

Helmo Raag\*  
 Communications Satellite Corporation  
 Washington, D.C. 20024

### Abstract

INTELPOST is an experimental international electronic message system which COMSAT has been developing for the United States Postal Service. The INTELPOST system design is based on the use of high-speed digital document facsimile scanning and printing equipment which is interfaced to minicomputers for store-and-forward operation. The INTELPOST systems forms an intercontinental packet switched network.

### Introduction

International Electronic Post (INTELPOST) is an experimental international electronic message system. The INTELPOST concept is illustrated in Figure 1. Since March 1978, COMSAT has been planning, designing and implementing the INTELPOST system for the United States Postal Service (USPS). The Postal Administrations of a number of countries have decided to implement similar INTELPOST installations, and have agreed with the USPS to conduct demonstrations and a field trial of the INTELPOST system.

The INTELPOST system has been designed to provide an international electronic message service between end users. It has been designed to be a postal service. This means that in addition to the technical design of the system, other INTELPOST service features, including message collection and delivery procedures as well as other message handling details, have been planned and coordinated between the participating Postal Administrations and are being implemented. This paper discusses mainly the more important technical features of the INTELPOST system.

\*Director, Electronic Mail Systems  
 Member of AIAA

The views expressed herein are those of the author, and do not necessarily represent the views of the Communications Satellite Corporation or the United States Postal Service.

### INTERNATIONAL ELECTRONIC MESSAGE SYSTEM CONCEPT

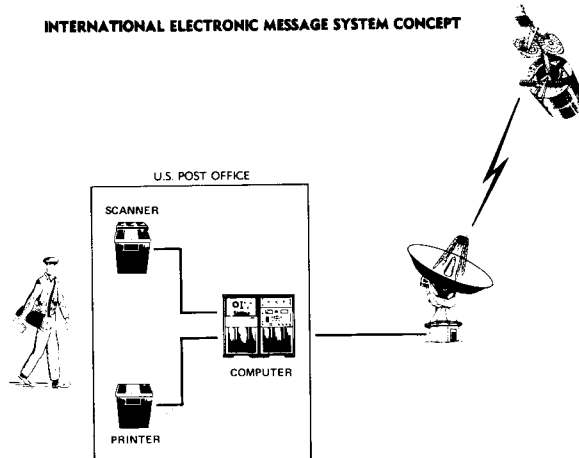


Figure 1.

### System Design

The more important INTELPOST system features are:

#### Network Approach

All INTELPOST sites are intended to be interconnected to form a network, instead of being implemented as a series of separate point-to-point links. The network enables the routing of messages between any of the sites in the network. Each site can act as a source or a destination of a message. In addition, commensurate with the throughput capacity of the site, each site can act as a transit center for messages of other sites when the necessary transmission facilities are installed and the necessary routing instructions are included in the computers of the sites.

The advantages of the network approach to INTELPOST system design parallel those in telecommunication networks. The amount of scanning and printing equipment required at the various sites is minimized, system utility is maximized, network topology and the use of transmission facilities according to traffic requirements can be optimized, and alternative routing paths between sites can be provided.

The INTELPOST network has been designed as a packet switched network using an end-to-end communication protocol. This provides for considerable flexibility for accommodating changes in network topology and for supporting network expansion.

The initial implementation of the INTELPOST network resulted from a series of bilateral agreements between the USPS and the participating foreign Postal Administrations. This determined the star configuration of the initial network as shown in Figure 2.

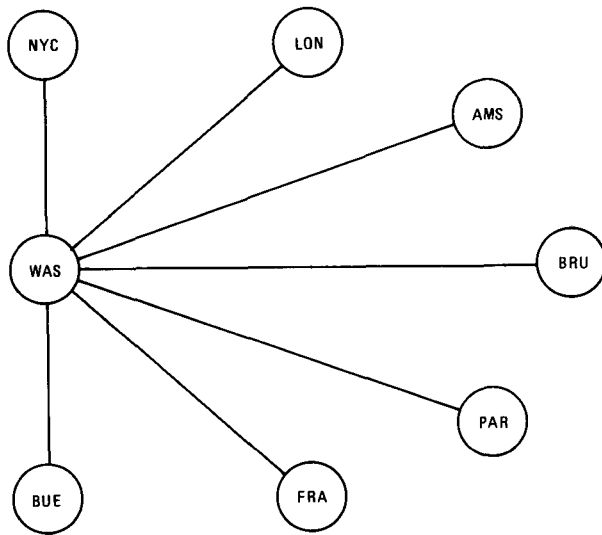


Figure 2.

#### Store-And-Forward Operation

The INTELPOST system equipment configuration is shown in Figure 3. It includes a minicomputer with disk storage for store-and-forward operation. All messages are stored on disk after scanning and before being transmitted to distant sites. Similarly, all received messages are stored on disk before printing. Thus the scanning and printing operations are separated from the message transfer procedures between sites. This provides a number of advantages. The transmission data rates to different INTELPOST sites are determined on the basis of traffic volume requirements and may vary (e.g., 9.6 kbs or 50 kbs). Store-and-forward operation provides transmission data rate buffering of the printers and scanners to the transmission lines. The disk storage allows for message load buffering both for incoming and outgoing message traffic. INTELPOST is intended to be an international system with sites in widely different time zones. It is not expected to have operating personnel at all sites, 24 hours a day, at least initially. Store-and-forward operation allows unattended reception and storage on disk of incoming messages as well as unattended transmission of stored messages to distant

sites. In the initial INTELPOST equipment configuration up to about 1000 pages can be stored on disk at a site at any one time. Store-and-forward operation allows to separate the transmission error control procedures from the scanning and printing operations, and it allows to retain the stored message on disk at the originating site until the receiving site notifies that it has received the entire message without errors.

#### **INTELPOST EQUIPMENT CONFIGURATION**

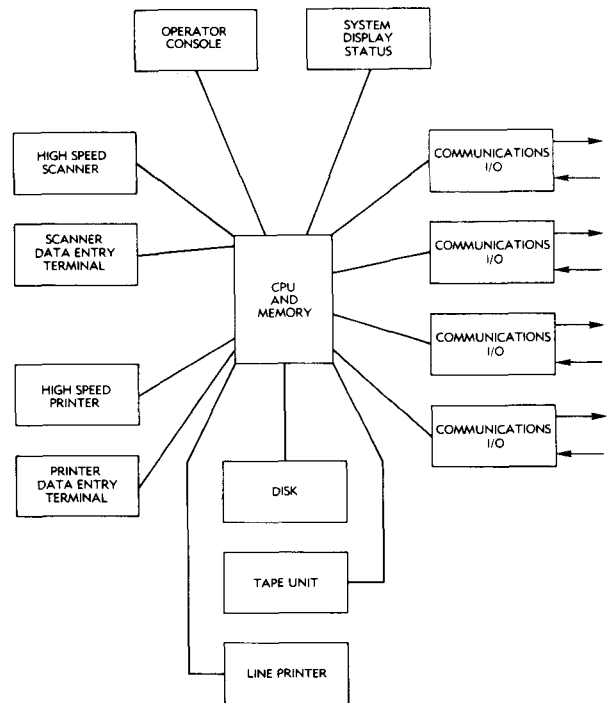


Figure 3.

#### High-Speed Scanning and Printing

High-speed facsimile scanning and printing equipment is important mainly for two reasons. First, it provides for operator convenience and secondly, it enhances system throughput capability. The facsimile data in the INTELPOST system conforms to the format of CCITT Draft Recommendation T.4. The specified resolution is 7.7 lines/mm and data compression is according to the modified Huffman run-length code specified in Rec. T.4. These parameters determine that a scanned page results in about four million bits uncompressed, and, on an average, about half a million bits compressed.

The facsimile scanners and printers in the present INTELPOST equipment implementation operate at about 10 - 12 seconds per page. The data compression and expansion is accomplished in the scanner and printer, respectively. Thus

the transmission data rate to/from the computer is 50 kbs.

### Message Control

In a postal electronic message system, message control is one of the fundamental and more important requirements. It is essential that no message or part of it be lost or misrouted. Measures must be included in the system design to keep a record of the scanning, transmission and printing times of messages along with other data although it is equally important that the contents of a message be not retained in the system for longer than to assure that the message has been successfully transmitted and printed.

Message control measures in the INTELPOST system are visualized to evolve in a phased manner. In the early phases of INTELPOST implementation, postal operators play a significant role in message control. Later, the use of more automated measures is visualized.

Message control in the INTELPOST system is exercised at present through the following system features. Each message to be transmitted is assigned an identification number which includes the originating site identity and a six digit assignable alphanumeric code. Each message is accompanied with a transmittal sheet where the sender's and addressee's names and addresses are included, the number of pages in the message, the destination site identity, the message identification number, the delivery method from the receive site to the addressee, etc. The scanner operator enters the required information (message identification number, destination, priority level and number of pages in the message) into the computer through an interactive data and display terminal.

The system keeps track of the message flow from the originating site to the receiving site through a series of updates of the "Document Information Block" (DIB) which is assigned in the originating computer to each message when the scanner operator enters the previously described data into the computer. The same information is transferred to and stored also in the receiving computer. The DIB is kept updated in both the originating and receiving site computers and it contains the time of message scanning, whether the message is in the transmission queue, time of transmission, time of printing and other information in addition to the data entered by the scanner operator. All times are recorded in GMT with resolution of one minute. Through the system operator interactive data entry and display terminal, and using the document identification number, it is possible to inquire about the current status of any message to be transmitted or received by that site.

The printer operator interacts with the

computer also through an interactive data entry and display terminal and he can instruct the computer and the printer what document to print, what acknowledgement to send to the originating site (printed OK, rescanning required, etc.) and so on.

At the originating site, a confirmation label is printed in duplicate for every transmitted and printed message which includes the message identification number, the destination, the priority level, the scanning time at the originating site and the printing time at the receiving site. The confirmation label is affixed to a copy of the transmittal sheet which is kept at the originating site as a record of the message handling.

Message control is exercised also as part of the message transmission procedures disk at the originating site until the receiving site signals to the originating site that the entire message has been received correctly. Similarly, the message is retained on disk at the receiving site until the printer operator acknowledges via the data entry terminal that the message has been properly printed.

### Error Control

To protect against transmission errors, an error detection and retransmission scheme has been included on end-to-end basis. That is, the destination INTELPOST computer checks the received packetized data for errors in the individual packets and acknowledges all correctly received packets. The intermediate or transit sites do not perform such checking. The originating INTELPOST computer waits for the acknowledgements to arrive for all transmitted packets, and after a preset time, retransmits only the unacknowledged packets.

### System Implementation

Since INTELPOST is an experimental system, an important requirement is that the system is flexible for accommodating changes in equipments as well as in operating features. At the same time, to permit its implementation in a relatively short time, the demonstration system was designed to include only the necessary basic system features which would allow a meaningful demonstration of system operation, and an initial evaluation of system operation and performance. The demonstration system was implemented with the following fundamental criteria in mind:

- Low cost
- flexibility for expansion
- nonredundant equipment configuration
- basic software

The INTELPOST systems have been implemented at present by all participants using RAPICOM 500T and 500R high speed facsimile scanners and printers and Digital

Equipment Corporation PDP 11/34 minicomputers. As the system evolves, implementations using other equipment can also be expected. The scanners and printers employ a specially designed computer interface. The minicomputer provides for modular system construction, for connection of different facsimile, character recognition or other terminal equipments, or for changes in INTELPOST network topology. Finally, the system software is also designed for implementation in a modular manner so that changes and additions of system features can be accomplished relatively easily.

The initial INTELPOST system implementation and operation have proved the soundness of the basic system design. During the field trial and for an operation system various system hardware and software enhancements are visualized. Among the more important intended improvements are the following:

- inclusion of additional scanners and printers and additional computer modules to increase system reliability as well as to increase system capacity;
- improve system monitoring, control, fault handling requirements and to provide for local options;
- provision of features for gathering system performance and traffic statistics, gathering accounting and billing data, message encryption, and dynamic traffic routing.

The star configuration of the initial INTELPOST network is not optimum for an operational system. Studies are currently underway to define a network configuration which provides for increased reliability, meets the varied traffic demands of the various sites and optimizes the use of transmission facilities. Figure 4 shows a mesh network of the same INTELPOST sites as in Figure 2. A meshed network can be engineered to provide the cited advantages over a star network.

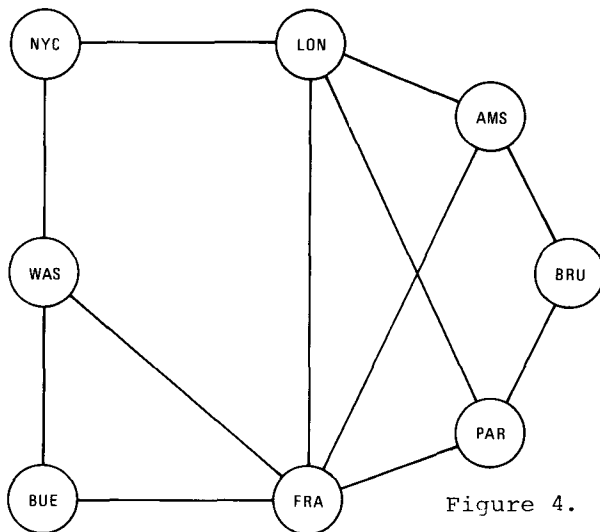


Figure 4.

The INTELPOST system is also particularly well suited for implementation as network through the use of satellite TDMA technology. The facsimile raster scanning and printing approach results in a relatively large amounts of data to be transmitted or received per message as compared with alpha-numeric transmission. This, together with the requirement to be able to transmit messages quickly in time windows constrained by large intercontinental time zone differences and mail cutoff times for letter carrier delivery schedules, makes the use of high data rate circuits attractive. The use of the needed transmission capacity of a communications satellite provides connectivity between all sites, allows to allocate transmission capacity on demand, and to dimension the transmission system to meet the traffic and delivery time requirements.