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Guidelines to Telecommunications Interconnection Requirements for Message Input to the USPS E-COM System

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Preface

The study reported here is part of a program conducted by the National Telecommunications and Information Administration, Institute for Telecommunication Sciences (NTIA/ITS) for the United States Postal Service (USPS) in support of that agency's proposed Electronic Computer Originated Mail (E-COM) System. The current contract agreement number between the USPS and the NTIA/ITS is 104230-79-T-1243.

Previous reports for the USPS by the NTIA/ITS have dealt with satellite frequency requirements, earth-space attenuation predictions, accuracy-cost studies, and electronic message service concepts and candidates (in unpublished form).

Technical and management supervision of this report was provided by Dr. P. M. McManamon and R. F. Linfield of the NTIA/ITS.

The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official United States Postal Service or National Telecommunications and Information Administration position, policy, or decision, unless designated by other official documentation.

Certain commercial names and companies are identified in this paper to specify or describe adequately some of the necessary information. In no case does such identification imply exclusive recommendation or endorsement by the National Telecommunications and Information Administration.

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LIST OF ABBREVIATIONS

ADCCP - Advance Data Communications Control Procedure

ANSI - American National Standards Institute

ARQ - Automatic Repeat Request

ASCII - American Standard Code for Information Interchange

AT&T - American Telephone and Telegraph

BDLC - Burroughs Data Link Control

bis - French for alternative or second version

BOLD - NCR Bit-Oriented Data Link Control

BSC - Binary Synchronous Communication

b/s - Bits Per Second

CCITT - International Telephone and Telegraph Consultative Committee

CDCCP - Control Data Communications Control Protocol

COT - Multi-Address Message with a Common Text

CPI - Characters Per Inch

DCE - Data Circuit-Terminating Equipment

DDCMP - Digital Data Communications Message Protocol

DTE - Data Terminal Equipment

EBCDIC - Extended Binary Code for Data Interchange

E-COM - Electronic Computer Originated Mail

EIA - Electronic Industries Association

EMS - Electronic Mail Systems

EMSS - Electronic Mail Service System

FEC - Forward Error Correction

GTE - General Telephone and Electronics

HDLC - High Level Data Link Control

IBM - International Business Machines, Incorporated

ISO - International Organization for Standardization

kb/s - Kilobits Per Second

MOC - Management Operations Center

NCR - National Cash Register Company

OSI - Open Systems Interconnection

PRC - Postal Rate Commission

SAM - Single Address Message

SBS - Satellite Business Systems

SDLC - Synchronous Data Link Control

SDX - American Satellite System Data Exchange

SOW - Statement of Work

SPO - Serving Post Office

TIM - Text Insert Message

UDLC - Univac Data Link Control

USPS - United States Postal Service

VAN - Value-Added Network

WU - Western Union

GUIDELINES TO TELECOMMUNICATIONS INTERCONNECTION REQUIREMENTS FOR MESSAGE INPUT TO THE USPS E-COM SYSTEM

D. V. Glen*

Guidelines for interconnection to the United States Postal Service (USPS) Electronic Computer Originated Mail (E-COM) System via telecommunications carriers are developed. A description of the E-COM System is given and the need for telecommunications standards for accessing the E-COM System is provided.

Key words: Electronic Computer Originated Mail (E-COM) System; interface standards; Open Systems Interconnection (OSI); protocols; telecommunication standards; United States Postal Service (USPS)

1. INTRODUCTION

1.1 Background

The United States Postal Service (USPS) is on the threshold of using the latest technological advances for improving postal operations. Electronic mail handling by the USPS will soon be a reality. This report develops guidelines for telecommunication interface requirements to facilitate interconnections to the USPS Electronic Computer Originated Mail (E-COM) System by customers through common carriers.

Three documents serve as the primary basis for developing these interface standard guidelines. The first is the Federal "Adminstration Policy Statement" of July 19, 1979 which established guidelines for the USPS role in electronic mail. In that document support was given for new services proposed by the USPS to use telecommunications systems to feed messages into the normal mailstream for delivery by letter carriers. Also, this Administration Policy Statement prohibits the USPS from offering services which would enable message delivery via telecommunications to the customer.

Two of the eight conditions provided by the Administration Policy Statement are relevant to this report. They are:

- "The USPS should purchase electronic transmission services from carriers rather than build a transmission network."

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- "To ensure that interconnection with the mail delivery system is available to all companies, technical interconnection standards should be developed through a cooperative effort by the American National Standards Institute, the USPS, the private carriers, and an impartial arbiter, if needed."

The second document which supports this effort is Resolution 80-5 of the Board of Governors of the United States Postal Service (Board of Governors, 1980). As a result of that resolution, the USPS can begin to implement the E-COM System, which is designed to provide the high-volume mail user with speedy, low-cost delivery of messages generated by computer. Electronic messages will be accepted at Serving Post Offices (SPO's), converted into hard copy, and delivered through regular postal channels.

The Board of Governors' (1980) Resolution dealt with two other matters regarding technical arrangements necessary for electronic mail service. It reiterated the Administration Policy Statement by stating: 1) SPO's will not undertake to provide functions or services which are customarily provided by the carriers; customers for electronic mail service will use the services of one or more commercial networks to transport and multiplex the necessary information from their computer(s) directly to the desired SPO. 2) Protocols should be developed by the Postal Service, along with their interfaces to adjacent higher or lower levels, with inputs from the technical community and the interested standards groups.

The third document providing impetus for this report is the USPS Statement of Work (SOW) for Electronic Computer Originated Mail (E-COM) System (United States Postal Service, 1980). The E-COM SOW follows the guidelines provided by the Administration Policy Statement and the Board of Governors' Resolution. The E-COM System will consist of 25 SPO's which will provide second business day delivery of mail (paper copy) to the SPO service areas. Messages are to be entered via telecommunications and on magnetic tape. However, Resolution 80-5 of the USPS Board of Governors (1980) has requested that the Postal Rate Commission (PRC) consider whether mailers can establish private communications lines to serving post offices and whether the USPS can accept magnetic tapes over the counter. Although the E-COM SOW does specify magnetic tape input, implementation of this or the private line input mode will not take place until approval is received from the PRC.

1.2 Purpose and Scope

The purpose of this paper is to develop telecommunication interface standards guidelines which will "ensure that interconnection with the mail delivery system is available to all companies". The interface standards resulting from these guidelines and subsequent work are intended to lead to 1) an American National Standards Institute (ANSI) application standard, or if deemed appropriate by the ANSI, an ANSI national standard, and 2) a user's guide for interconnection with the E-COM System. Available standards that are applicable will be identified. If additional standards are needed for unique USPS requirements, these needs will be identified as the basis for additional standards development by the USPS. In the identification and determination of interconnection standards, it is necessary to consult standards organizations (e.g., ANSI), the USPS, communications carriers, and customers of the USPS. As standards are identified, it is necessary for the USPS and the ITS to coordinate standards identification and development with the ANSI and other organizations with an interest in these standards (Appendix A).

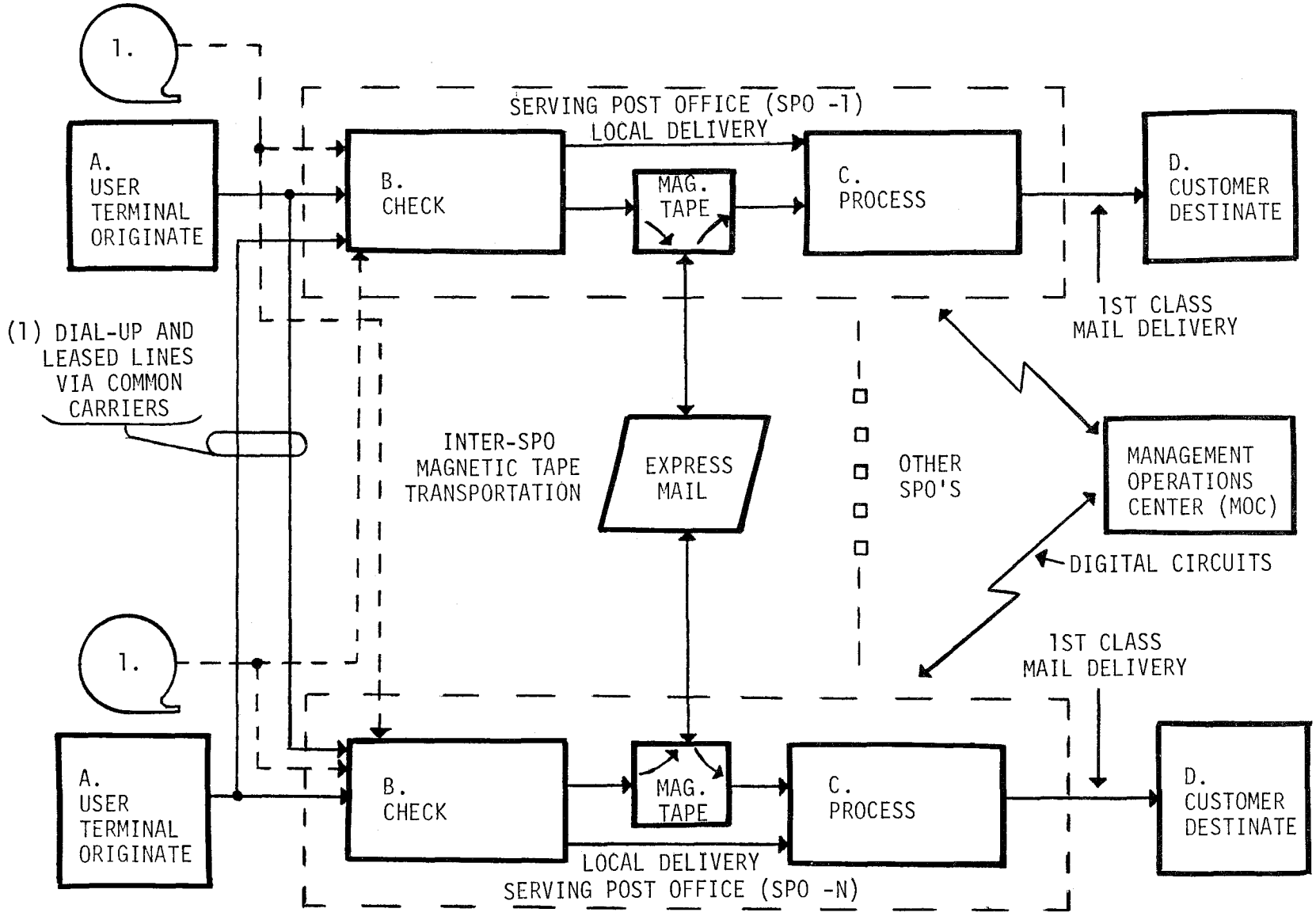
1.3 Organization of the Report

Section 2 describes the E-COM System as stated in the USPS E-COM System SOW. Subsequent sections discuss a) interconnection standards and selection criteria based on the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) reference model (Section 3); b) telecommunication requirements based on the location of the USPS and communications carrier interface (Section 4); and c) the identification of customer terminal equipment, communication equipment, and associated standards guidelines based on the OSI reference model (Section 5).

2. DESCRIPTION OF E-COM SYSTEM

2.1 Serving Post Offices

The E-COM System consists of operational processing systems located at Serving Post Offices (SPO's) in 25 cities (see Appendix B for the names of these cities). The SPO's are connected to a Management Operations Center (MOC) through an administrative control network which is based on several leased digital telecommunications circuits (Figure 1).



NOTE: (1) Magnetic tape and private lines input to E-COM will be implemented pending PRC approval.

Figure 1. E-COM System operation.

2.1.1 Message Input

Messages that are accepted for entry in the USPS mailstream can be entered via telecommunications lines (public or private) and on magnetic tape. Implementation of private line input or magnetic tape acceptance by the USPS is subject to approval by the Postal Rate Commission. Messages are originated at the user terminal (Figure 1, block A) for transmission to the SPO. They also may be recorded on magnetic tape for customer delivery to the SPO, or await postal carrier pickup. Messages that are entered via transmission lines can be sent to a geographically local or remote SPO of the customer's choosing.

After the messages are received at the SPO, they are checked for data and format errors (Figure 1, block B). If errors are found, the messages are rejected and the customer is notified. If the messages are accepted, the processing system electronically sorts and stores the message data by ZIP codes.

2.1.2 Express Mail Message Transfer

Messages which are destined for other SPOs are recorded onto magnetic tapes for overnight transfer via Express Mail service to the destination SPO for processing.

2.1.3 Message Processing

At the destination SPO, incoming mail is then sequentially printed by 9-digit ZIP code, enveloped, sealed, and trayed to form an E-COM mail batch according to a prescribed schedule (Figure 1, block C). After the batch is formed, it is transferred to a SPO mail processing area where it is merged with other First Class Mail.

2.1.4 Message Delivery

First Class Mail is then delivered by the USPS mail carrier to the customer as part of the regular mailstream.

Note that this process of electronic mail input and printed paper output adheres to the guidelines of the Administration Policy Statement and to the Resolution of the USPS Board of Governors.

2.2 E-COM System Customers

Large volume mail users, with the capability of electronically generating messages, are expected to be the primary customers for the E-COM System. These customers include oil and credit card companies, insurance and auto industries, and banking services. These transactions do not include transfer of funds between payee and recipient (e.g., bill recipient and credit card company).

2.2.1 Mail Volume

The E-COM System mail volume is projected to total 12.6 million pieces cumulative annual volume at the end of the first year of operation, 35 million at the end of the second year, and 70 million at the end of the third year (Table 1).

Table 1. Estimated E-COM Mail Volume

Year	Number of Users	Annual Volume (thousands)
1	45	12,575
2	80	35,000
3	105	70,000

These volumes are relatively small compared to the 106 billion mail pieces handled by the USPS during 1980. The E-COM System service is expected to begin in January 1982.

2.2.2 Mail Mix

The USPS estimates that 60% of all electronically originated messages will enter each SPO via telecommunications lines and 40% will enter the mailstream through magnetic tape.

2.2.3 Input Message Batch and Size

The USPS has established a minimum input message batch. The minimum number of messages that can enter the system at any one time from a customer is 200 in either the telecommunication or magnetic tape mode. The average number of alphanumeric characters per page is 1200 and there is a maximum number of 2, 8-1/2 x 11 inch pages per mail piece. There is essentially no limit on the maximum number of messages that can be sent.

Assuming that there are 10,000 bits per message (average, including overhead) the average bits per block of 200 messages is 2×10^6.

2.2.4 Message Types

The types of messages that will be processed by the E-COM System from telecommunication or magnetic tape input are:

1. Single address messages (SAM's);
2. Multi-address message with a common text (COT's); and
3. Multi-address with a common text message into which variable data can be added (Text Insert Messages, TIM's).

2.3 Message Headers and Formats

As indicated in Section 2.1.1, message entry to the E-COM System will be via telecommunications lines and on magnetic tape. It will be to the advantage of the USPS electronic mail systems to have a commonality of message header and print-image format instructions for messages entering the mailstream by either mode. The requirements should strive to identify applicable standards which will permit this commonality. A number of magnetic tape and message print formats have been identified in the E-COM System SOW (Appendix C). These will have to be verified and related to applicable data transmission header formats (e.g., ANSI X3.57) and print image formats under development by the ANSI.

3. INTERCONNECTION STANDARDS

3.1 Protocols and Interfaces

The need for interconnection standards has been previously noted. These interconnection standards encompass "protocols," referring to a set of rules for communication between similar processes, and "interfaces," referring to a set of rules for communication between dissimilar processes (McQuillan and Cerf, 1978; Green, 1980). Protocols are related to the division of responsibility between functional units of the same type. Interfaces are related to communication between dissimilar functional elements. However, another term coming into usage instead of "interface" is "interaction" which is more descriptive of the process (Folts, 1981). For example, there are protocols between computers while an interface or interaction exists between a host computer and a network switching node. Other interfaces exist between an end user (terminal operator) and a user's terminal, or between the interactive user terminal and a local network (Glen and Thompson, 1981).

3.2 Open System Interconnection Reference Model

The layered Open System Interconnection (OSI) reference model (ISO/TC 97/SC 16, 1980) has been chosen to provide a framework for selecting standards applicable to the E-COM System. The layered structure of the model permits the application of interface standards, defined by national and international standards organizations, in a consistent, organized manner, and the interconnection of dissimilar end-systems. This is accomplished by making the architectural layers modular in such a way that permits software development according to functional definitions. Note, however,

that the OSI model is still undergoing modification and refinement of functional definitions.

The OSI reference model consists of seven layers (Figure 2). These are shown as level 1. Physical, level 2. Data Link, level 3. Network, level 4. Transport, level 5. Session, level 6. Presentation, and level 7. Application.

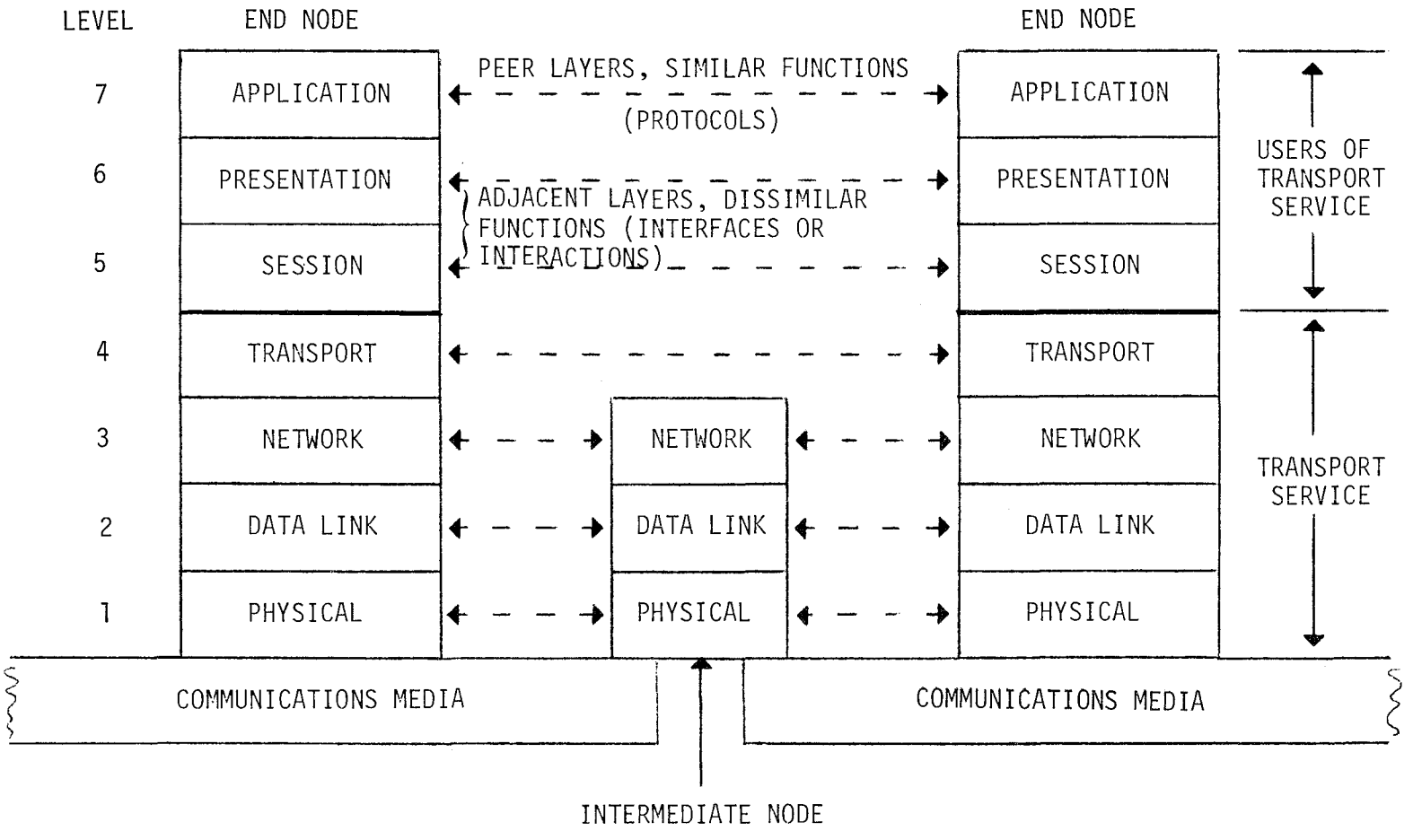
The peer layers (Figure 2), which communicate through protocols between similar functional units, are shown at the end nodes. The adjacent layers, which communicate between interfaces through dissimilar functional units are also indicated at the nodes. Levels 1 through 4 are shown as the Transport Service and levels 5 through 7 are shown for Users of the Transport Service.

The general purposes of the layers, with application to the E-COM System, are shown in Table 2. The functions of the layers are shown in Table 3. Some of the required and applicable interface standards for the E-COM System are shown also in Table 3. For the physical layer, these are the EIA RS-232-C and RS-449. For the data link layer, these are the ANSI X3.28 ASCII control character set usage, Bisynchronous, and ANSI X3.66 (ADCCP) protocols.

3.3 DTE/DCE Interface

An approach for applying the OSI reference model is shown in Figure 3. The physical layer, level 1, is shown as providing the connection between the Data Terminal Equipment (DTE) and the Data Circuit-Terminating Equipment (DCE) at the USPS customer location and at the E-COM SPO mode. A public data network consisting of leased or dial-up communications lines is used to connect the two locations. Host computers and data terminals or word processors are defined as DTE's; modems, multiplexers, concentrators, and similar equipment are defined as DCE's.

Interconnection standards that are to evolve from this effort will depend on determining which layers of the reference model are applicable or valid at the E-COM System SPO. For example, most layers are believed to be appropriate for the E-COM System. However, what are the circumstances that determine which layers are to be used? For the E-COM System, some may not be necessary. In the long term, interface standards for higher level layers will be needed. Protocols will have to be developed to enter mail at public terminals which are contemplated as part of a future USPS Electronic Mail Service System (EMSS). These would permit the general public to follow an interactive set of instructions while using a keyboard to enter the message. An application of this type is appropriate for the session layer.



NOTE: Removal of the intermediate node results in a point-to-point model.

Figure 2. OSI reference model architecture (tandem model).

Table 2. General Purposes of OSI Layers

Layer		Purpose
Application	-	Protocols of this layer directly serve end user by providing service to applications, such as Electronic Mail.
Presentation	-	Services for management of entry, exchange, display and control of structured data, and programming to encode and decode message blocks.
Session	-	Assists in the support of interactions between serving post offices and the management operations center (MOC) with respect to synchronizing and delimiting; activating/deactivating input to a port.
Transport	-	Provides control of data transportation from origination customer to USPS destination SPO (not intermediate). Relieves higher levels from concern with data transportation and provides for quality of service.
Network	-	Generates path header to control message blocking, switching, and link routing for a connection path between a customer's terminal and a SPO. Applies to circuit and packet switching.
Data Link	-	Generates link header/trailer to control data flow on link (e.g., phone line) to the SPO. Access control, addressing, and error control on the physical link.
Physical	-	Permits use of a variety of physical interconnections and bit stream transmission with different control procedures.

Based on ISO definitions with application to the USPS E-COM System. (ISO/TC 97/SC 16 Working Document and Folts, 1981).

Table 3. Functions of OSI Layers

Level 7 - Applications
- o Government Information Systems
  - Social Data Banks
- o Banking
  - Electronic Funds Transfer
- o Electronic Mail
- o International and National Corporate Information Systems

Level 6 - Presentation
- o Coding
  - ASCII, EBCDIC, Correspondence, Baudot
- o Languages
  - Basic, Fortran, Cobol, Pascal
- o Tape, Disc Formats
- o Facsimile
- o Text
- o Controls

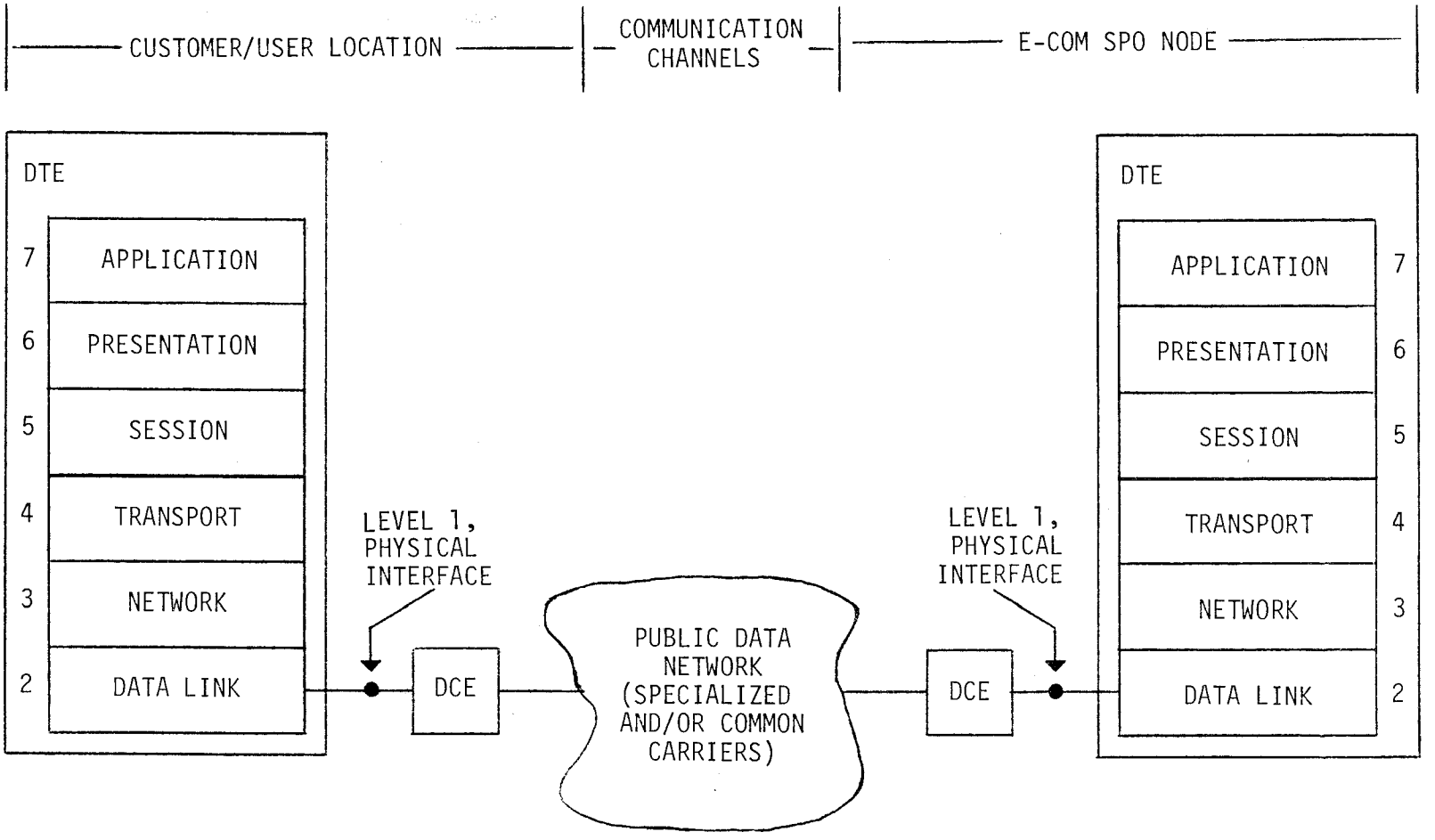
Level 5 - Session
- o File Management, Transfer, Access
- o Job Transfer, Manipulation

Level 4 - Transport
- o Connection Start/Stop
- o Addressing Point-to-Point, Multi-Drop
- o Sequence Control
- o Multiplexing
- o Error Detection, Recovery
- o Flow Control

Level 3 - Network (Character-Oriented: ANSI X3.57;
Bit-Oriented: ANSI X3, Project 281)
- o Routing
- o User Identification through Network Address
- o Error Notification, Recovery
- o Sequencing, Flow Control

Level 2 - Data Link (Character-Oriented: ANSI X3.28, Bisynchronous;
Bit-Oriented: ANSI X3.66 (ADCCP))
- o Data-Link Connection Between User and Station Over Physical Links
- o Sequencing
- o Error Notification, Recovery
- o Flow Control

Level 1 - Physical (RS-232-C, RS-449)
- o Mechanical } Connections Between DTE and DCE
- o Electrical }
- o Functional } Protocols Between DTE and DCE
- o Procedural }



NOTES:

a. DTE - data terminal equipment (e.g., data terminal).
   DCE - data circuit - terminating equipment (e.g., modem).

b. Applicability of layers at E-COM SPO to be determined.

Figure 3. DTE/DCE interfaces and layers.

3.4 Criteria for Protocol Selection

Criteria for the selection of protocols should hinge on a number of factors. These include system dependence and system independence. Use of an existing protocol is preferred over design of a new one unless none of the existing protocols is satisfactory, or a new one would be clearly superior to an existing one.

3.4.1 System-Independent Versus System-Dependent Protocols

The primary criterion for selecting a protocol is that it be system independent. Many protocols were developed for a particular system. They have features which are optimum for that system and not useful for other systems. A system-dependent protocol peculiar to a company that developed it is constrained to a particular code, speed, and system configuration. A preferable protocol is one that is company and system independent (Chan and Grunstein, 1977). It would provide flexibility needed for the E-COM System. Although use of the system-independent protocol is more desirable, it may be necessary to mitigate this selection based on communication system availability, customer preference, and E-COM System needs.

3.4.2 Character- Versus Bit-Oriented Protocols

The next most important criterion for selecting a protocol is that it be bit oriented rather than character oriented. Character-oriented protocols require that a message format contain only characters of a particular code set (e.g., ASCII, EBCDIC). Thus, they limit the freedom to use bit patterns such as binary representations which increase flexibility. A bit-oriented protocol is clearly more desirable for the E-COM System Management Operations Center communications control. However, this desirability must be tempered for the message input system by determining the preference of customers, whether they will be using character- or bit-oriented devices, for sending their mail to the USPS.

The E-COM System SOW does state that both the character- and bit-oriented protocols will be accepted.

3.4.3 Other Criteria

Other criteria for ideally selecting protocols are:

a) usability for full-duplex operation;
b) compatibility with both terrestrial and satellite channels;
c) capability for error control with forward error control (FEC) codes and/or automatic repeat request (ARQ);
d) compatibility with the desired message format, content, and length;
e) compatibility with use of message blocks and/or packets; and

f) potential for accommodating unforeseen functions (Chan and Grunstein, 1977).

Note that binary synchronous communication is not capable of full-duplex or ARQ operation.

4. TELECOMMUNICATIONS REQUIREMENTS

4.1 USPS/Communications Carrier Interface

The USPS/communications carrier interface point is at the DTE/DCE physical interface, OSI level 1. The telecommunications carrier, not the USPS, is responsible for supplying and maintaining the modem function at each SPO. The modems may be located on the SPO premises (Figure 4). All termination for proper system operation is required at the telecommunications input port which also may be on SPO premises. Location of the port and modem will influence level 1 interface selection.

It is the customer's option to determine the location of his interface point with the carrier.

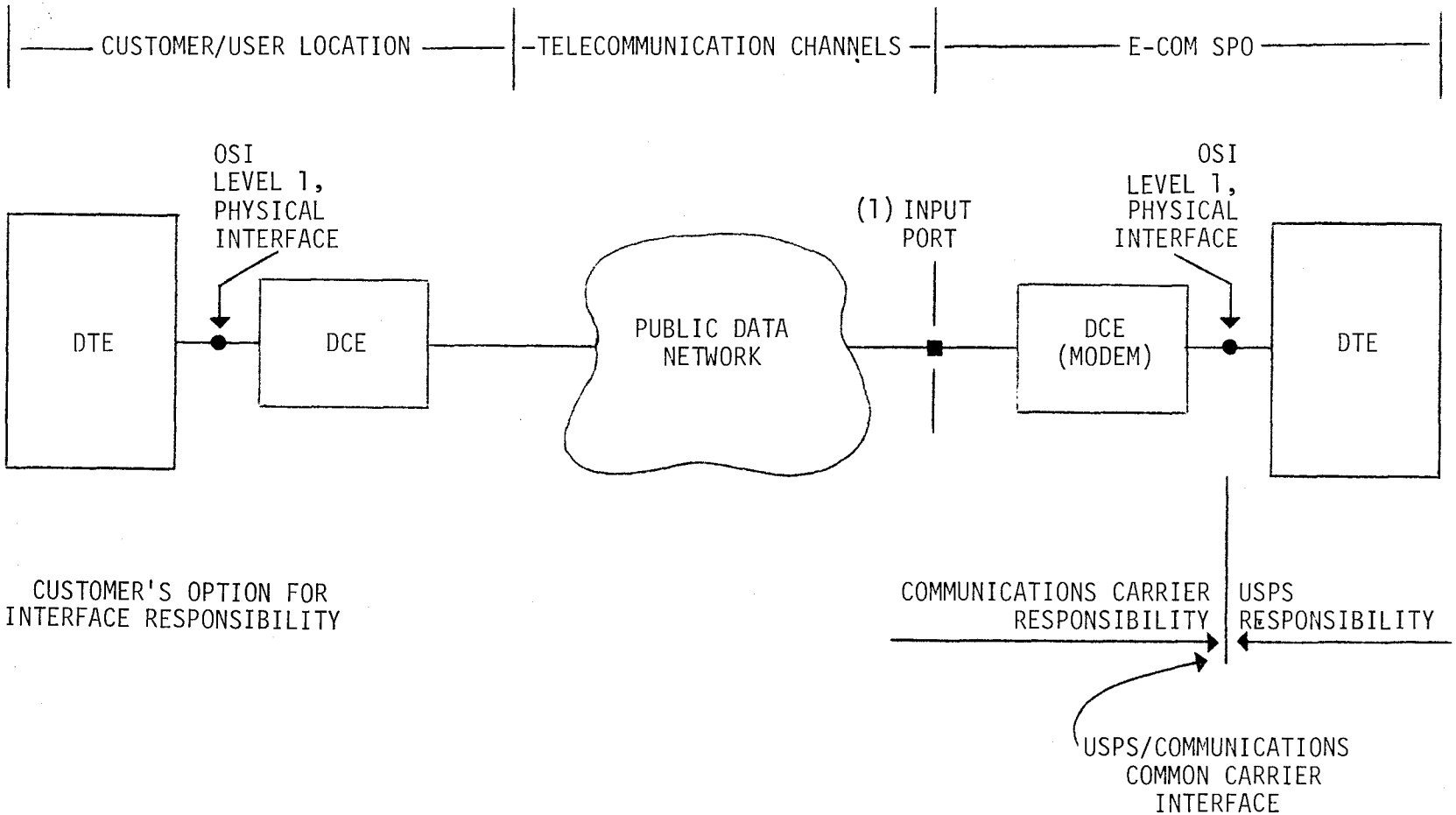
4.2 Required Telecommunication Standards

The E-COM System SOW requires, as a minimum, certain telecommunication standards between the USPS and the communications carrier (Table 4).

First, the input interface shall conform to the Electronic Industries Association (EIA) standards for the physical and electrical interface at level 1. This requires support for RS-232-C and/or RS-449.

Next, the SOW requires support for CCITT Recommendation X.25. CCITT X.25 is an internationally agreed upon packet-switching standard that specifies applicable standards for levels 1, 2, 3, and part of 4. Therefore, support for the CCITT X.21 physical interface is given by implication. Also, support is also given to the ISO 3309 high level data link control (HDLC) protocol at level 2. The packet level is considered to be level 3 and part of 4 (Figure 5). However, the American National Standards Institute is in the process of considering an ANSI version of the CCITT X.25, and an X.21 bis (alternative or second version) option is acceptable. The ANSI version of X.25 will determine one or more standards for the appropriate layers which at the physical layer consists of the following:

- CCITT X.21
- CCITT X.21 bis option equivalent to EIA RS-232-C



NOTE: (1) The SPO input port and modem may, or may not, be on SPO premises.

Figure 4. USPS/communications carrier interface.

Table 4. E-COM Statement of Work Standards Requirements for Telecommunications

Clocking	Asynchronous	Bisynchronous
Codes	ASCII (X3.4) IBM Correspondence ASCII Control Set (X3.28)	ASCII (X3.4) EBCDIC ASCII Control Set (X3.28)
Line Speeds	300-1200 b/s	2400, 4800, 9600 56,000 b/s
Level 1, Physical and Electrical Interface (EIA)	RS-232-C RS-449	RS-232-C RS-449

Support for CCITT Recommendation X.25

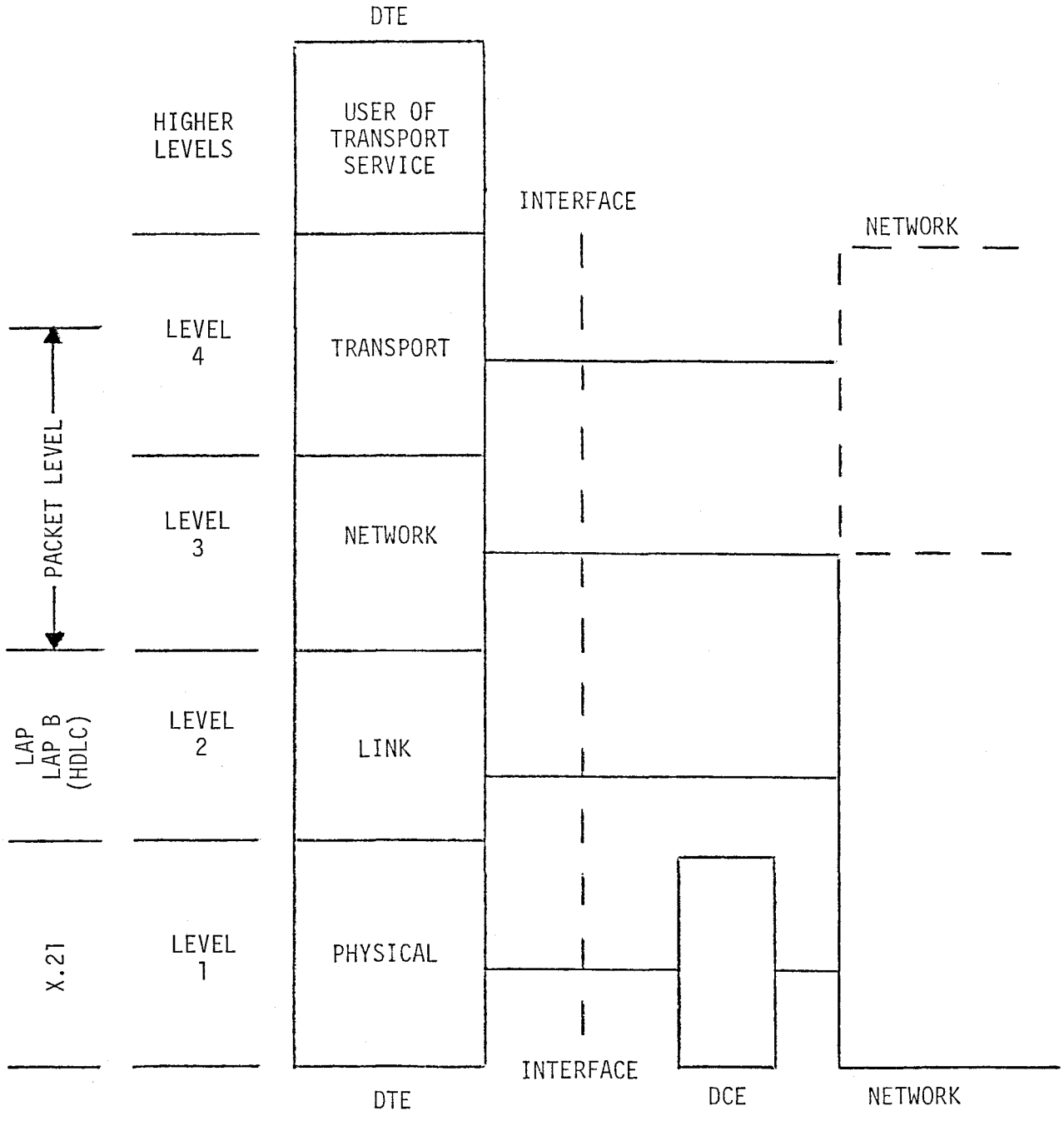


Figure 5. Architecture of interface layers for CCITT Recommendation X.25 relative to the OSI reference model (after Folts, 1980).

- o CCITT X.21 bis option equivalent to EIA RS-449 using only RS-423 unbalanced electrical characteristics.

Networks operating at 56 kb/s data signaling rate shall offer one or more of the following:

- o CCITT X.21
- o CCITT X.21 bis option that specifies CCITT V.35
- o CCITT X.21 bis option that specifies CCITT Recommendation V.36 which is equivalent to EIA RS-449.

The minimum SOW requirements for data communications clocking, codes, and line speeds are readily available and are part of the EIA and ANSI standards (e.g., ANS X3.1 and EIA RS-269-B, Synchronous Signaling Rates for Data Transmission).

4.3 Communications Carrier Systems

Telecommunications inputs to the E-COM System are to be permitted by common and specialized carriers (dial-up based) and value-added networks.

A review of communication offerings from various companies will be made to determine the carrier's interconnection requirements. There are a number of domestic communications carriers which provide service in the United States. The USPS is particularly interested in the following carriers without the exclusion of others: American Satellite Systems Data Exchange (SDX), Western Union (WU), American Telephone and Telegraph (AT&T) common carrier services, General Telephone and Electronics (GTE)/Telenet, Satellite Business Systems (SBS), Tymnet, the Xerox XTEN System and Graphnet.

Common carriers will be contacted as necessary to help determine potential interconnection requirements that may be unique. Identifying the carrier line tariffs is appropriate as part of the guidelines described in this section.

The broadband, high speed, type of local network (e.g., Ethernet) has made its appearance on the data communications scene. The relevance and application of this type of network to the E-COM System must be determined.

4.4 Switching and Communication Choices

Switching methods to be considered are circuit, message, and packet. Each has to be considered on its own merits, but according to the E-COM System SOW requirements, both circuit and packet-switched networks are to be provided as part of the system.

The circuit-switched network permits message input to the E-COM System via dial-up lines over the public telephone system (Figure 6). Switch connections take place at the telephone exchanges, as the number is dialed, to permit a data link connection between the data terminals and the central processing unit. The telephone goes "off-hook" and,

1. the number is dialed;
2. there is a tone response;
3. the activate switch is pushed on the data coupler and the connection is completed and held between the communications line and modem;
4. the telephone is then placed "on-hook"; and
5. a data exchange is started.

Note the application of the OSI model to this example. There is a physical wiring configuration (physical layer) and a procedure for completing the communications circuit (data link layer).

A customer may dial in over public or private line and use an acoustic coupler for connection with a communication channel. This same type of procedure is also used to communicate through a value-added network (VAN). Leased or dedicated lines are also available, if the customer's message volume warrants them (e.g., 56 kb/s).

From this discussion, the communication choices available to the customer are:

a. acoustic couplers over manual dial-up lines (to 1.8 kb/s)
b. asynchronous, low-speed (to 1.8 kb/s), dedicated or dial up
c. synchronous, medium-speed (2.4, 4.8, 9.6 kb/s) dedicated or dial up
d. synchronous, high-speed (56 kb/s), dedicated.

Provision also must be made for automatic answering for all circuits.

These communication choices exist over the public or value-added networks for a customer to be able to input messages to an E-COM system SPO.

A message input communications method which is not required in the E-COM SOW, but is technically feasible, is a direct coaxial cable connection between the customer and USPS compatible data terminal equipment. Use of a cable can permit data rates up to 230.4 kb/s between compatible front-end processors and minicomputers with data communications capabilities. This is another area of these requirements guidelines that will be explored. The use of short-haul modems will be determined within this context.

In contrast to the high speed lines, a least cost communications access method is the use of a push-button telephone for message entry. This would open up the

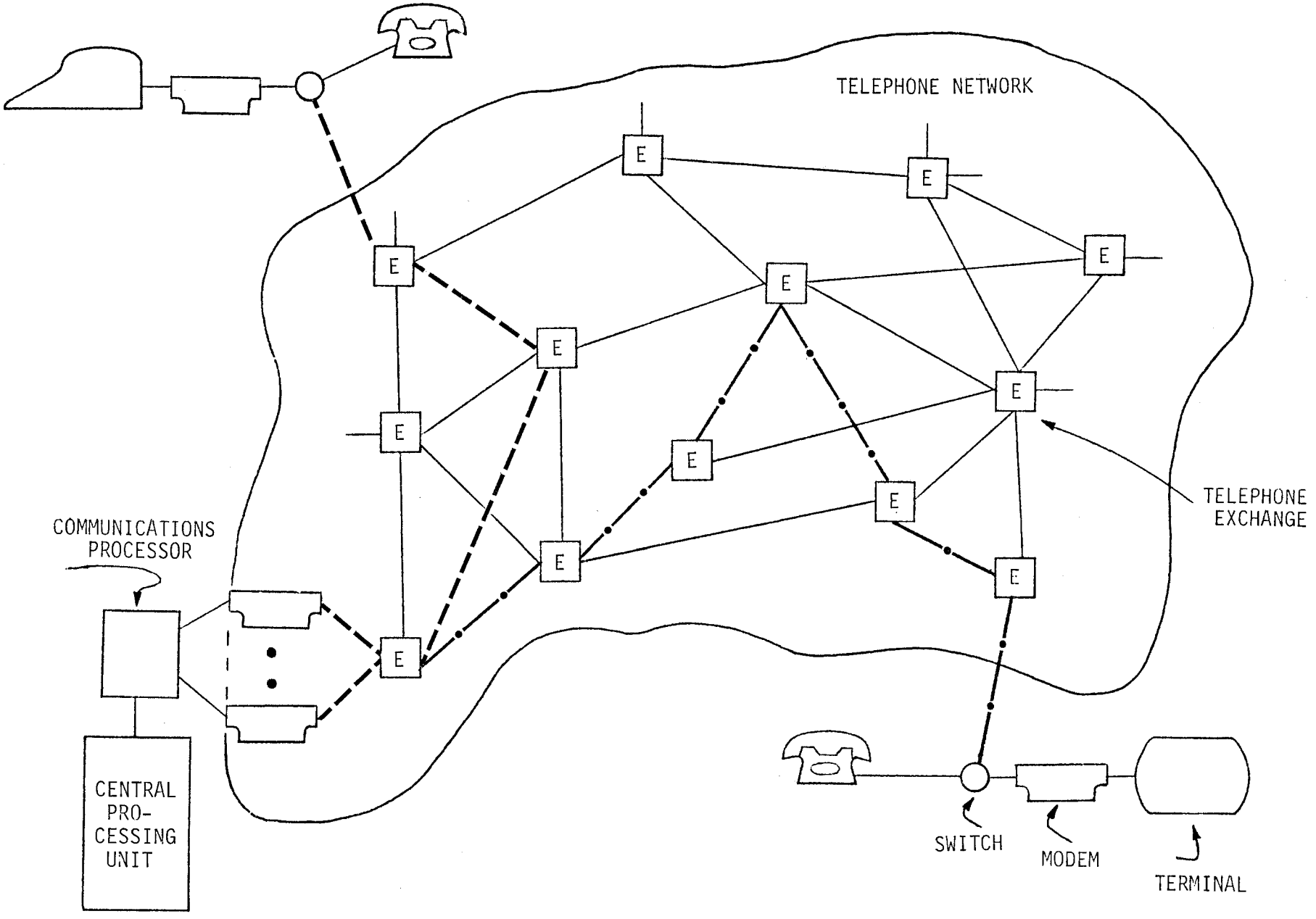


Figure 6. Data links through switched common carrier network.

use of manual data entry to USPS electronic mail systems beyond E-COM. A set of longer range requirements should consider this because it would permit mail entry by the general public, if an acceptable coding scheme is possible with the limited number keys on the telephone. This is not a viable message entry form for the E-COM System because no less than 200 messages can be entered at a time according to the E-COM SOW.

4.5 Connection Method

There are a number of connection choices available to the customer which would have an impact on the E-COM System interconnection modes. The modes are (after Pardoe, 1979):

a) dedicated - lines are always connected,
b) time-slotted - which permits a message input at a fixed time each day (auto-dial and auto-answer),
c) demand - which requires an immediate input of messages at any time,
d) polled - where the E-COM System would inquire whether messages are available for submission, and
e) reservation - which permits the reservation of a time slot depending on daily message input to the E-COM System.

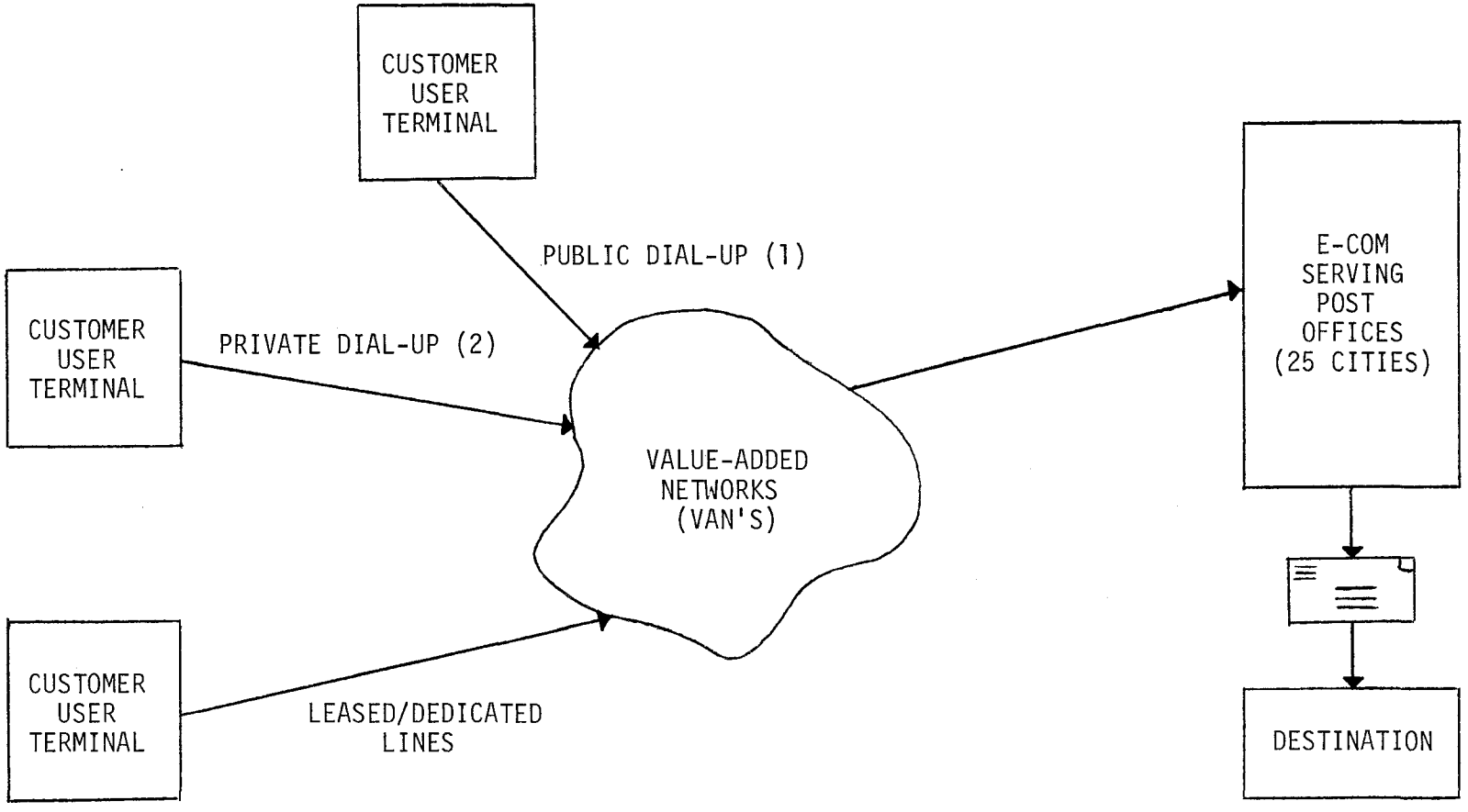
The impact of these connection modes will be considered as part of the development of interconnection methods.

4.6 Mail Privacy

The E-COM System SOW does not require encryption of messages being submitted via telecommunications. A number of security system requirements are listed in the SOW that protect the confidentiality of system files and prevent unauthorized access to and disclosure of customer mail. A message encryption scheme should be recommended for incoming mail for a future electronic mail system.

4.7 Composite E-COM System Configuration

So far, the development of these guidelines has shown a range of parameters to be considered for communication interconnection standards. Consideration of the types of terminal equipment, applicable standards (codes, line speeds, protocols, etc.) will be presented in the following sections. However, it is useful to consider an E-COM System, containing many of the parameters discussed, in a composite configuration (Figure 8).



NOTES:

1. Public Dial-Up input includes the telephone networks.
2. Private Dial-Up input includes the telephone network, WATS, TWX, and foreign exchange (FX) services.

Figure 7. Possible E-COM System using value-added networks.

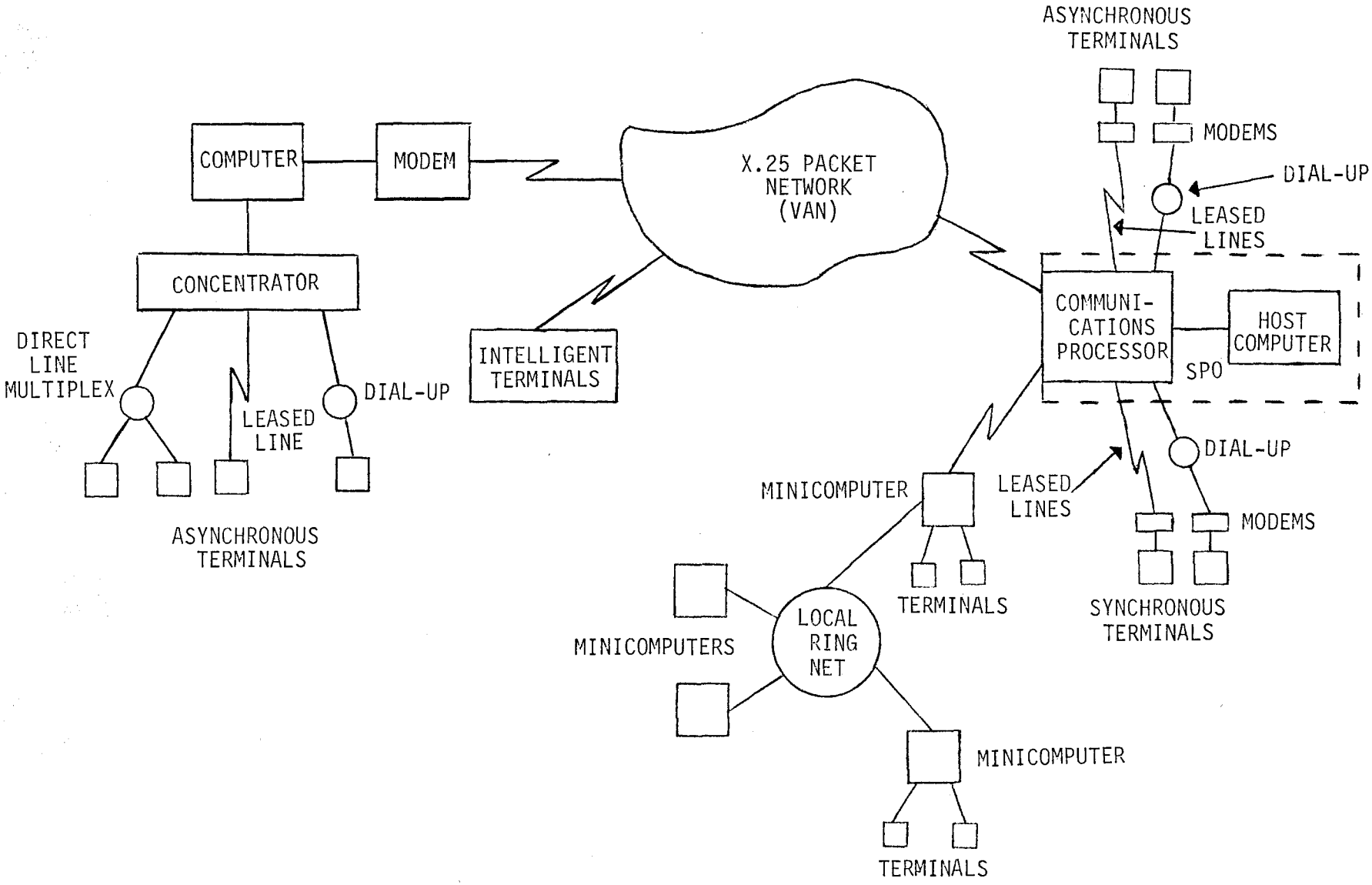


Figure 8. Composite E-COM System configuration.

This E-COM System configuration attempts to show all possible types of customer/user terminal inputs to a SPO over various communication links. The simplified SPO consists of a communications processor and host computer. Shown are inputs over various communications links from customer terminal locations.

The user equipment includes asynchronous and synchronous terminals, minicomputers, modems, and concentrators. Messages are submitted to the SPO input ports via public dial-up lines, private dial-up lines, leased/dedicated lines (leased from common carriers), a packet-switched network, and direct lines. The direct lines were discussed in Section 4.4. A local ring network is shown connected through a minicomputer and leased lines. If the distances were short enough (less than 6 miles), the minicomputers and leased lines could be eliminated and the SPO could become part of a high-speed message transfer ring network. A bus network, such as Ethernet, is not shown, but is a candidate for consideration of possible message input to the SPO.

5. TERMINAL DEVICES AND STANDARDS

Based on the guidelines developed here, equipment characteristics, codes, protocols, line speeds, access arrangements, and compatible communications interfacing equipment (i.e., DCE) that will be used by customers for message input to a SPO will be indicated. Definition of this customer equipment and the other parameters is needed to permit compatibility between the USPS and customer devices.

5.1 Identification of Terminal Equipment

There is a great variety of terminal equipment which may be used by customers of the USPS E-COM System to enter messages. The identification process will give priority to these equipment types most likely to be used, but the identification will not be limited to those types. Sources for this information will include the Booz-Allen and Hamilton reports (1979, 1980a, b) to the USPS and the Datapro series of reports (e.g., Datapro, 1981).

Equipment to be considered as part of these guidelines includes the following:

Keyboard Devices

- alphanumeric display terminals
- teleprinters
- word processors

Computers

- minicomputers
- medium scale computers
- large scale computers.

5.2 Identification of Interface Standards and Protocols

The identification of interface standards and protocols will be according to the OSI reference model and be applied to the equipment identified in Section 5.1. Preference will be given to system-independent protocols and standards in the selection process within constraints stated in Section 3.4.

5.2.1 Physical Layer

Standards for the OSI physical layer are specified by the Electronic Industries Association (EIA), the International Telegraph and Telephone Consultative Committee (CCITT), Federal, and Military Standards. The EIA standards (RS-232-C, RS449) and equivalent Federal Standards will be given priority in the selection of applicable standards for the E-COM System (Table 5). Selection of other appropriate standards depends on the required operating speed between the DTE and DCE.

The 20 milliampere (ma) current loop operating between teleprinters will not be considered because of low operating speed (<300 b/s).

5.2.2 Data Link Layer

There are a number of standards available for the OSI Data Link Layer (Table 5). These are both character- or byte-, and bit-oriented protocols. Table 6 provides a listing of the nomenclature for these protocols. Equivalent standards selection priority will be given to ANSI standards (e.g., ANSI X3.66 (ADCCP)) and to de facto standards (e.g., bisync or SDLC). The wide-spread usage (Booz-Allen, 1980a) of the binary synchronous protocol requires a high priority in its selection for the USPS E-COM System.

Generally, the BDLC, BOLD, CDCCP, HDLC, SDLC, and UDLC protocols are subsets of ADCCP. The CCITT X.25 standard specifies HDLC for its data link layer although the ANSI version of X.25 will probably specify ADCCP.

5.2.2.1 Asynchronous Protocols

Another commonly used communications protocol is the "asynchronous protocol" of the type used by the Teletype 33/35 and IBM 2740 keyboard teleprinter terminals. These particular keyboard terminals operate at 110 b/s and 134.5 b/s, respectively. Many other manufacturers have built devices that emulate the protocol characteristics of these terminals. However, in addition to emulation capability, these newer

Table 5. Partial List of Standards

Physical Layer

A.	Electrical:	EIA RS-422-A, RS-423-A, RS-232-C; CCITT V.10(X.26), V.11(X.27), V.28, X.21 FED-STD. 1020-A, 1030-A MIL STD 188-114
B.	Functional:	EIA RS-449, RS-232-C CCITT V.24, X.21, X.24 FED STD. 1031
C.	Procedural:	EIA RS-449 CCITT X.21/X.25 FED STD. 1040/1041
D.	Mechanical:	EIA RS-449 ISO 2110, 4902, 4903
E.	Maintenance:	EIA RS-449 CCITT V.54, X.101

Data Link Layer

A.	Character-Oriented:	ANSI X3.28 ISO 1745 Bisynchronous DDCMP
B.	Bit-Oriented :	ANSI X3.66(ADCCP) ISO 3309(HDLC), 4335, 6159, 6256 CCITT X.25 (Packet)

Network Layer

A.	Character-Oriented:	ANSI X3.57
B.	Bit-Oriented :	ANSI X3, Project 281 ISO/TC 97/SC 6 Project 24 CCITT X.25

Table 6. Protocol Nomenclature

Asynchronous Character-Oriented

- Teletype
- IBM 2740

Synchronous Character-Oriented

- BSC - Binary Synchronous Communication

Synchronous/Asynchronous Byte-Oriented

- DDCMP - Digital Data Communications Message Protocol

Synchronous Bit-Oriented

- ADCCP (ANSI X3.66) - Advanced Data Communications Control Procedure
- BDLC - Burroughs Data Link Control
- BOLD - NCR Bit-Oriented Data Link Control
- CDCCP - Control Data Communications Control Protocol
- HDLC (ISO 3309) - High Level Data Link Control
- SDLC (IBM) - Synchronous Data Link Control
- UDLC (Sperry Rand) - Univac Data Link Control

terminals are capable of transmission rates of 300 b/s or greater. Terminals with these characteristics will be considered as acceptable for data input to the E-COM System provided the transmission rate is 300 b/s or greater as required by the statement of work.

5.2.3 Codes

Another guideline for terminal device selection is the availability of ASCII and correspondence codes which also are the respective codes for the "terminal-oriented" protocols. EBCDIC is another required code format that is frequently found in bisynchronous terminals.

5.3 Identification of Communications Equipment

Previously, reference was made to the DTE/DCE interface (Section 3.3). The DCE interfaces with the DTE on one side, and with the transmission facilities on the other by converting the data signals to a transmission-compatible form, and vice versa. The communications equipment capable of performing this conversion consists of modems, multiplexers, concentrators, front-end processors, and terminal control units. Each of these devices will be related to the DTE's and to compatible line speeds.

5.4 Identification of Communications Line Speeds

The E-COM SOW has specified a number of line speeds for message input. These are asynchronous at 300-1200 b/s and synchronous at 2400, 4800, 9600 b/s, and 56 kb/s. These operating transmission rates will be identified according to the applicable ANSI (e.g., ANSI X3.1) and other standards, and then related to the terminal and communications equipment.

6. SUMMARY

The guidelines developed in this report are intended to provide an organizational structure which will permit the identification of interconnection standards and methods to the USPS E-COM System. The outline provided here will lead to 1) identification of applicable standards which are available, 2) areas where new standards development may be necessary because of unique requirements, 3) an ANSI applications standard, and 4) a user's guide which will provide information to a customer wishing to connect to the USPS E-COM System. Completion of these items will fulfill the objectives of the Administration Policy Statement and the Resolution of the USPS Board of Governors.

7. ACKNOWLEDGMENT

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APPENDIX A: GUIDELINES USING STRUCTURED DESIGN PRINCIPLES

A.1 Introduction

Any project that must be finished on time and within budget constraints, should have an overall project plan. Developing requirements and guidelines which "ensure that interconnection with the mail delivery system is available to all companies" is no exception. A top-down approach, applying structured design principles was used to develop an overall program plan for telecommunications interconnection with USPS electronic mail systems.

There are basic rules in a top-down project design approach. First, the project plan should be designed starting with the basic or central problem. Then, functional modules that conform to the structure of the problem are added. It is important to specify "what" is to be done within each of the modules, not "how." There can be many different "hows" depending on the individual who is assigned to perform the task.

Next, build outer functional modules and design a structure which supports preceding modules. Specify what is to be done in each succeeding module until a) the complexity of each module is manageable, b) additional modules add little information to the project plan, and c) you are satisfied with the level of detail added by the succeeding module(s).

Functional detail can be developed in a progression of charts. Only one chart is shown in this appendix (Figure A-1). Note that modules have arrows pointing down into them (information/data flowing into the function to be acted upon) and arrows pointing up from them (information/data flowing away from the function as a result of action within the module).

Numbers 2, 3, 4, and 5 are located in four modules. These correlate with sections of this report which were written using Figure A-1 as a guide. The use of this figure will also aid in performing subsequent work.

A.2 Structured Chart

The basic task is to "ensure that interconnection with the mail delivery system is available to all companies." This is stated as, "permit telecommunication interconnection with E-COM System," in the top-most module. Three main branches are connected to this module. They can be described as leading to an input phase (left), collection or verification phase (middle), and output phase (right).

A.2.1 Input Phase

The input phase is the most complex consisting of five branches starting at the third level (module labeled "coordinate input data (ITS, USPS)"). The modules which start these branches are titled,

1. input data from standards organizations and users
2. determine scope of E-COM
3. assemble interface standards
4. identify telecommunication input data and
5. develop requirements guidelines.

Items two, three, and four of this list are decomposed to additional modules with the most complex decomposition being related to item four, as follows.

"Identify telecommunication input data" has two branches leading to modules titled, "identify local telecommunication input lines" and "identify terminal equipment." These two modules are further decomposed adding to further detail in the functional structure.

A.2.2 Verification Phase

The middle branch of this structure consists of collecting the data gathered in the first phase and verifying the accuracy and appropriateness of the interface standards, protocols, and equipment.

A.2.3 Output Phase

The branch on the right side of the figure (output phase) consists of report writing and publication. An added detail feature could have been to add that these output reports could be ANSI standards, or a USPS user's guide for customers.

A.3 Conclusion

Use of a structured design approach to organizing a detailed, many-faceted problem permits an orderly approach to the effort. Although the structure may not be exhaustive in detail, it acts as a check list and permits a macroscopic view of the problem.

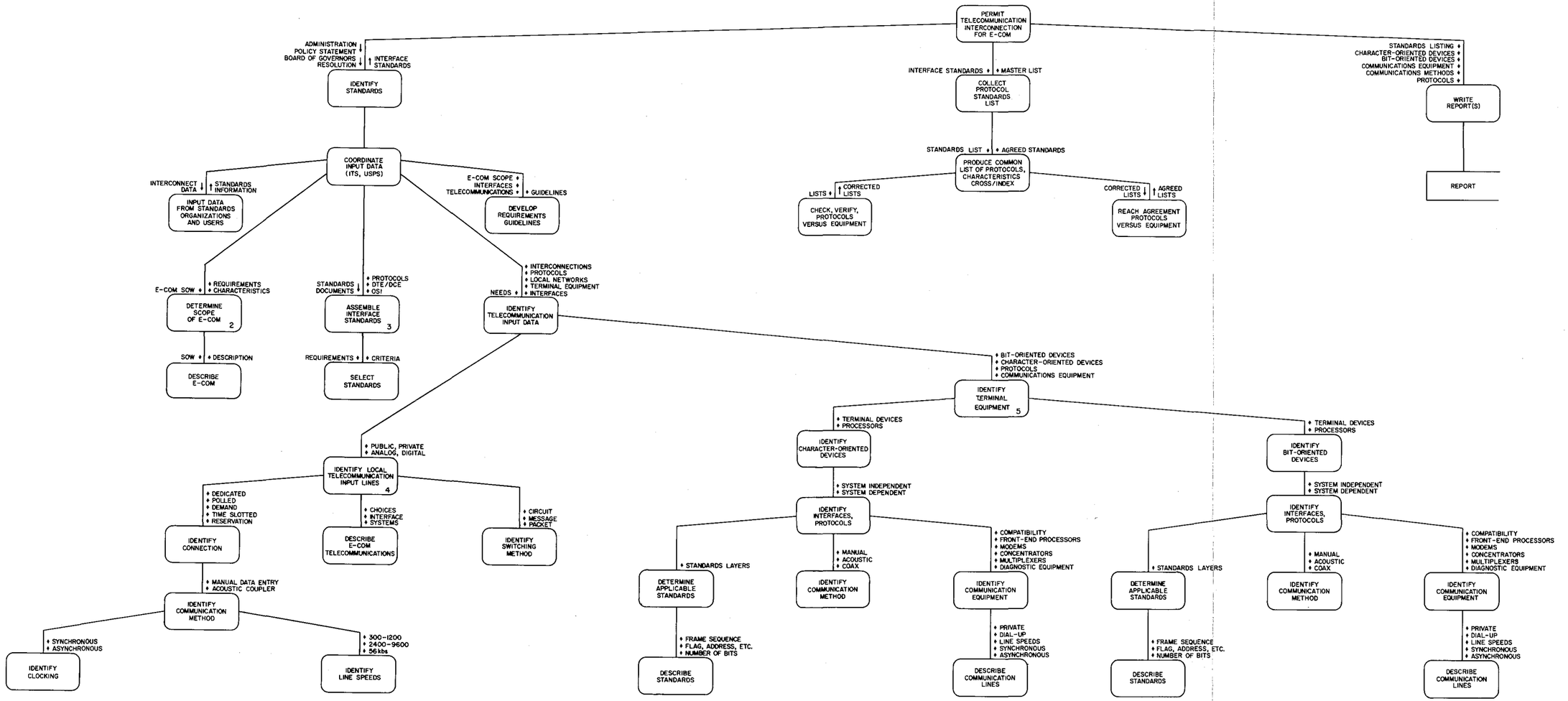

Figure A-1. Guidelines using structured design principles.

APPENDIX B: LISTING OF E-COM CITIES WITH SERVING POST OFFICES

1. Atlanta, GA
2. Boston, MA
3. Charlotte, NC
4. Chicago, IL
5. Cincinnati, OH
6. Dallas, TX
7. Denver, CO
8. Detroit, MI
9. Kansas City, MO
10. Los Angeles, CA
11. Milwaukee, WI
12. Minneapolis, MN
13. Nashville, TN
14. New Orleans, LA
15. New York, NY
16. Philadelphia, PA
17. Phoenix, AZ
18. Pittsburgh, PA
19. Richmond, VA
20. San Antonio, TX
21. San Francisco, CA
22. Seattle, WA
23. St. Louis, MO
24. Orlando, FL
25. Washington, DC

APPENDIX C: E-COM SYSTEM STATEMENT OF WORK MAGNETIC TAPE GUIDELINES

The SOW has identified applicable standards for magnetic tape characteristics and message formats which are to be used as guidelines for message input to the E-COM System. The standards are for the media, recording techniques, data formats, codes, and character sets.

The applicable documents are identified as follows in Appendix E of the SOW.

a) American National Standard Unrecorded Magnetic Tape for Information Interchange (9-track 200 and 800 CPI, NRZI, and 1600 CPI, PE), X3.40-1973.

b) American National Standard Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI), X3.22-1973.

c) American National Standard Recorded Magnetic Tape for Information Interchange (1600 CPI, PE) X3.39-1973.

d) American National Standard Magnetic Tape Labels for Information, Interchange, X3.27-1969.

e) American National Standard Code for Information Interchange, X3.4-1977.

The E-COM System will accept 9-track tapes recorded only at 800 and 1600 characters per inch (CPI).

Detailed instructions for two categories are given in the SOW. These are for magnetic media recording formats and data record structures for the three types of letters that may be submitted to the E-COM System. The three message types are:

1. Single address messages (SAM's);
2. Multi-address message with a common text (COT's); and
3. Multi-address with a common text message into which variable data can be added (Text Insert Messages, TIM's).

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Guidelines for interconnection to the United States Postal Service (USPS) Electronic Computer Originated Mail (E-COM) System via telecommunications carriers are developed. A description of the E-COM System is given and the need for telecommunications standards for accessing the E-COM System is provided.

16. Key Words *(Alphabetical order, separated by semicolons)*

Electronic Computer Originated Mail (E-COM) System; interface standards; Open Systems Interconnection (OSI); protocols; telecommunication standards; United States Postal Service (USPS)

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