ELECTRONIC MAIL AND MESSAGE SYSTEMS
Technical and Policy Perspectives

Edited by

Robert E. Kahn
Albert Vezza
Alexander D. Roth

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Proceedings of the AFIPS Workshop on Technical and Policy Issues in Electronic Mail and Message Systems

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Robert E. Kahn

Information Processing Techniques Office
Defense Advanced Research Projects Agency

Albert Vezza
Laboratory for Computer Science
Massachusetts Institute of Technology

Alexander D. Roth
Washington Activities Office
American Federation of Information Processing Societies, Inc.

American Federation of Information Processing Societies, Inc.
1815 North Lynn Street
Arlington, Virginia 22209

Foreword

This volume contains the proceedings of a two-day invitational workshop on technical and policy issues in electronic mail and message systems held on December 11-12, 1980 at the Rayburn House Office Building, Washington, D.C. The workshop was made possible by financial support from

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The workshop was organized by AFIPS, the American Federation of Information Processing Societies, Inc., Paul J. Raisig, Executive Director, under the auspices of the AFIPS Washington Activities Committee, John Gosden, Chairman. AFIPS is a federation of eleven scientific, educational and professional associations in the field of information processing.

During the two days of the workshop, twenty-eight presentations addressed key aspects of a subject of intense national as well as international interest in a highly important and rapidly developing field. In several cases two or more of these presentations are reflected in a single paper in this proceeding. Although the organizers went to considerable effort to achieve a balance of views on technical as well as nontechnical issues, the views expressed in the papers are those of the authors and are not to be attributed to AFIPS, to the employers of the editors or authors, or to the co-sponsoring agencies and subcommittees. The editors hope these proceedings will be durably useful in shedding light on the extremely important subject of electronic mail and message systems.

The editors would particularly like to thank the AFIPS staff for their invaluable support and assistance in preparations for the workshop and these proceedings. The workshop could not have occurred without the support and encouragement of Keith Uncapher. Particular thanks are due to Ellen Law and Sara Leigh Merrey for their helpful review of manuscripts, to Christine Huppert, Judy Guerny-Lusby at DARPA and Janet Schoof at MIT/LCS, to Lorraine Cummings, Linda Martin, and Patricia Mayo.

Robert E. Kahn
Albert Vezza
Alexander D. Roth

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Contributors to This Volume[1]

Henry W. Blume	INTEL Corporation Santa Clara, CA 95051
Vinton G. Cerf	Information Processing Techniques Office Defense Advanced Research Projects Agency Arlington, VA 22209
Michael L. Dertouzos	Laboratory for Computer Science Massachusetts Institute of Technology Cambridge, MA 02139
Howard Frank	Network Analysis Corporation Great Neck, N.Y. 11024
A. Lee Fritschler	The Brookings Institution Washington, DC 20036
Henry Geller	Washington Center for Public Policy Research Washington, DC 20036
John F. Haverty	Bolt Beranek and Newman Inc. Cambridge, MA 02138
Paul E. Jaquish	U.S. Postal Service Washington, DC 20260
Lloyd Johnson	Staff Director Subcommittee on Postal Operations and Services Committee on Post Office and Civil Service U.S. House of Representatives Washington, DC 20515
Charles C. Joyce, Jr.	Richard L. Deal and Associates, Inc. Burke, VA 22015

[1] Affiliations as of 29 December 1981.

Robert E. Kahn	Information Processing Techniques Office Defense Advanced Research Projects Agency Arlington, VA 22209
Stephen T. Kent	Bolt Beranek Newman Inc. Cambridge, MA 02238
J.C.R. Licklider	Laboratory for Computer Science Massachusetts Institute of Technology Cambridge, MA 02139
Stephen J. Lukasik	Federal Communications Commission Washington, DC 20554
John M. McQuillan	BBN Information Management Corporation Cambridge, MA 02138
Robert A. Myers	Thomas J. Watson Research Center International Business Machines Corporation Yorktown Heights, N.Y. 10598
Richard M. Neustadt	Kirkland & Ellis Washington, DC 20006
Jonathan B. Postel	University of Southern California Information Sciences Institute Marina Del Rey, CA 90291
Alexander D. Roth	AFIPS Washington Activities Office Arlington, VA 22209
Marvin Sirbu	Center for Policy Alternatives Massachusetts Institute of Technology Cambridge, MA 02139
Vincent R. Sombrotto	National Association of Letter Carriers Washington, DC 20001
Carl A. Sunshine	University of Southern California Information Sciences Institute Marina Del Rey, CA 90291
Albert Vezza	Laboratory for Computer Science Massachusetts Institute of Technology Cambridge, MA 02139

Philip L. Verveer — Pierson, Ball & Dowd
Washington, DC 20036

Edward K. Zimmerman — National Computer Graphics Assn.
Washington, DC 20036

Introduction

Robert E. Kahn

Information Processing Techniques Office
Defense Advanced Research Projects Agency
Arlington, Virginia

The melding of computers and communications which began scarcely more than a decade ago, has been a natural turning point in the evolution of information processing technology. We are truly in the midst of an information revolution whose total scope we can only begin to contemplate as a society. Nothing, however, appears more self evident than the central role which electronic mail and message systems seems destined to play in this evolution.

The field of information processing has brought us the modern digital computer and its current counterpart the micro-computer on a chip from which we can derive almost as much raw general purpose computing power as the largest computers could provide only a decade ago. We have seen the world of telecommunications branch out from a century dominated by analog telephony to include a wealth of new communication options including digital transmission systems, packet switched networks, broadcast satellites, and local networks of various kinds. And we have seen the use of computers for numerical computation augmented by powerful symbolic processing capabilities along the certain path to achieving intelligent computer and communication systems. The combination of these technologies will be at the heart of the electronic mail and message systems of the future.

We are limited only by our imagination. It was difficult to imagine an integrated circuit containing as many as a hundred gates only 20 years ago. Today we are on the verge of seeing the million gate chip come to be a reality. We may have difficulty visualizing the next leap in complexity to billion or trillion gate chips, close 3-D cousins to their stodgy 2-D ancestors of the mid 1980's. Inexpensive, high bandwidth computer communication networks will make it possible for anyone (or their computer) to communicate at high speed with anyone else's computer.

The first instance in which many powerful computers were linked together into an interactive computing environment was achieved by the ARPA research community when it developed the ARPANET during the late 1960's. Although many pioneering efforts occurred in that fertile environment, a major surprise was the grass roots development, totally unplanned, of a capability for communicating text messages among researchers. The ARPANET experience was significant culturally as well as technologically. A set of researchers began to experience first hand a new way to communicate, broadly and richly, with other geographically distributed workers in their field. And it was easy to do! Messages composed during their normal working sessions could contain files or programs, computed results, as well as normal text messages and annotations. Programs running on these computers could send these messages to people and other programs. A generation of young people -- computer scientists, electrical engineers, managers, executives and secretaries have experienced this cultural phenomenon. Once experienced, there is simply no return.

Historically, the electronic transmission of messages predated the telephone and, despite the fact that it has long since been overshadowed by its bigger brother the telephone system, telegram traffic still constitutes an important segment of the overall communications market. The telephone reigns supreme in the communication of local messages, but the number of non-local letters still dominates the number of long distance telephone calls.

The growth in toll calls over the last decade appears to be significantly greater than the corresponding growth in letter mail. This is not very surprising given the relative decrease in telephone costs versus letter costs. It might even appear that the total message traffic in this country as reflected in telephone calls and letter mail was relatively constant and that gains in one area would come at the expense of losses in the other. However, I believe there is a fundamental reason to doubt the soundness of this "Peter and Paul" premise.

In particular, network technology and the associated internetworking architectures introduced during the last decade add a new variable to the equation. It is difficult to get accurate data for any of these services, which may be a problem in itself for policy makers and planners. The ARPANET can be used as an indicator of the potential for growth in this new area. Since 1973, the traffic growth at a typical heavily used research site on the ARPANET has increased by about 400%. In large part, this represents a new kind of traffic growth which has not been encountered previously. Only a fraction of this traffic is conventional text messages. It also includes transfer of programs, data bases, VLSI designs and other educational and research material such as journals. Electronic publishing as well as interactive information retrieval can flourish with the appropriate investments and protections for those investments. This data is representative of one network, but the growth it reflects can be mirrored in other new networks. New forms of message communication will surely develop from this technological opportunity.

To those who are skeptical of the potential amount of electronic message traffic, I would conjecture that in the future, most large chips will have their own built-in message systems for communication. One prognosis is that most message senders in the future will not be people at all, but electronic agents acting on their own, or perhaps our behalf.

The Western Union Mailgram service developed during the early 1970's coupled the electronic generation of messages with prompt physical delivery through the postal mail stream. The U.S. Postal Service plans to offer its version of electronic mail in the near future. Numerous commercial offerings exist today including the ability to generate and receive mail electronically. In the face of these impactful developments, numerous questions face us to provide and achieve a class of service and set of capabilities commensurate with our national needs and faithful to our progressive traditions of excellence in service.

First, perhaps, among these questions is how will all these mail and message systems communicate with each other. For they must in effect speak a "common language," a "protocol" in computer talk.[2] We should familiarize ourselves with the notion of protocols as they are a key to this issue. We will hear more about them later in this series. But how we achieve and maintain this commonality is an issue of concern. And these capabilities will be prevalent on many different networks not all of which will be connected to each other. In fact, most local networks will be connected to one or perhaps two wide-area networks at most. How will we insure that users in different nets can communicate their messages reliably?

Even today, the cost options for telecommunications are almost as complex as airborne travel options. How can we render the various alternatives and options (both technical and financial) more comprehensible to the user?

The labor force in the Postal Service is both large and diverse. Must the Postal Service enter the telecommunications field or the computer services field to remain competitive with emerging commercial alternatives? How will we identify and resolve conflicts between postal and telecommunications policy or be able to predict the effects of changes in either one?

Because the user quickly learns to enjoy hands-on access to these systems, the interface to the user has become a matter of central concern for the suppliers of equipment. No longer is keyboard text and hard copy output the norm. In addition, we now have interactive graphics, speech input and output, integrated data and voice, facsimile, images and even animation. With thousands, or perhaps millions of personal computers all networked together, we will have entered an information environment as real and tangible to its users as the physical world of the post office, banks, commerce and management.

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[2]We should be a little more precise about what is meant by "common language" for a mail and message system would have no difficulty in handling messages that were written in either English, French, German, Italian, Spanish, etc. "Common language" refers to the language the message systems use to accomplish the transfer and presentation of the message and not the language of the message per se.

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Michael L. Dertouzos
Professor and Director

Laboratory for Computer Science
Massachusetts Institute of Technology
Cambridge, Massachusetts

Introduction

By *Information Marketplace* I mean the collection of people, computers, communications, software and services that will be engaged in the intra-organizational and inter-personal informational transactions of the future. These transactions will involve the processing and communication of information under the same economic motives that drive today's traditional marketplace for material goods and services. The Information Marketplace already exists in embryonic form. I expect it to grow at a rapid rate and to affect us as importantly as have the products and processes of the industrial revolution.

To sharpen up these abstractions, let us try to imagine the makeup of the Information Marketplace from a point of view that is 20 years ahead:

> *Large organizations of the year 2000 have been using computers and communications since the late 1980's to communicate business data, electronic memos and still images among their own plants. Automated inter-organizational transactions have grown substantially in the early 1990's, and the toy personal computers of the early 1980's have become useful and powerful machines owned by small businesses and by many individuals. Office automation has come of age and has led to increased productivity, and to reductions in the use of paper and travel for certain routine activities. A wealth of private and public networks interconnect all of the machines which number in the ten millions. Entrepreneurs and a new breed of information companies offer a variety of legal, financial, medical, recreational, educational and governmental information services for a fee. Many traditional ways of doing business have changed: For example, advertising is done in reverse, by a service that responds to consumer inquires with products and services that match. An informational labor force supplies, and many people and organizations consume, all of these services from remote rural, or inner city locations.*

This paper summarizes the reasons that will lead us to the Information Marketplace, the underlying technology that makes it possible, some of the future services that the Information Marketplace will support, and certain legal and socio-economic consequences that are likely to follow. Electronic mail and message systems will play a central role in their own right, and perhaps a major supporting role, in a host of other services that can be envisioned. The approach taken in this paper, while based on a recent book[1] and on current trends, is ultimately the product of the author's imagination and personal bias.

The Driving Force

The main force driving us toward the Information Marketplace is the ongoing relentless improvement of some 30% per year in performance/cost and size/cost of primary solid-state memories and processor components. This improvement which has been going on for some twelve years is expected to continue well into the 1980's and early 1990's. By the end of this century a 256-fold improvement is likely relative to today, leading to a cost of perhaps $50 (1980 dollars) for storing one million characters in a computer memory. This means, for example, that a personal information base equivalent to 100 books may be stored for the price of an automobile. The far more ambitious undertaking of storing the world's written knowledge would still be very expensive but not prohibitive at about one half billion dollars per LOC.[2] These expected hardware improvements are so huge that were they to happen in the field of personal transportation, they would promise by analogy a future price of $10 for today's cars or a future fuel efficiency of 5,000 miles/gallon at today's car prices. The incredible socio-economic impact of such an absurd transportation revolution is, by the same analogy, indicative of the socio-economic consequences of the Information Marketplace.

The second important technological force behind the Information Marketplace is the ongoing evolution of communications technology: Satellite communication makes possible the transmission of data between any two points on earth at affordable and progressively decreasing real costs. Local-network technology makes possible the communication of information among a few tens or hundreds of interconnected machines in the same building. Glass fibers promise substantial increases in speed and decreases in the cost of land-line communications. Mixed-media packet network techniques have already evolved to a level that makes possible the transmission of voice, computer data and images in digital form, hence with increased noise immunity and with the ability to easily mix and process such data by machine.

The above two major trends in *computer hardware* and *communications* have already caused a marked growth in the creation of new companies and a substantial change in the strategies adopted by existing organizations. The picture, however, is not all that rosy! Unlike the hardware with its spectacular and predictable trends, the software needed to make the hardware useful continues to be very expensive. Two reasons can be identified for this imbalance between hardware and software cost trends. The first is generic to the computer field where there are no "natural laws" and few formal ways to design effectively new programs. This weakness is evident in teaching programming -- there is little that a master programmer can explicitly teach to an aspiring youth. Apprenticeship, talent and other intangibles seem to distinguish a programming athlete from a plodding programmer, with staggering productivity differences of 10 to 1 or more. The second reason for the high cost of software stems from the historic desire of individual users to tailor programs to their varying needs rather than to conform their needs to a standard product. Improvement in this area is already visible with the advent of standard application programs for the small user who can now afford the

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[1] M.L. Dertouzos and J. Moses, *The Computer Age: A Twenty-Year View*, MIT Press, 1979.

[2] The LOC (for Library of Congress) unit of memory was established half jokingly, half seriously by the author to represent large amounts of information. It is 100 trillion characters.

hardware but not the older tailor-fitting software. Software costs, however, are likely to continue to be high and will undoubtedly be the main tempering factor in the growth of the Information Marketplace.

Geographically Distributed Systems

Historically, the computer has been a *centralized* resource. Because of its very high cost in the early days of its development, the computer was shared either through different programs on a *batch* basis (waiting for your turn to put in your cards and get your answers), or on a *time-shared* basis (spreading computer power in round robin fashion to several people so fast that each thinks he has the computer to himself). Both of these approaches which form over 90% of today's computer systems involve a centralized hardware and software structure which "knows" all that it must about different users, different programs, and different data stores. Such a centralized structure, because of inherent complexity limitations has an upper bound on the number of people that it can simultaneously serve. Today, this bound is somewhere in the vicinity of 50 to 100 users. This limitation is comparable to a human being's inability to cope simultaneously with more than a few tasks.

With the continuously decreasing hardware costs and communications advances discussed in the preceding section, it is now possible to interconnect many different machines so that in effect data is sent from one centralized installation to the other over a satellite or local network. This trend toward decentralization can extend quite rapidly to the extreme where each computer serves one user and all such computers are interconnected. The Xerox Palo Alto Research Center has demonstrated this principle with some 700 interconnected single-user computers.

The Information Marketplace that we envision will be a mixture of predominantly single-user, as well as multiple-user computers, all interconnected through a variety of paths, as in today's world-wide telephone network. The reasons leading to such interconnections are economic. First, large corporations with distributed plants and offices will seek such interconnections among their own locations in order to make their business more efficient -- this we discuss further in the section below on Office Automation. Later, perhaps in the early 1990's, different businesses will seek connections with each other to improve the effectiveness of automatically handling communications and transactions on an inter-organizational basis. Somewhere in this time frame, individuals may seek interconnections to certain data banks and to each other for a variety of reasons discussed in the section on Home computers. However, while the future evolution of inter-and intra-company interconnections appears fairly certain today, the interpersonal development is not as clear at this time. Indeed it may exhibit an avalanche effect, as was the case in CB radio -- if enough people and organizations are interconnected then the resultant Information Marketplace will be more useful, leading to more people seeking interconnection.

In conclusion, the technological infrastructure of the Information Marketplace lies in these geographically distributed and decentralized systems which are needed simply because people, hence the collection, processing, and use of information, are geographically distributed in the first place.

Intelligent Programs and Service Automation

Intelligent Programs are expected to play an important role in the Information Marketplace. Today's research programs that are characterized as "intelligent" exhibit expertise in such diverse fields as clinical decision making, mathematics and circuit design. Take for example a recent program developed at the MIT