 1990. The system was to be developed in five distinct phases: concept, validation, development, design and production, and implementation.

At about the same time, independent study groups were encouraging the Postal Service to develop its own electronic mail system. In response, the Postal Service asked the National Research Council (NRC) in 1975 to study the possibilities of electronic mail. The NRC study was to review technologies related to electronic message distribution and to recommend a course of action for the Postal Service with regard to the research, development, and application of electronic systems to supplement or partly replace first class letter mail.

Reporting in 1976, the NRC panel developed three conceptual models, each describing a different level of electronic message handling. "Generation I," the first of these models, involved mainly manual collection and delivery methods. It viewed electronic systems as a means only of sorting and transmitting mail among postal facilities. The second model, "Generation II," used electronic collection, sorting, and transmission with manual delivery and some manual input. The third, "Generation III," was totally electronic. It depended on the future development of economical user terminals and extensive electronic distribution methods.

The NRC panel concluded that technical feasibility would not limit the evolutionary development of electronic message services. Instead, any limitations would be a combination of technical, social, economic, and regulatory factors. The panel recommended that the Postal Service make a firm and continuing commitment to the electronic message field, with a strong emphasis on planning, research and development, systems engineering, and in-house capability.

The NRC's basic recommendation for the Postal Service to develop electronic mail was endorsed in 1977 by the Commission on Postal Service (the Freeman Commission) created by the President and Congress. It was further endorsed in 1979 by President Carter, who made clear, however, that such an initiative should not extend to an all-electronic message system--Generation III.

The Postal Service has accepted these recommendations and has developed plans to implement them. Unfortunately, as we shall explain later, the planning process within the Postal Service has been somewhat confused as a consequence of separate organizational responsibilities for long-term planning and near-term service development.

Chapter II

LONG-TERM PLANNING: ELECTRONIC MAIL SERVICE SYSTEMS

That the U.S. Postal Service has a role in electronic mail the
committee takes as given. The vexing questions concern the appropriate
scope and character of what that participation should and can
efficiently be. The committee notes that former President Carter and
the Postal Service reached a policy decision that the role of the
latter should properly be limited to what have come to be characterized
as "Generation I and II" systems; that is, systems that do not entail
final delivery of mail electronically (as in "Generation III"
systems). We understand that this decision took into consideration the
basic character of the Postal Service and the uncertainties about how a
universal electronic delivery system may evolve in the coming decades.
Both Generations I and II build on the Postal Service's unique
strength--its ability to deliver physical objects--letters or
packages--to millions of individual locations throughout the country.
Remaining to be clarified are the potential for a Postal Service
electronic mail system and the desirable design, development, and
implementation paths within the limits of Generation I and II
electronic mail.

BACKGROUND STUDIES

The committee's principal starting point for evaluation was the
long-term plan defined in two studies performed by the RCA Corporation
(RCA) for the Postal Service: the System Definition and Evaluation,
1976-1978; and the System Validation and Test Plan, 1979. The
committee was also provided with other studies and data on Postal
Service activities, including MAILGRAM and Electronic Computer-
Originated Mail (E-COM). However, integrating these additional studies
and data with the RCA reports sometimes proved difficult, since the
Postal Service's plans continued to evolve even as we deliberated. To
provide a fixed reference point, our comments are focused on the RCA
reports.

The study done for the Postal Service by RCA envisions the Postal
Service running a national electronic message system capable of
processing a high volume of messages. It would emphasize business-
oriented mailers and household recipients of mail, but would exclude no

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one. Functionally, the Electronic Mail Service System (EMSS) would accept messages in electronic or paper form and convert the latter, if necessary, into electronic form. The messages would be transmitted electronically from their sources to their destinations over communications networks, sorted electronically, and converted back to paper form for delivery.

Some 87 EMSS stations, co-located with other postal facilities, would contain satellite communications terminals and assorted conversion equipment—facsimile devices, optical character readers, magnetic tape readers, printers, and paper handling equipment. The stations would also have processing subsystems to store, sort, bill, and manage the system. Customers would submit mail to the Postal Service EMSS either at conventional post office windows or at terminals. The mail submitted at post office windows would be either on magnetic media (cards or tape) or on paper in cartridges of nonenveloped multiple letters. The terminals would accept paper letters in small quantities.

The Postal Services's plans for electronic mail are based on the two studies of EMSS by RCA. RCA's market analysis of EMSS indicated that anywhere from 3 billion to 25 billion messages could be anticipated annually. Because of the wide variance, the RCA study recommended that electronic mail be phased in to minimize investment risks.

Still, the RCA study found that the economic potential of such electronic mail was sound. A mature system capable of supporting an annual volume of 25 billion pieces of mail was estimated to represent an investment of $1.8 billion, with recurring operating costs of $309 million annually. The study estimated that 4,400 people would be required to operate the system and that the annualized cost of operation and ownership (using a cost-avoidance approach) would be $19.50 per 1,000 letters excluding collection and delivery. For comparison, in 1978 it cost the Postal Service $65 per 1,000 letters excluding collection and delivery. At $19.50 per 1,000 letters, the RCA study estimated that electronic mail would pay for itself in 11 to 16 years, depending on the volume growth. The study did not cover the potential adverse impacts on the labor force, except to consider whether changes could be accommodated through normal attrition.

Because of market uncertainties and technical considerations, the RCA study proposed a phased implementation that would include development of a three-year system validation and test network before the system is put into effect. During the first phase, a four-node test bed, with three operational systems and one overhead system, would be installed and tested. In the second phase, the system would be expanded to 10 locations.

In evaluating the general concept, the committee was concerned that the system definition and evaluation study specifically, and Postal Service plans generally, placed too great emphasis on long-term design. Given the dynamic character of the technology for electronic mail, attempts to forecast the design of a system 20 years into the future are fraught with uncertainty. The Postal Service should plan ahead, but should not place great reliance on a system designed 20 years before it is fully mature.

The Postal Service's EMSS plans define the final system and work backwards to develop stages for implementation. A better strategy would be to design near-term service offerings that would systematically adapt and grow as the market and technology develop. MAILGRAM, E-COM, and INTELPOST services offer alternative models that might be used as prototypes for such approaches. The Postal Service planning appears now to be shifting toward a more evolutionary approach building on discrete services. This change in approach in relation to E-COM is addressed in Chapter III.

The difficulties inherent in long-term plans are illustrated by the market forecasts offered in the RCA study. Given the study's basic approach, its techniques may have been reasonable, but the resulting estimates are open to question. A later market survey done for the Postal Service by Booz-Allen & Hamilton, Inc., found a range of 3 billion to 10 billion pieces of mail annually, a market estimate substantially different from the 3 billion to 25 billion given by the RCA study.

Specifically, the RCA study projects a total possible annual market for electronic mail of 48 billion letters (first and third class) out of a total of 93 billion by 1990. The remaining 45 billion pieces are considered to be unsuitable for EMSS. Of the 48 billion, the study estimated that about half, or roughly 25 billion pieces, would be captured by the Postal Service.

This estimate of the potential market is evidently based on an extrapolation of present letter mail volumes that does not take into account the possible impact of all-electronic (Generation III) mail systems. The Postal Service did not ask for a look at market diversion to Generation III mail. This seems to be a significant omission, since such a diversion could have a substantial impact on letter volume and hence on the market for EMSS. Clearly, this question should be investigated in light of modern developments in electronic technology.

A study by Arthur D. Little, Inc., in 1978 did look at the issue in terms of diversion by electronic fund transfer and general telecommunications. That study estimated the diversion of first class mail by 1985 to be more than 7 billion pieces. We offer no appraisal of this estimate, since we have no reliable data. However, on the basis of recent developments in telecommunications systems and services, we believe that the expected diversion to Generation III will be substantial.

Apart from the inherent difficulties of forecasting, the committee questions the RCA study's assumption that the competition from Generation III systems will be negligible over the coming 20 years. Many of the same forces affecting the computer and telecommunications industries will also affect electronic mail. They could impinge significantly on the Postal Service's market opportunities for its Generation II systems.

For business-to-business mail, Generation III systems are already available. Their use is likely to be extensive by 1990. These systems

now focus on intracompany messages,* but they could easily capture a significant share of the intercompany market by the end of the decade. Thus, the Postal Service's EMSS could face significant competition for a sizable amount of company-to-company mail.

However, for Generation III systems to offer widespread service to households, at the least some acceptable manner of providing economical input/output terminals in individual households must be found. Many communications networks will be available to support a Generation III system in the 1980s if economical terminals are available. Accordingly, whether prices of a competitive private sector system will significantly affect the volume of the Postal Service electronic mail hinges on whether home terminals become widespread. While the availability of such terminals is growing apace, we do not foresee that such terminals will be sufficiently widespread to support an extensive Generation III system for many years to come.

Competition may also occur within Generations I and II for some electronic mail services. For example, EMSS can be viewed as consisting of four functional elements: electronic mail sorting, printing and enveloping, the electronic transmission of information, and local mail distribution. Competition would probably affect each of these areas differently. Sufficient data are not available to support any general conclusions about what effect competition will have. Still, certain trends can be discussed and some observations made concerning whether the Postal Service can compete in each area.

The Postal Service appears well equipped to compete in mail sorting, a service in which it has had long experience. However, the same economic inducements that have led large businesses to presort could provide incentives for others to acquire the necessary skills and technology to use computers for sorting if presorted electronic mail creates sufficient cost savings in the postal system to support an associated postage discount. Moreover, neither the Postal Service's experience nor its skill levels would be sufficient to deter outside entrepreneurs from entering the mail sorting business, given a presorted electronic mail postage discount. Indeed, the Postal Service policy of crediting mailers for presorting nonelectronic mail encourages outsiders to enter the field.

The Postal Service may not have a clear competitive advantage in printing and enveloping either. Mailers large enough to have their mailings put on tape may be able to sort, print, and envelope as cheaply as the Postal Service can. The former can use their letterheads and other designs more cheaply and can add inserts and make other variations more flexibly.

This does not suggest, however, that the Postal Service cannot attract printing and enveloping business. Small and medium-sized mailers might prefer to deal with the Postal Service. Even large businesses may be limited in their ability to print large mailings at

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*A significant volume of intracompany mail is now distributed by the companies themselves and is not in the Postal Service's mail stream. Obviously the diversion of this mail to Generation III systems is of no consequence to the Postal Service.

multiple locations throughout the country; moreover, many large businesses seem to prefer to centralize billing and other specialized operations. Such firms might also use the printing and enveloping services of the Postal Service. Additionally, large businesses may use the Postal Service to handle peak loads for which they do not wish to maintain permanent standing facilities. But this last task may not work to the advantage of the Postal Service. If the Postal Service incurs an obligation to perform this function, it could find itself the printer and enveloper of last resort. It might thus have to invest in equipment to meet loads far above its normal requirements if the peak loads of large mailers failed to average out. Such a commitment could become a major financial burden, forcing the Postal Service to increase rates for medium or small users to cover the peak-load investment. Increased rates, in turn, could discourage even medium-sized businesses from using the Postal Service facilities.

On the other hand, economies of scale may give the Postal Service an economic advantage in sorting, printing, and enveloping. Because of its size and expected volume, it may be able to handle these functions more cheaply than even the larger mailers. If so, the Postal Service could successfully compete for this business.

The Postal Service has no special competitive advantage in electronic information transmission since, at present, it has no material investment, operations, or special expertise in electronic mail. By contrast, a number of companies either already have or are experimenting with various forms of electronic mail, ranging from systems based on customer premises to electronic mailboxes, already marketed by more than a dozen companies. Economies of scale associated with the Postal Service as a principal source of supply, such as were mentioned for sorting, printing, and enveloping, would not apply to transmission.

As long as competing electronic systems remain uneconomical, physical mail distribution at the local level will still be the nearly exclusive province of the Postal Service for final message delivery to most business and household recipients. At some point, the price of local mail delivery may ultimately have to reflect its high costs. To the extent this price increase occurs, the economies and speed of competing electronic distribution systems will become more attractive as an alternative to local mail delivery. The entire first class mail volume will become subject, in time, to competition.

To survive as a viable entity, the Postal Service must take advantage of its current strengths as soon as possible. In this regard, the Postal Service should ultimately separate ("unbundle") the various functional components of its electronic mail offerings and offer the physical delivery separately from other service components. This "unbundling" may soon be required by the Postal Rate Commission or by the Congress. The Postal Service now offers a presort discount, which, in effect, partially separates the sorting and delivery components. Whether the present presort discount will encourage a large diversion from unsorted mail to presorted mail is unclear, but a separate, unsubsidized rate might do so. The concept could substantially increase the market for Postal Service electronic mail.

Just as sorting is partially separable from other electronic mail functions, so too is long-haul transmission. In that case, users or private providers could insert messages at the destination station for direct delivery by the Postal Service mail carrier. This possibility could also increase the market for the local segment of electronic mail service while introducing competition into the long-haul segment.

Just as it is difficult to evaluate the market estimates for EMSS far into the future, so too is it difficult to gauge the soundness of financial rate of return and payback estimates derived from such estimates. The RCA report indicated that, under the standard financial efficiency criteria, the system will be very successful. Its estimates can be summarized as follows:

Economic Factors	Market Response		
	Fast	Medium	Slow
Internal rate of return (%)	39.6-47.1	35.0-40.6	18.4-23.3
Net present value ($ million)	2,788.3-3,237.5	1,687.5-1,886.3	238.3-303.3
Investment ($ million)	92.8-339.0	169.7-209.3	113.1-178.1
Cost per 1000 letters ($)*	24.0-25.4	28.4-30.7	23.2-28.9
Payback years from start of program	11-15	12-14	15-16
Payback years from start of traffic	5- 9	6- 8	9-10

While the conclusion may turn out to be correct, the figures that underlie it are questionable. The RCA report estimates that the electronic mail system will be handling 25 billion pieces of mail within 20 years of the initial expenditure. However, as noted earlier, a subsequent report by Booz-Allen & Hamilton, Inc., forecasts an electronic mail volume of only 3 billion to 10 billion pieces. The considerable difference in the volume projections of these two reports suggests the uncertainty in estimating volume. This uncertainty, in turn, makes it hard to estimate with any degree of precision the related economic benefits of an electronic mail system operated by the Postal Service.

The RCA report indicates that even with slow market growth (volume 3 to 4 billion pieces of mail in 20 years), the internal rate of return would be 18 to 23 percent. While considerably less than the 40 to 47 percent rate of return expected in a rapidly growing market (25 billion pieces in 20 years), a return of that magnitude for a slow-growth, small-market system is not unattractive. Again, however, even these estimates are not firm, given the uncertainty in the underlying market and cost estimates.

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*Averaged over a span of 20 years. Ranges are due to differing growth strategies.

Moreover, the relatively late payback (11 to 16 years, depending on the rate of volume growth) is troubling, particularly given the uncertainty of the market and the likely changes in technology over this period. Private companies would probably expect a much more rapid payback given the anticipated risks. Limited durability of software and hardware in a field of rapidly changing technology is also troubling. The hardware would be depreciated over 10 years; no figure is given for the important area of software changes. In short, the Postal Service should not rely heavily on long-term forecasts, based as they are on uncertain data, in developing near-term strategy for electronic mail.

A number of costs were apparently excluded from consideration in the RCA study. These include the costs of maintaining the system software, customer service organizations, operational and administrative control, and spare parts and replacements. In addition, no calculations were undertaken to define the cost of the time it takes to learn how to operate an electronic mail service. Learning time costs depend, in part, on the quality of the related systems engineering, the completeness and accuracy of descriptive information, and the quality of documentation and debugging.

Because the excluded costs are not trivial,* the RCA report probably overestimates the economic efficiency of the electronic mail system. To what degree the economic efficiency has been overestimated is not known. In a high volume market, the financial efficiency would probably still be considerable, even if the excluded costs were taken into account in the Postal Service's electronic mail project. However, if volume were to grow slowly, including these costs in the calculation might predict only modest benefits for electronic mail. An important factor affecting volume is competition from the private sector, which seems to be accelerating.

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*Based on experience with other systems, the excluded or underestimated costs can be estimated as follows:

- Software maintenance costs will be 15 to 30 percent of the original development cost annually.
- Operating costs could increase by 5 to 10 percent as a result of unscheduled downtime, which would cause volume to be rerouted or reprocessed.
- The cost of replacement spare parts and other consumables could range from 10 to 15 percent of the annual capital cost.
- Computer systems generally depreciate (in terms of their useful economic life) at a rate of 20 to 25 percent annually.
- For learning curve experience, the increase in system operating cost is 20 percent in the first year, 10 percent in the second year, and 5 percent in the third year.
- Software production costs between 1980 and 1985 could be as high as $40 per line of clean code; approximately 1 million lines will be needed.

The RCA study also omitted an estimate of the effect of a presort discount on the volume of EMSS traffic. The study estimates that "processing" costs under EMSS will be about 2 cents per letter compared to at least 5 to 6.5 cents per letter in the present system. "Processing", as used in the study, appears to include some costs of moving mail among major distribution centers. These transportation costs, however, seem to represent only a small portion of the cost difference.

The Postal Service has raised the presort discount to 3 cents and 4 cents for presorting first class letters to ZIP code and carrier respectively, based on a proposed 20-cent first class rate. The Postal Rate Commission recommended the 3- and 4-cent discounts, although it recommended postage for first class mail of 18 cents instead of the proposed 20 cents. The effect of such a discount would presumably narrow the price gap between conventional and electronic mail. One presumes that such a discount will diminish the incentive of large presort users to switch to EMSS if the latter is priced on the basis of cost relative to the cost of conventional mail. No effort seems to have been made to assess the impact of this discount on the EMSS market.

EMSS offers advantages to users beyond cost savings. Under present delivery standards, 95 percent of local mail is delivered overnight, 86 percent of mail going to locations within 600 miles is delivered in two days, and 87 percent of mail going beyond 600 miles in three days. EMSS is expected to meet the 95 percent overnight delivery standard nationwide. However, there is no evidence regarding the preference of users for overnight delivery for nationwide mail; indeed, estimates of local and nonlocal EMSS traffic are not available. If mailers who already presort obtain delivery roughly comparable to that promised for EMSS, then its speed of service will not significantly increase the demand for electronic mail.

ARCHITECTURE AND OTHER TECHNICAL CONSIDERATIONS

The electronic mail system that emerges in 20 years may not bear much resemblance to the one that the Postal Service had considered based on the RCA study. Hence, implementing less ambitious near-term offerings may be a wiser course than pursuing long-term designs. Nevertheless, the 87-node structure seems well enough conceived to be worth examining as a concept of what an effective system might look like.

Basic Architectures

The proposed 87-node EMSS system would use an all-satellite network for transmitting messages from one electronic mail station to another. Existing terrestrial networks would provide local communications from area post offices and sectional center facilities to the EMSS station. Initially, a single satellite transponder would be adequate to handle the anticipated traffic in the EMSS system. No more than two should be

required to handle the volume of the full system. These transponders can be leased from a domestic satellite common carrier; the Postal Service need not own its own satellite.

The proposal recommends a frequency division multiple access (FDMA)/time-shared approach, wherein the transponder is divided into 80 channels of 500 kilobits per second each. Thus, 80 time division multiple access (TDMA) channels would be available. By reducing the frequency bandwidth, the modem cost is reduced, a desirable result.

The FDMA/time-sharing approach appears to be the best method of handling the EMSS trunk network. No mention is made of network management in the RCA report and, on the basis of the proposal, satellite trunk network control has not been adequately described. Nor is it evident that the costs of network management have been included in the system costs.

A computer is required to assign users (EMSS stations) to the network via the appropriate FDMA channel in the correct time slot. There are a number of network control techniques: polling under central control, random access under central control and orderwire coordinated, and random access under distributed control and orderwire coordinated. Orderwire coordination is done either via terrestrial circuits or via a dedicated satellite channel. Some satellite network designers feel that the terrestrial control network is more reliable.

For the system to work, network traffic needs to be monitored so that equipment and channels can be appropriately allocated. In addition, monitoring is needed to analyze malfunctions and to make corrections through the use of redundant equipment or alternative paths. Network statistics can be used to analyze performance; the results in turn can lead to capacity changes, like the addition or elimination of equipment or communications channels.

System Validation and Test

The EMSS system validation and test plan developed by RCA is designed to obtain data in an operating environment to substantiate or replace market estimates made in the initial EMSS plan. As proposed, the test plan would be divided into two phases. Phase I would be implemented at three locations; after validation of Phase I, Phase II would expand the system to ten sites. As discussed below, the committee questions whether the Postal Service should proceed with this proposed plan given the development of E-COM. However, setting aside this general reservation, the RCA design is generally adequate for EMSS validation and test plan.

At least three sites are required to test a network system. A single site would require no trunk communications and indicate only how well a single node could accommodate local traffic. Two sites (two nodes) still would not constitute a network, but would show only how well communications between two locations could be managed. Three sites form a network. Testing such a network can determine the presence or absence of cross-modulation disturbances and other variables in multiple-path transmission.

The Postal Service should consider selecting three geographically dispersed sites that have potentially large volumes of traffic. Validating a system requires testing it at the largest volume contemplated. On this basis, the logical test sites are Los Angeles, New York, and Chicago. If enough actual messages cannot be generated, a computer must be programmed to generate a suitable volume of simulated traffic.

Software

RCA and the Postal Service have paid insufficient attention to software development and maintenance. In any computer system of the magnitude of EMSS, software design, development, and integration are critical to whether the program can be implemented on schedule. Although the proposal states that software development costs are included in the system development costs, it provides no insight on software development. A more extensive treatment of software development would have been necessary in order to make a convincing case that software costs and complexities had not been underestimated.

While definite software estimates depend on the detailed designs of exact modules, a gross estimate can be derived based on the overall kind of software involved. Current estimates for the development of production-quality, complex, real-time software vary from $80 to $120 per instruction. Near-real-time, production-quality, control software costs are approximately $30 to $40 per instruction. Less complex, common support, production-quality software costs vary from $8 to $12 per instruction. These estimates include design, programming, debugging, and test, as well as system integration to achieve production-quality software.

These estimates include three major packages of complex software required to operate the overall system. One is a message switching package, estimated to require about 50,000 lines of code with a development cost of about $2 million. Next is a "middleware" package covering such functions as security, encryption, decryption, system recovery, common queues, authority level recognition, and accounting; this package would require about 200,000 lines of code and cost $16 million to develop. The third is a network management software package, which controls functions like monitoring traffic, allocating channels and equipment, monitoring and analyzing malfunctions, and providing network statistics; this package would require an estimated 100,000 lines of code and cost $8 million to develop.

The final report on system definition and evaluation indicates that the software was included in development cost estimates along with hardware. The figure is, however, not separately identified.

Software maintenance would cost as much as $14 million over a seven-year cycle. Even this figure might well be conservative for just the basic computing software package. To this might be added that much again for a network control system. However, software development and maintenance costs might be reduced by adapting software packages that already exist and are available from and supported by computer

vendors. For example, Scotland Yard was able to use, with a small modification, the message switching software module contained in the standard airline system software package from Univac. Similarly, the Postal Service should investigate using or adapting existing software.

Electronic Mailbox

The RCA proposal provides for an electronic mailbox, a rugged, reliable terminal to be placed in post offices, office buildings, hotel lobbies, and shopping malls. The terminals, much like public telephone booths or automatic bank teller machines, would permit individuals and small businesses to use EMSS for correspondence. The terminals would need to be made more rugged in order to make them vandal-proof. The expensive and vandalizable parts of the equipment could be made inaccessible. These terminals would make the electronic mail system available to the general public at all times, thus contributing to the public acceptance of electronic mail.

Chapter III

EVOLUTIONARY DEVELOPMENT: INTELPOST, E-COM, AND BEYOND

An evolutionary approach to planning for electronic mail should properly begin with discrete service offerings and expand gradually as the market dictates. MAILGRAM is now provided by Western Union in cooperation with the United States Postal Service. Although a form of electronic mail, MAILGRAM is too limited in scope to offer a very promising basis for a major venture into electronic mail. More substantial are two other services now being developed, INTELPOST and Electronic Computer-Originated Mail (E-COM).

GENERAL CONCEPTS

INTELPOST is planned as a digital facsimile network between U.S. and foreign post offices for international electronic mail. Messages would be delivered to an INTELPOST office, where they would be scanned by a facsimile reader and transmitted via satellite to their destinations. On receipt, the messages would be reproduced on paper by facsimile printers, inserted into a special envelopes, and delivered by the post office in the participating countries. The original plan called for a network linking the United States, Argentina, Belgium, France, the Federal Republic of Germany, Iran, the Netherlands, and Great Britain.

However, full implementation of INTELPOST has been delayed pending the resolution of regulatory issues. The Federal Communications Commission (FCC) ruled that the International Record Carriers, which provide the telecommunications link, could not furnish the necessary circuits to the Postal Service consistent with existing tariffs. The FCC reasoned that use of the circuits by the Postal Service would constitute a resale of international carrier circuits. Since international tariffs forbid resale of circuits by other users (i.e., domestic common carriers), the FCC found it to be discriminatory to allow the Postal Service to "resell" these circuits. While the FCC has ruled that domestic services can be resold, invalidating carrier tariffs to the contrary, it has yet to extend that ruling to international services. A proposal to permit resale of international communications services is pending before the FCC.

While waiting for a ruling, the Postal Service has instituted INTELPOST services with Canada, which is not classified as an international point under present FCC resale rules. The Postal Service is also expanding service to western European countries through a switching arrangement with Canada.

The committee has not reviewed INTELPOST in detail. Though it is an attractive service for high-valued, time-sensitive international messages, it is too limited in scope and volume to provide a good model for major domestic electronic mail. A better model is E-COM.

E-COM was first proposed as a marketing venture by the Postal Service in September 1978, and Postal Rate Commission (PRC) rate and mail classification recommendations were sought at that time. Although all parties agreed that the Postal Service should take advantage of electronic technology, the system architecture and telecommunications services to be provided became a point of contention involving the PRC, the Postal Service, and the FCC. In December 1979, the Postal Service made major changes in its original proposal, hoping to clear the way for implementing E-COM. Plans now call for E-COM to be put into effect in January 1982.

While similar to the Electronic Mail Service System (EMSS) in most basic characteristics, E-COM is a more limited form of electronic mail. It is designed to receive message input only in electronic form. As presently approved, it is further limited to input received through telecommunications common carriers. It is the responsibility of the customer to select the carrier, which then transmits the message to one of the 25 serving post office (SPOs) that comprise the initial E-COM system.

E-COM messages will consist of single-address or multiple-address texts of one or two pages. The initial rates have been set at 26 cents for the first page and 5 cents for the second. A minimum quantity of 200 messages per transmission will be required.

Although communications carriers will provide transmission links between mailers and SPOs, the Postal Service will issue technical standards for the speeds, codes, and protocols of interconnections. Also, the Postal Service may negotiate standards for the transmission service as a condition of the interconnection contracts; and it may require any carrier to connect with all serving post offices. If there is a need, the Postal Service may itself offer E-COM by contracting for the transmission services of one or more carriers, subject to terms and conditions that preserve free and open competition in the transmission phase. This offering will require new consideration by the PRC.

Measured against regular first class mail, E-COM will be a minor service at first. E-COM is expected to handle about 70 million messages in its third year of operation, or about 0.1 percent of all first class mail volume--more than 60 billion pieces in 1980 alone. Nevertheless, despite modest beginnings, E-COM could be an important precursor of future major electronic mail service, and it is in this light that we have reviewed Postal Service plans.

Unfortunately, those Postal Service plans are still somewhat clouded. The relationship between E-COM and EMSS was not clearly defined when the committee first began its review. The relationship still appears somewhat vague, although the Postal Service has now outlined its concept for relating EMSS to E-COM. That concept calls for a phased development plan in which E-COM would ultimately be folded into the planned implementation of EMSS, according to the system validation and test network plan described in Chapter II.

The Postal Service should concentrate its efforts primarily on implementing discrete services to test and develop the market. How far and in what direction electronic mail will evolve from these initial services is difficult to foresee. Hence, the evolution of services arising out of E-COM or other discrete services should not be forced to conform to some long-term system design, such as EMSS, in advance of operating and market experience.

We suggest phasing in a series of incremental steps, one every two to three years, each of which would expand on the initial E-COM services by offering new features. These features could include such improvements as the following:

- Improved quality, including higher quality printing, graphics (for example, signatures), color, predistributed forms, and inserts.
- Additional input options, like new communication protocols, higher input speeds, facsimile, and new media.
- Shorter delivery time to the recipient, probably achieved through greater reliance on telecommunications and additional stations for printing and enveloping.
- Reduced rates for comparable services achieved through developing markets, learning curve experience, and new technology.
- Additional telecommunications options, including the possibility that the Postal Service would offer a nation-wide network of telecommunications (in addition to or instead of the first phase of E-COM, whereby nationwide access is gained through telecommunications offered by common carriers).
- More options for private industry to participate in electronic mail by separating services offered, including allowing industry to print, envelope, and deliver to regional post offices.
- New supporting services, like improved security or better accountability.

A plan to develop electronic mail slowly should call for an operational system that can evolve through frequent incorporation of incremental near-term capabilities. The plan should also reflect a management approach oriented more to market projection and development than mere technological opportunity. Our concept is not necessarily in conflict with Postal Service plans insofar as they too contemplate incremental expansion of E-COM. If there is a difference, it lies in the Postal Service's apparent intent to mold the future evolution of

E-COM to fit into the planned evolution of EMSS through the system validation and test plan. If E-COM is an appropriate prototype from which other electronic services can evolve, there is no need for the system valdation and test plan at all. There is also no need to force the evolution and expansion of discrete electronic mail services into the somewhat artificial EMSS model.

Pursuing separate evolutionary paths is likely to lead to confused planning, research, and development. Until actual market experience is gained with E-COM, there is no compelling reason to implement an EMSS system validation plan. Once experience with E-COM is gained, that experience can and should be used directly to expand or modify E-COM services and markets, in an evolutionary fashion, rather than to deploy an EMSS concept planned many years earlier.

SYSTEM OPTIONS

Institutional Roles

What is the Postal Service's role in promoting and marketing E-COM and other electronic mail services that may evolve from it? This question is one of technical architecture insofar as it is tied significantly to providing telecommunications input. Providing input would give the Postal Service an end-to-end service role in message delivery.

As E-COM service is now established, pursuant to a recommendation by the PRC, in the Domestic Mail Classification Schedule, the initial offering depends on existing domestic telecommunications services for putting computer-originated messages into the postal system. Under the PRC's design, the Postal Service's role in marketing E-COM to customers will be negligible; E-COM will resemble MAILGRAM, which is marketed by Western Union rather than the Postal Service.*

The Postal Service plans to propose to the PRC that users be allowed to make direct input to E-COM either through dedicated communications lines or physical delivery of magnetic tapes at serving post offices. If the PRC and the Governors approve the move, as appears desirable, the Postal Service would presumably have a major role in marketing E-COM to end users.

Under an arrangement that calls for a competitive input by different service providers, customers may be faced with numerous offerings. One result may be confused and fragmented efforts to plan,

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*Western Union also manages and operates the telecommunications network that electronically transmits MAILGRAM messages, the receiving equipment, and the associated printers in the post offices. The Postal Service envelopes the messages, owning the automated folding and enveloping equipment at 127 receiving stations. In contrast, E-COM calls for the Postal Service to own the receiving equipment and printers. Under its original E-COM proposal the Postal Service would have had end-to-end responsibility for the service, a structure that would have given it full marketing responsibility.

define, market, and operate the system. This situation could undermine the cost-effectiveness of the overall system and significantly reduce the number of messages. The system's evolution depends on developing a number of connections between telecommunications suppliers and their customers, and on an equal number of connections between the suppliers and the Postal Service.*

On the other hand, because of the advantages of diversity and competition, a seemingly fragmented approach could also lead to faster development, a larger market, greater volume for the Postal Service, and a more efficient use of its overall resources.

Whatever the balance between these competing possibilities, the Postal Service should consider carefully a range of options:

Option 1

The telecommunications common carriers are responsible for providing links and switching between mailers and the regional receiving nodes of the Postal Service (with a possible exception for direct user input through dedicated lines or physical delivery of magnetic tapes). This responsibility includes marketing of the service (so long as the services offered are compatible with the capabilities of the Postal Service portion of the link) and development and operation of the communications network under the FCC's regulatory authority. Essentially, this is the MAILGRAM approach. Both this and the approach in Option 2 could be used for E-COM at first.

Option 2

The Postal Service markets electronic mail (including the telecommunications portion), but the "front end" of the service is provided by any common carrier that can meet technical standards set by the Postal Service or by direct user input through dedicated lines or physical delivery of magnetic tapes. The Postal Service has wide authority for establishing standards to connect carriers to its "tail end" portion.

The Postal Service might also establish service standards for the carrier's portion of the system. These standards might pertain to security, journaling, accountability, dependability, or speed of service, for example. The Postal Rate Commission even suggested that the common carriers might be limited to those that offered services to all regional nodes operated by the Postal Service. Under this option, billing for the telecommunications portion of the system could be handled by the Postal Service as part of a single billing action; a separate bill means a separate offering, as in Option 1.

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*However, some value-added common carriers can receive simultaneous inputs from many separate customers and, using certain protocols, combine these into single communications channels to the receiving post offices.

Option 3

The Postal Service funds and operates the total system, but uses publicly available network services and tariffs for the telecommunications system. Under this option, the Postal Service does not develop or operate any communications systems of its own. The services of more than one common carrier are used. Selection of specific carriers by the Postal Service is governed by several criteria, including economy, impact of communications quality on overall system service, and sound procurement practices. This option is analogous to the way in which the Postal Service currently procures transportation carriers for air or surface delivery of mail.

Option 4

The Postal Service specifies and procures competitively its own dedicated telecommunications and switching services from one or more common or value-added carriers (using the kinds of selection criteria listed for Option 3). Although the services procured fall under the authority of the FCC, this option differs from Option 3 in that it would provide greater leeway to the Postal Service to get a specialized service and a more dedicated system. This might, among other things, facilitate economy, security, and dependability.

Option 5

The Postal Service procures communication links from common carriers but develops, implements, and operates the network switching with its own nodes and switches. The criteria for selecting the transmission capability are the same as those in Option 3.

Option 6

The Postal Service funds, develops, and implements its own telecommunications facilities. (The Postal Service does not contemplate doing so; such an arrangement appears to be quite impractical from both economic and political standpoints.)

Option 7

The Postal Service pursues a course that combines two or more of the above options. For example, the Postal Service could initiate E-COM services as planned (Option 1 or 2) and then seek to establish a more integrated offering by having a parallel and competitive telecommunications segment using some of the other options.

Comments on the Options

Options 1 through 6 illustrate the basic structural possibilities, and Option 7 suggests that some combination of the basic choices might be more suitable to the actual institutional form of electronic mail. With the exception of Option 6, which is not a realistic one, it is not possible to determine yet which option or which combination can best serve the public until operating experience is gained with E-COM.

One consideration that would affect the actual institutional arrangement is the desirability of offering separately the various components of a complete end-to-end service—that is, "unbundling" the service. Customers would be able to buy and pay for whatever parts of the service they need. Thus, various private companies could compete with different subparts of the service, provided their inputs were compatible with system standards. The Postal Service could offer what seemed to it useful to offer in the different parts of the total system, and competitors might offer similar services with the customer opting for whatever service combination is desired. Such an arrangement would maximize competitive service offerings, allow market choices to create an efficient mix of services, and reduce concerns about extension of a postal monopoly into the field of electronic communications.

Whichever structure may ultimately prove to be best, however, the Postal Service needs to develop a working plan that will show how E-COM is expected to evolve. In that way, E-COM's actual performance can be judged against the plan. The plan itself should be based on market surveys. It should identify problems to be solved, alternative ways to solve them, and opportunities for services. In this way, the Postal Service can better judge electronic mail services.

Technical Interconnection

Setting aside the more general question of the Postal Service's providing telecommunications as part of E-COM, the more immediate problem is one of designing appropriate standards and protocols for connecting different telecommunications carriers with the 25 serving post offices.

There is no generally agreed upon standard for connecting messages on public networks. Therefore, the Postal Service must decide which formats and protocols should be supported. During the initial phases of E-COM, a limited range of connections should be adopted to simplify the problem of getting the network started. To decide which standards to support, the Postal Service could solicit the opinions of the various mailers who would use the serving post offices. As the network matures, the support of additional standards could be considered. In the longer term, the Postal Service should consider providing protocol conversion services at the serving post offices.

The Postal Service should also maintain close contact with associations like the International Standards Organization, the International Consultative Committee for Telephone and Telegraph, the

American National Standards Institute, and the Institute of Electrical and Electronics Engineers. This liaison will help the Postal Service keep abreast of evolving standards and help guide the development of domestic and international standards for interconnection on electronic message switching systems.

In another area, the Postal Service may have allowed insufficient time between publication of E-COM guidelines, decisions on which protocols and interconnection standards to promulgate, and the start-up date for the initial operation. In June 1981, the Postal Service issued a notice of proposed interconnection arrangements with tele-communications carriers, inviting comments within a month. A timely response by interested parties and swift follow-through by the Postal Service will be essential to meeting the scheduled E-COM start-up date.

Finally, each serving post office must ultimately support a variety of link protocols and formats. Which ones to use and the appropriate time for introducing them can only be determined after a full marketing research study that defines the users and the expected volume of material each is to provide. In summary, the problem of interconnection standards should be handled in an evolutionary manner using accurately determined market data obtained from potential users.

Chapter IV

SPECIAL CONCERNS

The U.S. Postal Service asked the committee, in addition to its review of Postal Service planning efforts for electronic mail, to examine the following special areas: management approach, including market research, staffing, and finances; research and development priorities; and security and privacy. We considered it also appropriate to comment briefly on the labor implications of electronic mail, since cutting labor costs is one of the Postal Service's main goals in adopting electronic mail.

MANAGEMENT APPROACH

In general terms, the Postal Service's management approach to electronic mail has been covered in the previous three chapters. For emphasis, two major criticisms expressed earlier are reiterated here. The first relates to overemphasizing development based largely on very long-term planning concepts, as embodied in the Electronic Mail Service System (EMSS), as opposed to near-term programs like Electronic Computer-Originated Mail (E-COM). The second criticism, which is perhaps a partial cause of the first, is the lack of effective coordination between long-term systems planning and near-term development of specific services. This latter deficiency, we suspect, may have reflected the absence of interest regarding electronic mail that once characterized high-level management in the Postal Service.

The second deficiency appears now to have been remedied. The Postmaster General and his staff are fully committed to electronic mail and are prepared to give it the priority it warrants. In 1980, the Postal Service took a positive step towards a more coherent integration of its heretofore divergent efforts by centralizing management control over all planning and service development for electronic mail. Central control is now exercised by the Senior Assistant Postmaster General for Research and Technology, who now needs to develop a high-quality, well-organized staff which would enjoy the full support of top management.

When E-COM becomes operational in 1982, a separate unit will be formed within the Postal Service to operate that electronic mail service. Organization and staffing details are yet to be fully

developed; but the Postal Service plans to use a small cadre of managers, drawing on other postal units as needed to operate the system. Though the unit would not be fully self-contained, the Postal Service expects it to be an independent fiscal center within the Postal Service. As such, its use of postal manpower and facilities would be charged against special electronic mail accounts. Ultimately, the Postal Service hopes the unit will become financially self-sustaining.

We applaud the recent move to centralize management control over electronic mail. And we think the general plan for a separate electronic mail department is sound, as far as it goes. But the committee cautions that the Postal Service may ultimately be pressured to go further than current plans appear to contemplate in making the electronic mail department financially independent of, and perhaps even organizationally separate from, the Postal Service generally. Some degree of financial autonomy is likely to be necessary. Insofar as the Postal Service's electronic mail services will compete with private carriers,* such autonomy is necessary to preclude the cross subsidization that might occur from the sharing of appropriate facilities and functions with other Postal Service activities.

Whether financial autonomy of electronic mail under separate accounts will be acceptable to the regulators is open to question. In the absence of a separate organization with separate staff, functions, assets, management, and so on, proper and accepted cost accounting will be constantly open to challenge by competitors. On the one hand, we see an opportunity for the Postal Service to improve its efficiency of delivering messages by the use of electronics; on the other hand, we see direct competition with the private sector for this segment of its business. Consequently, the Postal Service should be prepared to deal with such challenges to its market presence in electronic mail.

A solution that is being tested in the telecommunications industry is the fully separate subsidiary**. Such an approach tends to isolate the costs in order to avoid cross-subsidies, but the solution itself is not without cost.

Too great a separation would eliminate one of the advantages of allowing the Postal Service to offer electronic mail—the ability to integrate electronic technology into conventional mail handling.

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*The degree to which the Postal Service is regarded as a competitor with private carriers depends significantly on the extent of its involvement in providing end-to-end service, as noted in Chapter III. This discussion assumes that, in time, the Postal Service will be significantly involved in promoting and marketing electronic mail and will be competing with comparable private services.

**The separate subsidiary approach to separation of activities was used in the unsuccessful attempt to revise the Communications Act in the 96th Congress. It is noteworthy that at one time proposed legislation included a provision requiring the Postal Service to establish a separate subsidiary for electronic mail. A bill now pending in Congress requires a separate unit within the Postal Service for electronic mail, but it does not mandate a separate subsidiary. A bill containing such a provision passed the Senate on October 7, 1981.

Separation also runs the risk of creating hard organizational divisions based on technology. That eventuality could prevent a new technology from getting the money it needs to start up, or prevent an old one from making a transition to the new. Indeed, the unbundling of the various components of the complete end-to-end service, as discussed in the subsection "Institutional Roles," in Chapter III, would reduce the need for strict separation of electronic mail offerings from other Postal Service operations. In the competitive situation that would result, cross-subsidies would be hard to sustain.

Plainly, tradeoffs must be made to balance the benefits and risks of single-firm integration with those of separation. These tradeoffs may be made in the future. For now, it is impractical to establish a separate subsidiary to develop electronic mail. In the years ahead, however, the Postal Service may have to give serious thought to establishing a separate subsidiary once it is actually marketing electronic mail in competition with private carriers.

In a related area, the Postal Service needs to develop the management expertise required to begin and eventually operate electronic mail. This is particularly important for financial management. Management expertise should be developed within the Postal Service rather than contracted out to another organization or business.

A few brief comments concerning marketing are appropriate. The success of electronic mail will depend heavily on an early, vigorous, and continuing marketing capability. This marketing function should have a primary role in system planning, in defining the evolution of services to be offered, and in establishing directions for research and development. As such, it should have a primary role in E-COM management.

Most important, marketing needs to work closely with potential or active customers to determine what services can best be provided by electronic mail and which functions should be assumed by the customer, consistent with technological and economic realities. As indicated earlier, electronic mail will represent only an evolutionary improvement over existing first class mail. For this reason, customers will use electronic mail only if their overall costs are reduced and if it provides at least comparable communications with addressees.

These economic and other factors will probably vary considerably as evaluated by different potential users of electronic mail. These factors will be sensitive to (1) the design of the boundary between users and the Postal Service and (2) the functions performed by each. The various possible boundaries and functions must be explored by the customer services component of marketing. Successive generations of the evolving system will also require continuing evaluation of customer needs.

LABOR IMPLICATIONS AND RELATIONS

The study of the RCA Corporation (RCA) did not determine how many conventional mail handling jobs would be eliminated by a fully operational EMSS system, nor did it determine what categories of jobs

(if any) would be reduced. Instead, RCA compared the costs per 1,000 letters for EMSS with those for conventional mail.

EMSS may offer the Postal Service an opportunity to reduce its work force and payroll. Implicit in the RCA study is a reduction of about 60,000 workers over a period of 20 years. This reduction assumes a volume of 25 billion messages sent annually by electronic mail in that period. The cut of 60,000 jobs, however, is only an approximation, for there has been no actual projection of the impact of electronic mail on the work force. Most jobs lost would be those held by mail handlers and clerical workers, although the electronic sorting-to-carrier sequence might also reduce the number of carriers because the sorting they do would require less time.

The RCA study estimated that 4,400 employees would be necessary to operate EMSS. Since this number did not include supervisors, a somewhat larger work force might actually be needed; but it would not likely be more than 7,500. An effort has been made to describe each of the jobs involved at each EMSS station and to determine its labor grade. Those job descriptions are exceedingly sketchy because it is difficult to determine job content in advance of actual operations, particularly where the operations are of a totally new type.

When industry attempts to project job descriptions and labor grades, it often finds that labor grades average one step above that projected. That is particularly true when more sophisticated equipment is used, resulting in great increases in productivity. Under such circumstances the unions can be expected to press for a share in that increased productivity.

The possible underestimation of EMSS's labor costs, however, is not significant in measuring the system's overall economic feasibility. Even assuming that the number of employees required is underestimated by 50 percent and the labor grades undervalued, the extra cost is relatively small compared with the 60,000 jobs eliminated. Fewer jobs resulting from electronic mail should cause no serious labor problems because the reduction can be absorbed by normal attrition. Eliminating 60,000 jobs over 20 years, as contemplated, for example, by the RCA plan, would average 3,000 jobs a year. Although the Postal Service has apparently developed no comprehensive data from which attrition can be projected accurately, half of the more than 500,000 current postal workers will reach retirement age within the 20-year period required for EMSS to become fully operational. Even assuming no one quits before retirement age, the number of retirements alone would be four times greater than the reduction in jobs resulting from EMSS.

A reduced work force resulting from electronic mail, however, can not be viewed separately from other changes that would also cut the number of postal workers. These include introduction of the nine-digit ZIP code, increased electronic sorting, presorting by senders, and elimination of Saturday deliveries, among others. The Postal Service is confident that even the cumulative impact of these changes can be absorbed without disturbing employment. However, from our discussions with Postal Service representatives, it appears that this confidence does not rest on any well developed study of what the cumulative impact of these changes may be on the work force or the labor problems they could generate.

The Postal Service has projected the number of jobs expected to be eliminated by the nine-digit ZIP Code. On the assumption that volume does not grow, the worker-year changes have been projected as follows:

Year	Change in Labor Requirements (Worker-Years)
1982	+ 90
1983	- 1,334
1984	- 2,382
1985	- 3,301
1986	- 4,378
1987	- 4,295
Total	-15,600

Since the ZIP + 4 Automated System is planned for gradual implementation over a period of years, the worker-year reductions can be achieved by attrition and reductions in overtime. The separation rate for Postal Service clerical employees in fiscal year 1980 was 8.4 percent, or about 22,000 employees. In the above implementation plan for ZIP + 4 Automation, the maximum worker-year reduction in any one year is 4,378. Therefore, the worker-year reductions achievable with full implementation of the program (1987) are 15,600, or less than clerk separations in a single year.

We wish to emphasize that our concern is not that electronic mail alone will cause labor problems, but that its implementation could be delayed because of cumulative labor problems that may, at particular times, require layoffs that cannot be immediately absorbed by attrition. Such difficulties might be reduced or avoided by timing the various changes so that their impact is evenly distributed rather than coming all at once. Given the data the Postal Service has on the age distribution of its work force and its past experience with separations, it should be able to develop useful projections as to attrition through death, retirement, and other causes. It should also be able to project how many workers will be affected, and when, by the changes being contemplated. Using both projections, the Postal Service should be able to time its changes to avoid labor problems.

The four principal postal unions are the Americal Postal Workers Union, American Federation of Labor & Congress of Industrial Organizations (AFL-CIO); the National Association of Letter Carriers, AFL-CIO; the National Post Office Mail Handlers, Watchmen, Messengers, and Group Leaders Division of the Laborers' International Union of North America, AFL-CIO; and the National Rural Letter Carriers Association. Officers of these unions met with a representative of the committee during the course of the study. From the discussions at the meeting it developed that these labor leaders would present no serious obstacle to implementing electronic mail or other postal changes. They have all declared that their primary concern is to make the Postal Service competitive with alternate methods of communication.

Consequently, they strongly favor electronic mail. Indeed, the postal unions are impatient with the slowness with which the Postal Service has moved. They know that steady employment for their members depends on the continued viability of the Postal Service. They are prepared to accept fewer jobs that may come with electronic mail in order to increase the Postal Service's overall ability to maintain or increase its business. Postal employees and the leadership of the postal unions appear to have a genuine concern for the welfare of the Postal Service. This is a valuable resource to be developed and used, for it provides the potential for cooperation with and support for management in adjusting to electronic mail and other changes.

The Postal Service should accept at face value the unions' stated desire to contribute to the success of electronic mail. Union participation should take place at the initial stages, when changes are first being considered and studies are being planned. It should not wait until concrete proposals have been developed, thereby effectively foreclosing many alternatives and considerations. The unions should be encouraged to participate in studies of electronic mail, and their suggestions should be seriously considered. Major changes should be made only after the unions have had an opportunity to comment on the proposals.

In this way, the Postal Service can enjoy the cooperation of the postal unions and their members in developing and operating electronic mail for the benefit of both management and labor. Management should view the postal workers as a resource to be used to get the most out of electronic mail. By recognizing the contribution that unions can make and by developing a labor-management relationship based on joint concern for the enterprise, the Postal Service can become a model for other government agencies and businesses.

RESEARCH AND DEVELOPMENT PRIORITIES

In the past, the Postal Service has concentrated its research and development efforts primarily on equipment and technology, ranging from advanced optical scanning equipment to more fuel-efficient vehicles. For electronic mail use the Postal Service is conducting a program to develop equipment such as input and output paper handlers, scanners, printers, and multimedia input terminals.

The merits of the development programs depend largely on the market. Until market research data are available, it is difficult to assign priorities to the proposed effort. Market research is an area in which the Postal Service has historically been weak; this weakness is typical of a monopolistic operation, particularly one operated by the U.S. Government. The Postal Service must look at the market for electronic mail in much greater detail than it has in the past so that it can develop strategies for both equipment development and marketing services.

The following comments provide specific examples of situations where quantitative market research data would affect technical programs. The Postal Service is proposing to develop input paper

handling, such as a cartridge or a stacked-sheet input feed. Both require that customers load stacks of paper into a specially designed cartridge. The Postal Service has proposed that the number of sheets per stack would range from 250 to 500. The cartridge would be sealed and would identify the user. After the material in the cartridge has been read, the sheets would either be returned to the customer or be disposed of by automatically routing them to a shredding device. The empty cartridge could then be returned to the customer.

We have not seen any data that would indicate customers' perceived requirements. For example, is a cartridge required for security? Do customers want the letters returned or shredded? Also, no data are available to determine the minimum and maximum number of sheets of cartridge capacity that would best meet customer needs. Much of this information should have been gathered earlier to determine the input handling requirements more realistically.

Developing an output paper handler is not as customer-sensitive as the input handler. This observation is true especially when the system requires that initially each output letter, which can range from one to three pages, be automatically folded, enveloped, and sorted for the carrier to deposit on the customer premises.

An input scanner is required to read all input media brought in as hard-printed copy. The Postal Service presumably ascertained that current state-of-the-art scanners do not meet its requirements. Nor do private companies appear to have scanners under development that would be available when EMSS is launched. Therefore, the Postal Service has been forced to develop a scanner with the capabilities described in the System Definition and Evaluation study of RCA.

The Postal Service is pursuing two printer developments at the same time; one uses electrographic paper and the other plain paper. But again, no market research data was used to ascertain whether customers would accept electrographic paper. Industry experience has shown that customers dislike the texture and weight of electrographic paper. Consequently, most companies that had developed the electrographic paper copier have essentially abandoned it. Electrographic paper will probably not be any more acceptable to postal customers than it was to industry customers. Therefore, the Postal Service should consider shifting from developing an electrographic printer to developing a plain paper printer.

The program to develop multimedia mail input terminals appears to be too broad. Specifically, the Postal Service is willing to accept manually messages stored on a large assortment of media, which include printed pages, floppy magnetic discs, magnetic cards, magnetic tape cassettes, and reel-to-reel tapes. The input media handler would permit reading from all of these media.

Again, market research data are not available to forecast the volume of input that could be expected with each type of medium. Research might indicate, for example, that inputs via tape cassettes or magnetic cards would attract the fewest users and that most users might present their inputs via a reel-to-reel tape or floppy disc. If the Postal Service had quantitative data, technical research efforts could

be concentrated on those input media that represent the largest volume of message inputs.

The question is from where business is likely to come, and in what volume. Equipment development could then be concentrated in those areas. Otherwise, the Postal Service might find that some of the input media devices would never pay for themselves in terms of usage. Generally, the Postal Service should not spend money to develop technology or hardware unless the market indicates it would be worthwhile. Hardware can be bought from the private sector for the lower volume input media.

On the other hand, the Postal Service should definitely continue to monitor closely technical developments in the private sector. It should also have the capability to test and evaluate those developments. Still, the greatest priority remains market research, in particular the market elasticity of services to be offered. Questions arise, for example, on price flexibility and the prices that can be obtained in relation to other alternatives. The threshold effect should be considered: that is, at what price would users seek alternatives? What alternatives are available to users? Current postal rates seem to be based either on historical precedent or on basic costs. As postal rates rise to a specific level, customers will seek alternatives. At that point, the Postal Service will find its volume of business eroding; the erosion will continue as new thresholds are reached.

The Postal Service now has little flexibility in pricing. Greater pricing flexibility should be made available to the Postal Service in the future. Ideally, the Postal Service might initially price a new service differently in several key cities to determine the price elasticity. Data could be obtained to determine what premium customers actually will pay for 24-hour delivery versus 48- or 72-hour delivery. It would also be useful to determine the premium that customers are willing to pay for color versus quality black and white, as well as for additional privacy and security precautions. The latter question is especially important if the Postal Service plans to provide a full customer billing service. In this case, billing records and customer lists are proprietary; that is, postal customers will not want these data to get into the hands of competitors.

A Generation II service will face competition from a Generation III service. Since the success of the Generation II service depends somewhat on the market for Generation III service, the Postal Service has to estimate the growth of the latter and continually monitor the market to ascertain actual and potential penetration. Moreover, the price charged for Generation II services could slow the growth of Generation III.

As the Postal Service finds itself competing with private carriers, the time required to adjust its prices should be reduced. It now takes at least eight to nine months for the Postal Service to adjust its rates. Since the commercial competition is much more flexible, the Postal Service may find its competitors have a six- to nine-month lead. Therefore, a procedure should be established to permit faster rate adjustments when necessary to compete with private carriers.

The above discussion illustrates that the Postal Service will have to do strategic business planning as it enters areas where it will face competition. The Postal Service may need alternative business strategies as well as a preferred strategy. This need is especially pertinent if Postal Service electronic mail volume begins to decline because private industry can offer both Generation II and III services at very competitive prices. Since employees of the Postal Service cannot be terminated after six years of service, it could find itself with an overstaffed and overpriced national service whose costs are higher than those of competitors and cannot be easily lowered. The Postal Service may have to adopt an alternative strategy as soon as possible to meet the competition.

Thus, it is important to establish separate profit and loss criteria for each particular service. We have already emphasized the importance of separating electronic and conventional mail operations. This separation will presumably be accomplished as part of the proposed institutional division between the two types of services.

However, further accounting separations may be necessary for the different types of electronic mail services to measure their economic success against those of competitive services. The Postal Service should develop a business plan for new services. Periodic audits can compare actual experience with the business plan and adjust the latter where needed. If investment costs rise above the plan's estimates, management must determine if additional revenue can be obtained or if some planned service or installation must be reduced or eliminated. The Postal Service should be able to determine its projected return on investment at any point during the program to ensure that it will remain viable during the program's entire life.

SECURITY AND PRIVACY

As electronic systems have become more sophisticated, powerful, and pervasive, concerns have been raised about their vulnerability. These concerns include the following:

* Malevolent intruders might successfully gain access to the processing capacity and data in the systems and use this information for fraudulent purposes.
* Individuals with authorized access to the information in these systems might be able to violate the privacy of individuals or corporations.
* Government officials might misuse the information in their official capacities.

Vulnerability of Information Systems

As information technology and systems attain higher levels of performance, there are several tendencies:

- Information storage, processing, and transmission techniques become more interrelated and complex, so that a much higher degree of sophistication is needed to develop, operate, and manage the systems. This is true whether a system is centralized or decentralized (though these architectural decisions can affect the vulnerability of a system to intrusion and violations of privacy).
- With careful planning and design, it becomes possible to incorporate security into the system at an increasingly lower cost. In part, this is achieved through improved technology. However, security does not stem only from technical features like link encryption; equally important are organizational, personnel, and administrative practices.
- The same technology that undergirds sophisticated information systems is also available to sophisticated intruders.
- Once a system is penetrated or subverted, the presence of large amounts of data and high information processing power can allow a sophisticated intruder to search through large volumes of potentially valuable information.

In considering the vulnerability of electronic-based systems to penetration, it is common to consider various levels of sophistication of the intruder:

- The least technically sophisticated intruder has little familiarity with electronics and can gain access to the system only by seeking more professional help or by getting the information from the system's operators.
- The more sophisticated intruder has a good knowledge of electronics, computers, and software.
- The most professional intruder--for example, a military or economic competitor--knows the most sophisticated digital-processing techniques plus cryptography. Such an intruder also has significant capital resources and an organization that can collect and process large amounts of information.

As communications links have been improved, their capacities have increased by many orders of magnitude. As communications systems become more complex, so too must the equipment capable of penetrating them. The simple telephone wire can be tapped by a very unsophisticated intruder. Microwave links, which can transmit hundreds or thousands of channels of information, can be tapped with equipment that can be purchased in any electronics store; but that equipment requires considerable sophistication to operate. To penetrate the simpler communications links from satellites (links that use frequency division multiplexing), more sophisticated communications receivers are required. These receivers are becoming increasingly available commercially, however.

Penetration of satellite communication links that use advanced time division multiple access techniques requires an investment of hundreds

of thousands of dollars and many months. Finally, if circuits are encrypted, penetration, if possible at all, would require the significant resources of a very large and technically sophisticated corporation, a significant commitment by organized crime, or the intelligence organization of a medium-sized or large nation. Of course, if only a small volume of specific information were needed, it could conceivably be obtained by buying off a source at a small cost.

Concern with the potential misuse of proliferating automated information systems has led to a number of actions at the national level. The Privacy Act of 1974 establishes guidelines for access to records maintained on individuals by the U.S. Government. In some cases, Congress has turned down or delayed the development of federal information systems because of a concern for security or privacy.

In 1979, the White House became concerned with the vulnerability of commercial communications to eavesdropping, and issued a Presidential directive:

- "Nongovernmental information that would be useful to an adversary shall be identified and the private sector informed of the problem and encouraged to take appropriate measures.
- "As a precautionary measure, the responsible agencies should work with the Federal Communications Commission and the common carriers to adopt system capabilities which protect the privacy of individual communications....
- "...[A]ppropriate government research and development information shall be made available so as to help and encourage [private sector telecommunications carriers] to devise adequate protection strategies."

In implementing this White House policy directive, the Department of Commerce has made use of the Data Encryption Standard (DES) to support procedures for the encryption of commercial telecommunications. DES has been validated by the National Bureau of Standards, received wide publicity and acceptance by users and producers of encryption equipment, and led to the commercial availability of integrated circuit electronic devices that incorporate the DES algorithm. These developments and parallel improvements in electronic technology should reduce the cost of "bulk encryption" of major communications links to a small fraction of the overall cost of the link.

The General Services Administration (GSA) operates one of the federal government's major communications systems, the Federal Telecommunications System (FTS). This system handles unclassified voice and data. A manifestation of federal concern with eavesdropping has been the increasing use of bulk encryption of major FTS backbone circuits. Encryption was first adopted in 1979 for several hundred transcontinental satellite circuits. GSA is now preparing to encrypt all satellite circuits and many microwave circuits in selected areas—some 8,000 circuits in all.

Confidentiality of Mail Sealed Against Inspection

Confidentiality is a concept that recognizes the sensitivity of information and indicates the conditions under which specific individuals are or are not permitted access to a document or to information related to the document. Confidentiality standards have been developed for many different areas like national security (e.g., "Top Secret"), federal income tax returns, and educational records. For a particular document, the standards can become quite diverse. They often depend on the role of a particular individual with respect to the document-- originator, subject, transmitter, storer, criminal investigator, etc. The standards also depend on a particular situation that relates to the document (e.g., whether there have been problems in storage or transmission).

In most cases other than those relating to national security, confidentiality standards result from a concern for individual and corporate privacy. A growing body of law establishes privacy rights, standards, procedures, and penalties. From the inception of the Postal Service, high standards of privacy have been set to ensure the sanctity of the mails. There is considerable evidence, derived from surveys, that the public considers this privacy important and has confidence that the Postal Service provides it.

For current first class mail, and other classes of mail that are sealed against inspection, strong and specific confidentiality standards are prescribed by statute. One pertinent law (39 U.S.C. Section 3623) states that

> The Postal Service shall maintain one or more classes of mail for the transmission of letters sealed against inspection. No letter of such class of domestic origin shall be opened except under authority of a search warrant authorized by law, or by an officer or employee of the Postal Service for the sole purpose of determining an address at which the letter can be delivered or pursuant to the authorization of the addressee.

In addition to the above statute, numerous other laws have been passed to deter obstruction of correspondence, the unauthorized opening of mail, and theft of mail. Judicial decisions have leaned in the direction of broadly construing the laws protecting the privacy and security of mail and providing penalties for those who subvert the confidentiality of mail.

One privacy issue that deserves special mention is access to first class mail by law enforcement or intelligence investigators. The law is clear with respect to the contents of mail. Access is allowed only under "authority of a search warrant authorized by law." Such a warrant can be issued only by a court or magistrate based upon a showing of probable cause to believe that the letter contains (1) property that constitutes evidence of the commission of a crime, (2) contraband or the fruits of a crime, or (3) property which is intended for or has been used as a means of committing a crime. This restricted access applies to the contents of a letter. In contrast, the

identities and addresses of the mailer and the intended
recipient--called the "cover"--can be and are made available to law
enforcement officials, without a warrant, under the authority of a mail
cover order issued by the Postal Service based upon "reasonable
grounds" to believe that the order is necessary to locate a fugitive,
detect evidence of a crime, or protect the national security.

While it may not always have been true, these confidentiality
standards now seem to be well recognized, observed, and protected by
the Postal Service. All employees are well indoctrinated as to their
responsibilities, liabilities, and procedures for observance. For
example, if a mechanical sorter malfunctions and inadvertently opens a
piece of mail, there are clear procedures for quickly identifying the
incident, authorizing those few individuals allowed to inspect and
reseal the contents, notifying the addressee, and reporting the
incident to Postal Service headquarters.

Confidentiality of MAILGRAM

Although MAILGRAM differs in some important ways from E-COM
(described above), the former to some extent illustrates the privacy
and confidentiality issues that may need to be considered in future
electronic mail.

Roughly speaking, MAILGRAM is a two-step process. In the first
step, the mailer sends a message by telephone, teletype, or computer to
a Western Union receiving location. The messages are then processed at
one of two centers in the United States. There, messages are routed,
journaled,* billed, and transmitted. Finally, the message is printed
on Western Union equipment located at more than one hundred serving
post offices.

In the second step, the printed message is enveloped and then
enterε the mail stream for delivery. Conventional sorting,
transportation, and home or office delivery end the process.

Privacy standards for the first step in MAILGRAM do not fall under
the jurisdiction of postal statutes. Rather, they fall under the
Communications Act of 1934. The second step in MAILGRAM--the one
handled by the Postal Service--involves privacy standards derived from
the postal statutes discussed above.

The confidentiality standards with respect to telecommunications
are set forth in Section 605 of the Communications Act of 1934. Two
aspects are noteworthy. First, the act recognizes that many
telecommunications are vulnerable to eavesdropping by those who provide
the telecommunications service or by outsiders who intercept the
messages. It is illegal for such an individual to use the information
"for his benefit or for the benefit of another not entitled thereto."
By comparison, the main point of physical vulnerability of a MAILGRAM

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*Entered into a record maintained by Western Union of each message--
"header," addressee, sender, date, and contents.

message in the postal system is when it is printed out and is scanned by a postal employee to determine adequacy of print quality.

Second, the Communications Act requires that the contents of a telecommunications message must be made available to authorized investigators either "in response to a subpoena issued by a court of competent jurisdiction" or "on demand of other lawful authority." This is a much weaker restriction than that which allows release of first class mail only pursuant to specific search warrant. Also, "other lawful authority" has been interpreted to include a wide range of investigators, including some associated with intelligence and counterintelligence agencies.

Thus, the major differences in the confidentiality standards for the first step of MAILGRAM (governed by the Communications Act) and the second step (governed by the postal statutes) are as follows:

- First class mail is protected during transmission and storage because it is "sealed against inspection." In contrast, MAILGRAM messages, as they enter and are transmitted throughout the Western Union network, use unencrypted phone lines, microwave links, and satellite links. If senders do not encrypt messages (as some senders do), then the latter are vulnerable to unauthorized access while within this network.

- Western Union operators have some access to the messages during processing. The company has taken significant steps to limit this access. For example, if a message encounters a technical or procedural difficulty in passing through the network, a manual operator can often find what is a minor and correctable error. Operators are not shown the actual message content when they try to determine whether an error can be corrected. Rather, they see only the message "header." But there is general agreement that these steps could be relatively easily circumvented by a competent and determined employee. In addition, authorized employees can gain ready access to the addresses and contents of many messages.

- All MAILGRAMs pass through a large computer system capable of scanning each message to isolate those that come from a particular mailer, deal with a selected subject, or are addressed to a particular person or office. These messages can then be stored within the computer, printed out at a selected time, and transmitted both to the intended recipient and to an external location. However, to eavesdrop on computers requires special software. Western Union told the committee that it is fully aware of this risk and has developed software practices to prevent such eavesdropping. Indeed, such precautions are becoming prevalent throughout the data-processing world. However, even very good procedures can be overcome.

- Because MAILGRAMs while in the custody of Western Union are viewed as telegraphic communications, the FCC has directed that copies of the messages should be journaled and stored for at least six months at one of two central switching centers.

By contrast, the Postal Service never obtains or keeps copies of the mail it transmits. Its INTELPOST system, for example, is programmed to erase the electronic record of the contents of the message instantaneously after completion of each processing step that requires electronic memory. Journaling increases the period of time that employees could gain access to the messages, and it increases their accessibility to law enforcement and other investigators.

* Whereas mail sealed against inspection can be opened only "under authority of a search warrant issued by law," the Communications Act seems to permit search warrants, subpoenas, and other "lawful demands."

Telecommunications Carrier Security

The Postal Service plans to make full use of the commercial telecommunications carriers for its electronic mail service. From discussions with representatives of several telecommunications carriers, they appear to be fully aware of the vulnerability of unprotected and unencrypted commercial communications and of the steps being taken to protect communications links.

The telecommunications carriers agree in their projections that the cost of encrypting new links is not prohibitive today. Further, they say that the cost will continue to drop significantly in the next few years as a result of increasing use of digital versus analog transmission, advanced large-scale integrated circuits, and economies of scale.

For example, a study conducted under Postal Service auspices in 1978 indicated that encrypting electronic mail would increase its cost by 25 to 50 percent. If the market for electronic mail grows to billions of messages per year, the cost of encryption should be reduced by at least a factor of ten. Several telecommunications carriers have already announced various plans for encryption. A few seem to be planning to encrypt all of their major telecommunications links on a routine basis. Some are planning to offer encryption as an option. Thus, mailers should be able to obtain message encryption if they desire it.

The EMSS plan of RCA called for encrypting all backbone links. Messages would be picked up from bulk mailers, stored magnetically, and taken to one of the 87 network nodes. During this first phase, the stored messages would be treated as first class mail and "sealed against inspection." During the second phase, the messages would be sorted and transmitted to other network nodes. During this phase, the links would be encrypted so that eavesdropping targeted against the contents of messages or addressee-addressor traffic would be difficult, if not impossible. At the receiving node, the messages would be printed and enveloped and treated as sealed first class mail. From the point of view of security, such a system could protect electronic messages as well as physical mail, if the complete system were operated as carefully as the encrypted portion.

Again, because of its importance, the security of an information system requires much more than technical features like link encryption. At best, encryption will secure the system only against external intruders. Full security depends on a host of administrative, organizational, personnel, and other security measures that protect the system from internal and external compromise. These measures help to ensure that the system does not fall victim to an end run.

In this regard, the telecommunications carriers seem to differ significantly with respect to security for the total system. A telecommunications network consists of links, processors, software, and a complex organization that develops, maintains, operates, changes, audits, and inspects them. The total system is still very vulnerable to internal compromise unless a wide variety of practices--including checks and balances in organizational and operational responsibilities--are instituted to protect it. Experience in this area is gradually being accumulated, particularly by financial institutions. The various telecommunications carriers seem to understand and be planning for security for the total system. The system's total security should continue to receive very high priority.

Issues for Electronic Mail

We recommend that the Postal Service establish strong internal security procedures, including an option for mailers to enter messages manually and to have them transmitted over encrypted links. Such security measures should be applied even though potential intruders will value Generation II electronic mail less than the message content of other telecommunications systems. Electronic mail will be used primarily by businesses to reach potential customers. Thus, the most sensitive information will generally be mailing lists, information on gross revenues, and data on contractual actions.

In contrast, other telecommunication systems handle internal or company-to-company communications that could relate to major economic commitments, highly proprietary technology, international actions, litigation, and the like. These are the communications that the U.S. Government and private corporations alike seek to make secure.

Thus, encrypting all electronic mail should not be given a high priority. If a single telecommunications network were used for all or most electronic mail, then encryption cost would probably be a very small fraction of overall costs and consequently a prudent investment. But since total encryption is not of high enough priority to justify a limitation to a single network to reduce the costs of encrypted transmission, it may be well to allow more diversified services from several carriers and networks to evolve. For those users who want security for their electronic mail, we recommend that the Postal Service work out arrangements with telecommunications carriers to offer encryption as an option. As indicated above, there may come a time when some carriers routinely encrypt all their digital traffic.

More importantly, the Postal Service should implement the full panoply of security procedures needed to protect electronic mail when

it is in its custody. These measures should include procedures to prevent employees from using the computational power of the electronic mail network to browse through the mails of one individual, to summarize the data in the mailing of one user, or to extract mailing lists. The Postal Service should take the lead in highlighting the differences between the postal statutes and the Communications Act of 1934 with respect to access by legal authorities. In this regard, the Postal Service may wish to recommend legislation to Congress to strengthen the protections for electronic mail.

Finally, the Postal Service should not be required to journal electronic mail messages for six months, as the Federal Communications Commission (FCC) now requires Western Union to do for MAILGRAM. This requirement seems to be an unnecessary threat to personal privacy. Fortunately, the FCC has indicated that journaling would not apply to the initial E-COM offering through the facilities of Western Union. Journaling times should be kept to the minimum needed for message tracing and verification.

Chapter V

FOREIGN DEVELOPMENTS

At the same time that the Postal Service is planning a Generation II electronic mail service, several European countries are proceeding with their own electronic mail systems. INTELPOST and FONOFAX use facsimile transmission techniques. Other systems offer Generation III services that involve terminal-to-terminal communications (in either an interactive or a passive reception mode) with no handling or delivery. Examples include PRESTEL, TELETEX, and VIEWDATA. Since the Postal Service is limited to Generation II service involving physical delivery of mail to the final addressee, these end-to-end systems are not relevant here. They do suggest, however, the potential competition that Generation III systems might pose.

FEDERAL REPUBLIC OF GERMANY

Electronic mail has been reviewed by the Bundespost over the past several years. The Bundespost did not find convincing technical or economic reasons for implementing such a service on a general basis.

In surveying the overall volume of letter mail, which includes single letter items, printed papers mailed in bulk, and small packages, a maximum of 50 percent is estimated to be suitable for electronic transmission. This finding implies that even if an electronic mail service were introduced, the mail carrier would still have plenty to do. Since about 70 percent of the total cost of mail service is attributable to delivery and only about 10 percent to long-distance transport, it is not possible to achieve any economic advantages from a general electronic mail system. This is particularly true for home delivery, which would require the general installation of costly home terminals.

Therefore, at present, the Bundespost is not considering a general electronic mail system, but rather is focusing on specialized service areas:

- The TELETEX service for business customers, which permits the rapid and direct transmission of letters (text) among businesses.
- A facsimile service within the business sector, which, in conjunction with TELETEX, covers about 40 percent of the overall volume of letter mail.

* A teleletter (facsimile) service for the general public, in the testing stage, which would provide express delivery to the addressee.

When reviewing the need for electronic mail in the Federal Republic of Germany, it is necessary to consider the high quality of the existing mail service. Over 90 percent of all internal mail in the country is delivered on the day after mailing. The gain in speed offered by electronic mail delivery does not, therefore, justify its additional cost.

FRANCE

The General Directorate of Telecommunications in the Ministry of Posts and Telecommunications is active in the development of electronic mail.

The Directorate has established specifications for a low-cost digital facsimile terminal for home and business use. The terminal is being manufactured in several versions. One of medium resolution, using thermal paper, is being manufactured by Thomson, Sagem and Matra; a second of higher resolution, using electrostatic printing, is made by Sagem and CIT-Alcatel. The terminals are all compatible with one another and conform to the existing Group 3 standards* of the International Consultative Committee for Telephone and Telegraph (CCITT). An available option offers comformity with Group 2 standards. A standard page can be transmitted in 2 minutes with a 1-minute transmission option. Unattended reception is possible. Some versions will offer an automatic stack feeder of 20 pages.

Prior to message transmission, the sending and receiving terminals exchange identities. At the receiving terminal, the sender's identity is printed at the beginning of the message; at the transmitting terminal, the identity of the recipient is either printed or displayed. Acknowledgement is sent by the recipient terminal on completion of transmission. Material on the screen can be reproduced in hard copy. The terminal may be used in a local mode as a photocopier.

The existing Group 2 facsimile units are available for public use in some telephone stores and pilot post offices.

A high-speed public facsimile service, called TRANSFAX, allows the transmission of high-speed facsimile on digital leased lines. Under study is the development of a store-and-forward switch, enabling use of telephone lines and a high-speed facsimile unit (CCITT Group 4).

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*Group 1 facsimile systems are suitable for the transmission of 8-inch by 11-inch documents over voice grade lines in 6 minutes. Group 2 systems exploit transmission bandwidth compression techniques to achieve transmission over voice grade lines in 3 minutes. Group 3 systems reduce transmission time to 1 minute over voice grade lines by reducing the transmission of redundant information. Group 4 systems transmit in 6 seconds.

The postal service is studying the use of electronic mail. The TRANSFAX service could be used to transmit letters between post offices.

GREAT BRITAIN

The British Post Office (BPO) envisages an increasing use of computer technology and systems among its customers. The rate of introduction of such systems and their effect on traditional mail levels is far from clear. Current forecasts, however, foresee a possible loss of 5 percent of letter traffic by the end of the 1980s. This assumes that the BPO's vigorous marketing policy will continue, that it will be able to compete effectively in the electronic mail market, and that it will react quickly and imaginatively to changing customer demands. A start has already been made in the area of 'hybrid' electronic mail services. June 1979 saw the launching of the USPS-inspired INTELPOST service between London and Toronto. This service was subsequently extended to Washington and New York via Toronto, several other Canadian cities, and Amsterdam. In addition, a domestic INTELPOST service was inaugurated during February 1981, linking 18 centers in Great Britain. This service, unlike comparable European services, uses Group 3 facsimile technology, and is being extended to a further 18 centers in June 1981. The domestic service interlinks with the international INTELPOST system using manual retransmission from the London Stock Exchange INTELPOST center. There are plans to extend further both the domestic and international networks.

The BPO is also planning to introduce trial service of a system much like Electronic Computer-Originated Mail (E-COM) between two cities in September 1981.

Mechanization will have a major impact on British postal operations, especially in congested areas like London. The BPO has been experimenting with mechanized letter handling since before World War II. However, substantial prototype developments did not occur until after 1966. Then, progress was delayed in 1972 when British postal unions placed an embargo on the further extension of mechanized systems. At that time, only 12 of a planned 120 post offices had been mechanized. A mechanization plan was jointly approved by both Post Office management and unions in 1975. Of 84 planned mechanized offices, 44 are now in full or partial operation, with the remainder scheduled to be mechanized by 1984 to 1985.

The mechanization falls into three broad areas: conventional handling equipment including conveyors for mail bags and letter trays; automatic segregation, face and stamp canceling machinery; and coding desks and automatic sorters. Central to the process is a postcode similar to the U.S. ZIP code. The postcode consists of five to seven mixed letters and numbers. Every address in Great Britain has a postcode and some 50 percent of all letters mailed in Great Britain include the code as part of the address. That rate is even higher in London. For mechanization to be successful, postcode use needs to reach 70 percent. To reach 70 percent within two years, the BPO has

launched a publicity campaign to advertise the advantages of the postcode.

Mechanization aims to increase postal productivity from a manual handling rate of 900 letters per hour (most letters have to be handled more than twice) to a mechanized once-for-all throughput of 1,600 letters per hour. At the same time, mechanization provides an automated capability for sorting the mail at every stage up to delivery.

This mechanization will permit a reduction of 6,000 postal workers. However, mechanization plans have continually slipped since 1975 and the achievement of the 1984 to 1985 target will depend on the availability of the necessary capital. Difficulty has also been experienced in the past with maintaining adequate numbers of trained higher grade postal workers, although this is not a problem now. For the future, the BPO is aware of the need to revise letter routing to ensure the best circulation between mechanized centers.

A recent study expressed concern that electronic mail and VIDEOTEX systems will significantly affect letters. The study suggested that the Post Office should be prepared to provide public facilities for the sending and delivery of messages to addressees not possessing the necessary electronic message equipment. The BPO is implementing the study's recommendations to increase research and development on optical character readers, the mechanical sorting of letter packets, various equipments to reduce or eliminate manual handling, and electronic data transmission systems.

British TELECOM is currently running a one year trial of an international facsimile forwarding service called BUREAUFAX involving 15 countries. Negotiations are under way to increase the number of participating countries to 30. The service is seen as complementary to the BPO's participation in INTELPOST. However, the complementary relationship between INTELPOST and BUREAUFAX is likely to be altered because of the impending split of British postal and telecommunications services.

The BUREAUFAX service offers automatic acceptance at one center in London from existing facsimile users, but counter acceptance facilities are being established at selected sites in London and elsewhere. Inward documents to Great Britain are currently delivered by either facsimile or first class mail, but it may be possible to collect from counter acceptance points later.

SWEDEN

The Swedish parliament has restructured the postal organization to increase its market orientation. Swedish Postal Administration business operations are divided into two main areas: distribution and counter service. Distribution includes sorting, transportation, and delivery; counter service consists chiefly of accepting and handing out mail, plus payment transactions and bank services for clients.

Swedish postal officials expect their volume to increase by an average of 1 percent per year over the next five years. To meet that increase, they have established goals to raise productivity over the

same period by 1 to 1.5 percent per year. To accommodate these increases and still maintain high service standards, the Swedish Postal Administration is pursuing a broad range of programs that include mechanized sorting, improved post codes (similar to ZIP codes), classification of mail rates based upon delivery service, and facsimile services.

Since 1978, the Swedish Postal Administration has sought to reduce the number of sorting and distribution post offices. In the past few years, experiments to gain experience in mechanization have been conducted with mechanical letter sorting in Stockholm. Based on these experiments, the Postal Administration expects to install new plants to sort letters mechanically in Stockholm, Gothenburg, and Malmo between 1982 and 1986. These plants will use optical character recognition and other related equipment. The Swedes also foresee a future network of automated plants that will exchange coded mail within Sweden mechanically.

In the area of telecommunications, the Swedish Postal Administration has had a "teleletter" system among eight different post offices since 1973. This service is now being expanded in cooperation with the Swedish Telecommunications Administration. In conjunction, "POSTFAX" has been introduced as a two-year test system. POSTFAX is designed to supplement general telephone service by providing public access to telefax equipment at post offices for either transmission or reception and delivery.   POSTFAX will initially be offered at 20 major post offices. If the service, chiefly aimed at domestic traffic, is well accepted, the number of post offices will be expanded to 40.

As an important adjunct to its electronic mail systems, the Swedish Postal Administration is developing on a step-by-step basis a system similar to E-COM that will accept brief letter information on magnetic media for sorting, transmission, printing, enveloping, and physical delivery. As an initial stage, the Administration currently prints, envelopes, and delivers computer-produced letters. The Administration envisages an eventual electronic post service (EPS) which could be established among the three largest Swedish cities.

The Federal Republic of Germany, France, Great Britain, and Sweden are but examples of how European postal services have moved forward to adopt the latest appropriate technologies to improve their internal productivity and to enhance delivery. However, the U.S. Postal Service faces a significantly greater volume of mail and area over which it must be distributed than most other nations. Further, the U.S. Postal Service faces stiffer private sector competition in areas that involve telecommunications and value-added services than do other nations, where the governments control and operate telecommunications systems. Therefore, to retain an equal position relative to other national postal services the U.S. Postal Service needs to offer even greater flexibility in future services than its foreign counterparts.

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GLOSSARY

Analog transmission: Transmission in the form of a continuous electrical signal that is the analog of the input signal

CCITT: International Consultative Committee for Telephone and Telegraph

DES: Data Encryption Standard

Digital transmission: Transmission in the form of digits (discrete, on/off electrical signals or bits), which form a complete representation of the input signal

E-COM: Electronic computer-originated mail

EMS: Electronic message system

EMSS: Electronic mail service system

Electronic Mail: A partial or total electronic message delivery service between the sender and recipient:

Generation I--A form of electronic mail that substitutes electronic transmission of information for a portion of the mail stream. Functionally this is analogous to the World War II "V-mail" service, in which a letter was photographed and reduced to microfilm which was transported to an overseas location for reproduction.

Generation II--A form of electronic mail in which information enters the mail stream at a postal installation close to the recipient. Prior to the production of a hard copy at this postal installation, the information exists in electronic form, possibly with a concurrent hard copy for local record purposes. All transmission and sorting is electronic. An example of Generation II is MAILGRAM, developed jointly by Western Union and the U.S. Postal Service.

Generation III--A totally electronic message delivery system between the sender and receiver

FCC: Federal Communications Commission

FDMA: Frequency division multiple access

FTS: Federal Telecommunications System

GSA: General Services Administration

Hardware: Physical items in an electronic system, such as computers, circuits, tape, readers, etc.

INTELPOST: A postal service implemented in part by means of a high-speed, store-and-forward, digitized facsimile system for international electronic mail exchange between postal administrations

MAILGRAM: A message service combining aspects of the telegram and the letter using electronic transmission and printing by Western Union, and enveloping and manual delivery by the Postal Service.

Middleware: Security, encryption, system recovery, common queues, authority level recognition, and accounting, etc. (See also Hardware, Software.)

Modem: A device that modulates and demodulates signals transmitted over communications facilities

NRC: National Research Council

PRC: Postal Rate Commission

Protocols: A formal set of conventions governing the format and relative timing of message exchange between two communications terminals

RCA: RCA Corporation

SCF: Section center facility

Software: Computer programs, routines, programming languages and systems, etc.

SPO: Serving post office

TDMA: Time division multiple access

APPENDIX: COMMITTEE MEETINGS AND BRIEFINGS*

Subject	Place and Date
Review of Postal Service EMSS Plans	USPS R&D Laboratories Rockville, Maryland April 24, 1980
RCA Systems Definition and Evaluation Study	USPS R&D Laboratories Rockville, Maryland June 18, 1980
Preliminary Report by Committee on EMSS Review of Postal Services EMSS Plans	World Trade Center New York, New York September 10-11, 1980
Postal Service Near-Term Electronic Mail Activities	Joseph Henry Building Washington, D.C. December 17-18, 1980
Federal Communications Commission Postal Rate Commission Activities Related to Postal Service Electronic Mail Systems	National Academy of Sciences Washington, D.C. February 12, 1981
Final Committee Review of Report	National Academy of Sciences Washington, D.C. April 30, 1981

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*Does not include special briefings of individual committee members