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Need for Telecommunication Standards for Interconnection with the U.S. Postal Service EMSS

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U.S. DEPARTMENT OF COMMERCE
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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 Mail Service System (EMSS). 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earth-space attenuation predictions, accuracy-cost studies, and electronic message service concepts and candidates (in unpublished form).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 authors 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.

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LIST OF ABBREVIATIONS

ANSI - American National Standards Institute

CCITT - International Telegraph and Telephone Consultative Committee

DSN - Distributed System Network

EIA - Electronic Industries Association

EMS - Electronic Mail Systems

EMSS - Electronic Mail Service System

HP - Hewlett-Packard

IBM - International Business Machines, Incorporated

NAU - Network Addressable Unit

OSI - Open System Interconnection

SNA - System Network Architecture

NEED FOR TELECOMMUNICATION STANDARDS FOR INTERCONNECTION WITH THE U.S. POSTAL SERVICE EMSS

D.V. Glen and R.E. Thompson*

This report describes the effort which will be undertaken to determine telecommunication standards necessary for interconnection to the United States Postal Service (USPS) planned long-range Electronic Mail Service System (EMSS). This work is in compliance with an Administration Policy Statement which requires that organizations desiring to input messages into a future USPS EMSS via telecommunications means can do so if the interconnection standards are satisfied.

Key Words: communication protocols; Electronic Mail Service System (EMSS); telecommunication standards; United States Postal Service (USPS)

1. INTRODUCTION

1.1 Background

The United States Postal Service (USPS) has been investigating the feasibility of using technological advances to improve postal operations; electronic mail is one of the most promising opportunities for the application of these new technologies. Long-range planning studies have identified a need to develop technical standards which would apply between the message originator, the telecommunication common carriers and the USPS Electronic Mail Systems. These long range planning studies have focused on the system configurations and possible services which might be considered for a USPS Electronic Mail Service System (EMSS).

This report is intended to give a general overview of possible EMSS services and the functional relationships to system configurations, interfaces, and interconnection standards.

A Presidential Administration Policy Statement (July 19, 1979) established administration guidelines for the USPS role in electronic mail. Support was given for new services proposed by the USPS, which will use long-distance telecommunications systems to feed messages into the normal mailstream for delivery by postal carriers. However, the USPS does not plan to offer services which would enable message delivery via telecommunications to the customer.

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The Administration guidance consists of conditions for fairness between the USPS and telecommunications common carriers. Conditions relevant to this report are:

- The USPS should purchase electronic transmission services from carriers rather than build a transmission network.
- 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 USPS has studied an Electronic Mail Service System (EMSS) which is consistent with these conditions. The system concepts allow for acceptance of hard copy, magnetic recordings and electronic inputs; transmission of messages in electronic form among EMSS stations; performance of routing and sorting functions; and production of hard copy for physical delivery by USPS mail carriers.

This report specifically responds to the need for technical interface standards based on an interconnection policy to insure input interface requirements and to permit unrestricted access via telecommunications to the USPS.

1.2 Purpose and Scope

The purpose of this report is to give an overview for the development of standards to ensure that organizations can interface with the planned mail delivery system through the telecommunications common carriers. This interface is to be available to all organizations through a cooperative effort with the American National Standards Institute, the private carriers, and the USPS, with assistance from the National Telecommunications and Information Administration, Institute for Telecommunication Sciences (NTIA/ITS) and the National Communications System (NCS).

The interface standards will need to be considered within the seven-layer structure of the International Organization for Standardization (ISO) reference model for Open System Interconnection (OSI). The layers are: 1. Physical Link, 2. Data Link, 3. Network, 4. Transport, 5. Session, 6. Presentation, and 7. Application. Provisions within the model include requirements for address fields, billing, printing instructions, return-to-sender, message nonacceptance, and additional general information that may be required. Other aspects of the standards requirements consider the applicability of coding (ASCII, EBCDIC) clocking (synchronous, asynchronous) and the need for character and bit-oriented interface standards.

Some layers may not be necessary. It is also recognized that standards already exist for some of the layers listed above. It is necessary to determine the appropriateness of those interface standards and whether they are sufficient to meet the requirements of the USPS for an Electronic Message Service System.

This report was prepared prior to the decision by the U.S. Postal Service Board of Governors (August 15, 1980) to allow the prompt entry of the United States Postal Service into the field of electronic mail with the implementation of the Electronic Computer Originated Mail system (E-COM). Consequently, the approach and discussions presented in this report should be considered as not necessarily applicable to E-COM.

1.3 Organization of this Report

The following sections describe the initial considerations related to the interface requirements for interconnection with the EMSS. Section 2 deals with interface requirements at EMSS stations, customer terminals, and local telecommunications networks. Section 3 considers the terminology used at various layers, their purposes, application, and some of the standards that are available. Section 4 is a summary.

2. INTERFACES OF THE USPS EMSS

2.1 EMSS Stations

For purposes of discussion the EMSS will contain operational centers called EMSS stations. The locations of EMSS stations can be dispersed, perhaps in accordance with the USPS Origination Destination Information System (ODIS) city mail volumes, business/population trends in urban areas, growth, or economic projections for EMSS. The number and types of EMSS stations may vary with time. EMSS stations will be engineered to serve the traffic, and to correspond to EMSS markets, applications, and services.

Physically, the EMSS station facility can be either separate or combined with an existing USPS station. In the first case, the EMSS station is housed in its own building(s). In the second case, the EMSS station is collocated with a USPS station in an already existing, or specially constructed USPS complex.

The EMSS station concept as an EMSS element is illustrated in Figure 1. The presence of several USPS stations displays the separate and collocated options for

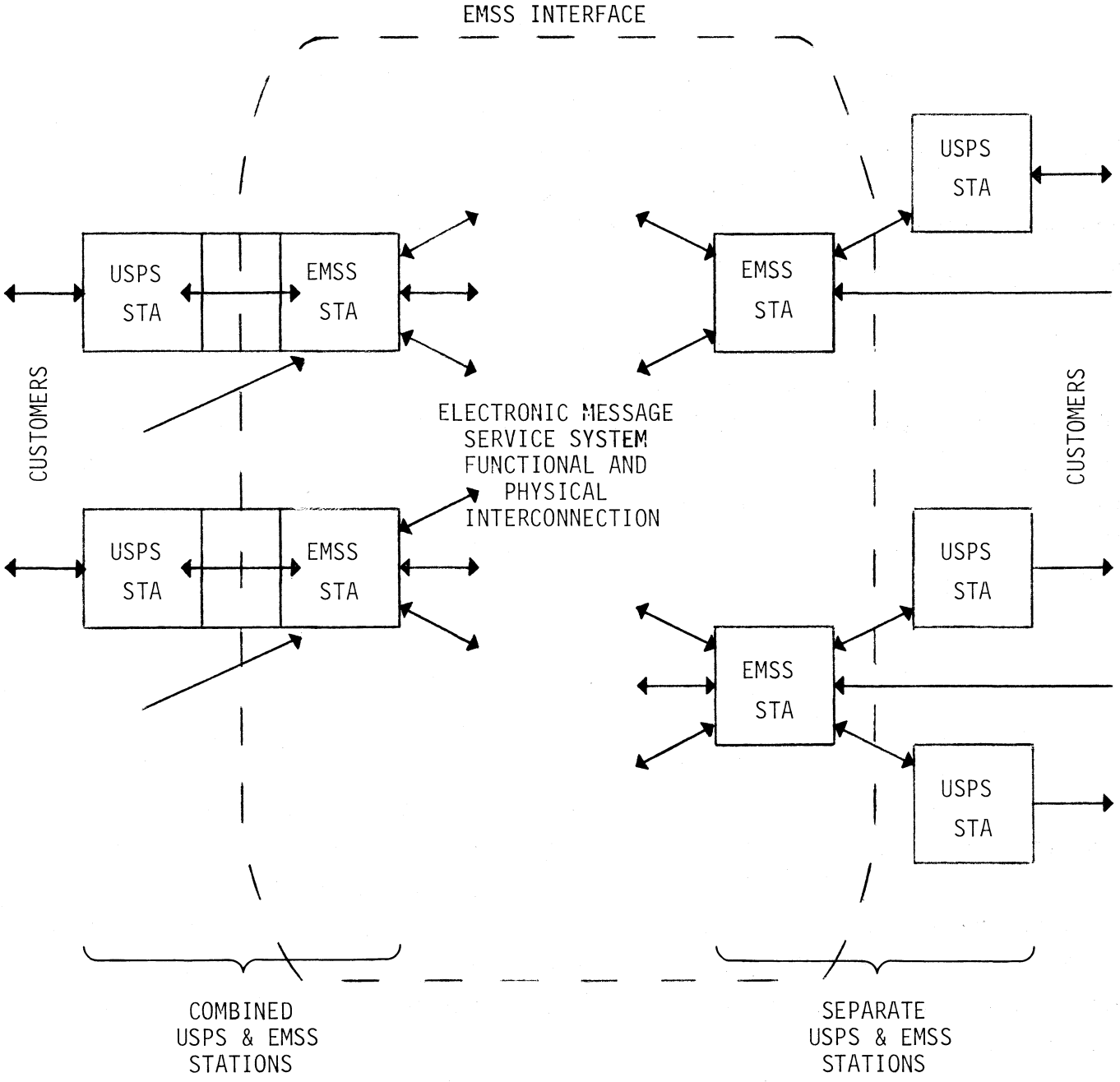

Figure 1. EMSS stations as part of an EMSS.

the two station types. The EMSS stations, by definition, are always part of the EMSS. Equivalently, the EMSS stations are said to be inside the EMSS interfaces.

The definition of EMSS interfaces is needed at all stations, even if the boundary may seem arbitrary in certain instances. Such a situation occurs when the EMSS station is collocated with an existing USPS facility.

The arrows of Figure 1 indicate message flow and the various interfaces involved. For instance, the arrows from customers to the USPS traverse a customer/USPS interface, the flow between USPS and EMSS stations crosses the USPS/EMSS interface, and so on.

Through EMSS stations, the EMSS receives its input messages from customers. Likewise, EMSS stations are instrumental in delivering physical outputs to customers outside the system. To reach the final output station specified on an address, a message may be handed from one station to another. This transfer would take place through intermediate EMSS stations.

The information medium (e.g., paper, magnetic tape, telecommunications, etc.) used for an individual message will vary as the message is transferred from the customer interface through the EMSS trunk network to the final output. Thus a magnetic tape input in a specific format will be transformed into an electronic data stream for transmission over local and trunk EMSS circuits as well as for the trunk networks. A printed, folded, final hard copy will be delivered. The conversion processes that transform the message from copy to data stream and back again are all part of the EMSS station functions.

Figure 2 amplifies the illustration of message flow at an EMSS station. The EMSS station interfaces serve as standard functional gateways for all of the EMSS traffic. Note that both separate and combined locations are permitted for the EMSS station and the USPS station. Proximity of stations need not modify the basic functional roles of the EMSS station interfaces.

In Figure 2, the station interfaces via local telecommunication lines (i.e., the local network) with USPS-owned public and user-owned terminals. Also, the EMSS station must interface with the trunk network to address other EMSS stations.

The USPS station of Figure 2 provides lobby, window, or counter services to those customers who either deliver or pick up their EMSS messages in person. The EMSS station may, as mentioned earlier, have to provide an interface with an existing USPS station.

The user and public terminals, which provide electronic message inputs to the EMSS stations via the local telecommunications lines, are essentially message

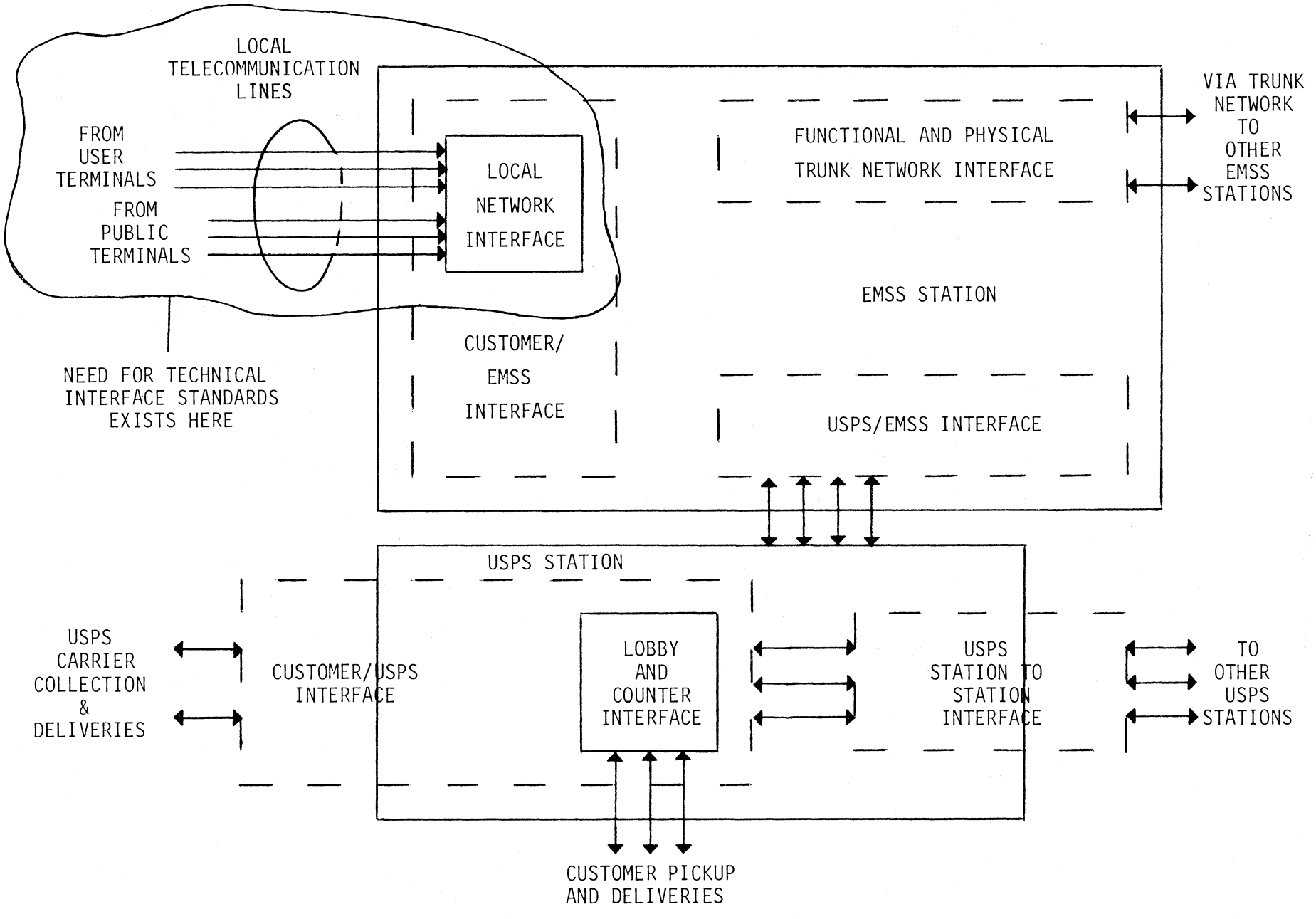

Figure 2. EMSS station interfaces.

media conversion locations. The messages which may be on magnetic or paper media, generated on a keyboard, or stored in a computer memory file can be converted into bit streams for transmission to the EMSS station. The primary differences between the user and public terminals are:

1. the user terminal is company-owned and accessible only to employees at a plant location, while,
2. the public-terminals are USPS-owned and accessible to the general public.

The following sections deal with the electronic interface requirements between public terminals, user terminals, and EMSS stations via local telecommunication networks. This is the area in which technical standards for interface and interconnection are required.

2.2 Interconnection of Terminals with Stations

The local telecommunications network can interconnect public or user terminals to the nearest EMSS station. At the public terminal (PT), a local network-PT interface defines the physical boundary between the public terminal facility and the local telecommunications network (Figure 3). Also, the user terminal (UT) is distinguished from the local network by the local network-UT interface. As shown in Figure 3, the public and user terminals have similar message traffic flows. Both types of terminals can only transmit messages. This is indicated by the direction of the arrows between terminals and stations. However, information concerning message and communication-line control and status can be received at the terminals. Each station collects the messages of its local subnetwork through the local network-station interface.

The local network can provide interconnection with distant EMSS stations via the intercity networks of telecommunication common carriers (Figure 4). Messages generated at user and public terminals have EMSS stations as their destination although public terminals could be collocated at the EMSS stations. EMSS mail cannot be transmitted to user or public terminals (Presidential Administration policy statement on electronic mail (July 19, 1979)). The letter carrier delivers the mail.

The EMSS station processes are made compatible with the local telecommunications network processes (e.g., data rates, formats, timing, signaling, multiple access and other protocols) as the message is passed through the local network-station interface. A similar compatibility is required between the terminal's message generation and the local network telecommunications processes.

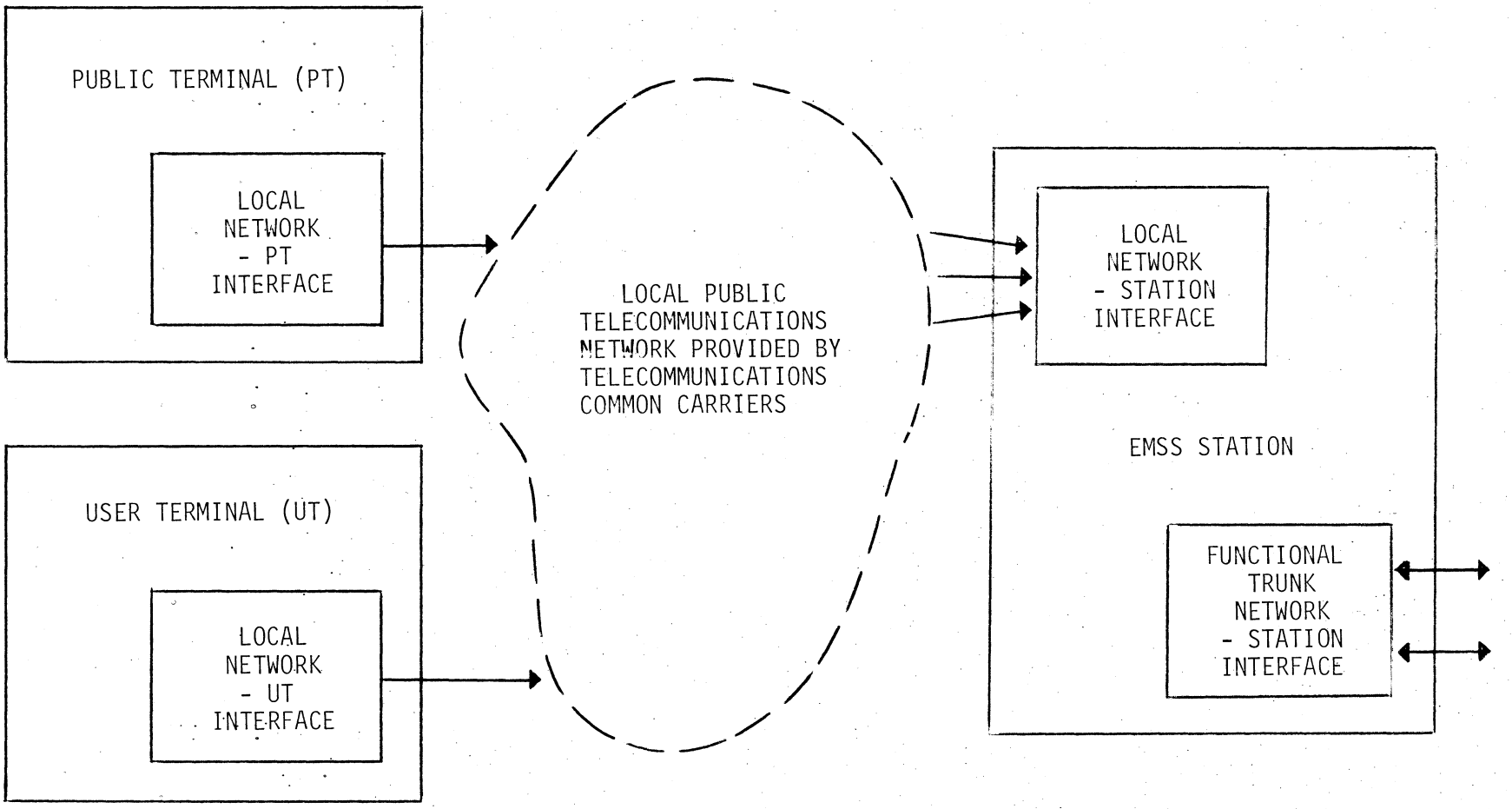

Figure 3. Interfaces of an EMSS local telecommunications network.

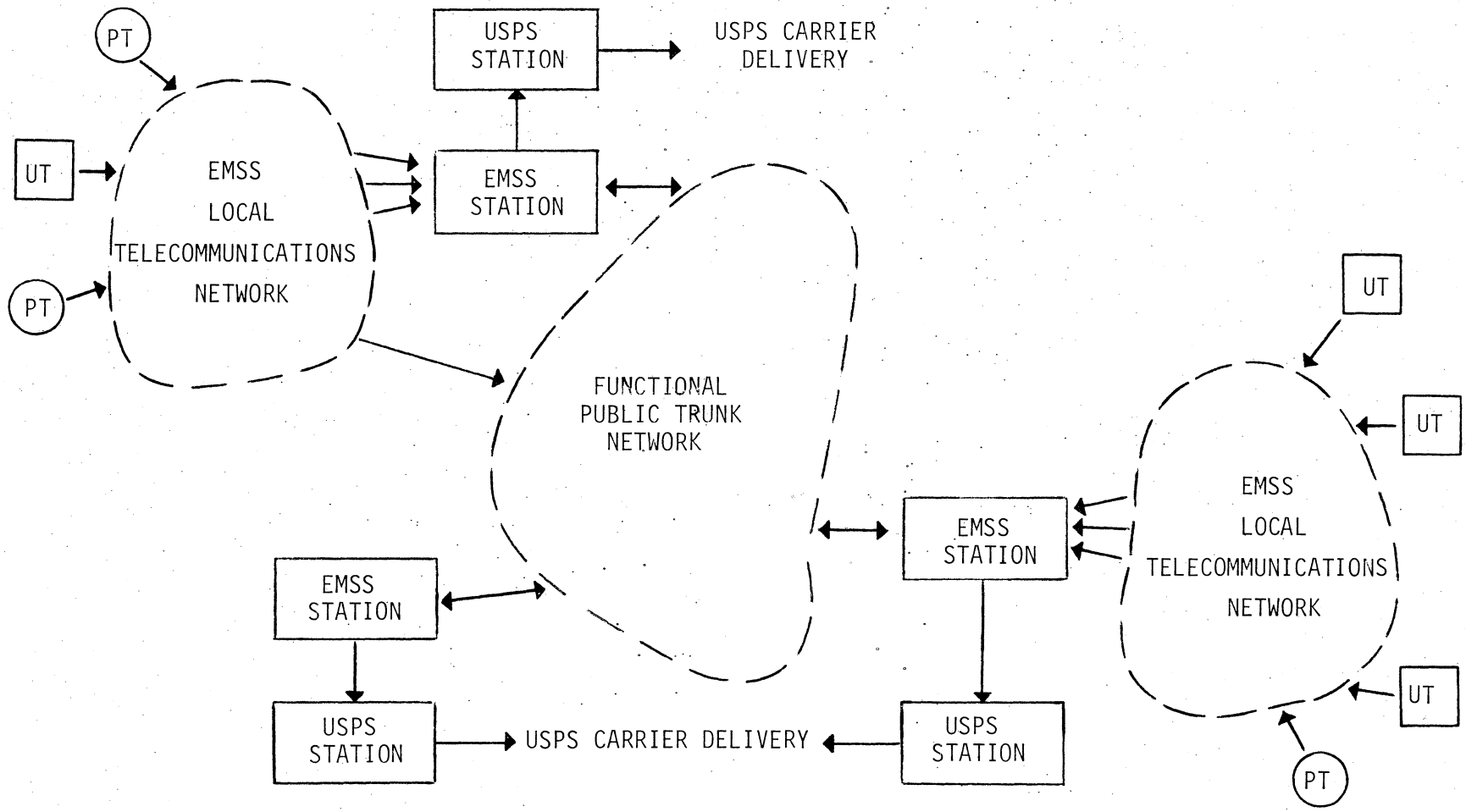

Figure 4. Local and trunk telecommunications with public terminals (PT), user terminals (UT), and EMSS stations.

2.3 Public and User Terminals

There are two types of terminals envisioned for the EMSS: public and user.

The public terminals will be located at USPS facilities such as post offices and EMSS stations. The services of public terminals (PT) will be available to all of the paying public. The user terminals will be located on customer premises, thus accessible to authorized personnel of the customer organization.

The public terminal interacts only with the EMSS local telecommunications network at the local network-PT interface (Figure 5). A similar local network-UT interface separates the user terminal from the local telecommunications network (Figure 6). Both of these situations assume remote locations of the terminals, in which case the required communications protocols may be similar. If a public terminal is collocated at the EMSS station, a local telecommunication network is not necessary, and a different or reduced set of protocols may be required across the PT-hardwired communications interface.

The only customer interaction at the public terminal will be either self-service or through a postal clerk at a USPS station or an EMSS station. In the initial phases of EMSS inception, the public will not interact directly with public terminal equipment, although this may occur later. Initially, all operation of equipment at a public terminal will be by trained USPS personnel.

Provisions at the PT will include address entry through a keyboard, message media conversion, storage, and terminal controls. Payment will be through clerks, and return of materials (such as magnetic tape) will be accomplished by standard USPS procedures. Using this approach, a standard set of message protocols for message transmission from public terminal to station can be invoked by the USPS.

However, if the public is eventually permitted to interface directly with an equipment console at a public terminal, additional interface standards may be needed. If so, the protocol standards to be considered would have to encompass keyboard addressing, paper or magnetic tape conversion, process and flow controls, acknowledgement of payment in the proper amount (whether by cash or credit), security, and provision for message storage for transmission to an EMSS station (Figure 7). The necessary entry and conversion equipment may be owned or leased by the USPS while the transmission lines will be leased from the common carriers.

In contrast to public terminals, the users are assumed to own and operate their own terminal equipment such as control consoles, message processing equipment, memory storage facilities, media conversion systems, and compatible user data units. It is also assumed users can lease or own message transmission lines (Figure 8). This figure illustrates the role of the local network-user terminal interface.

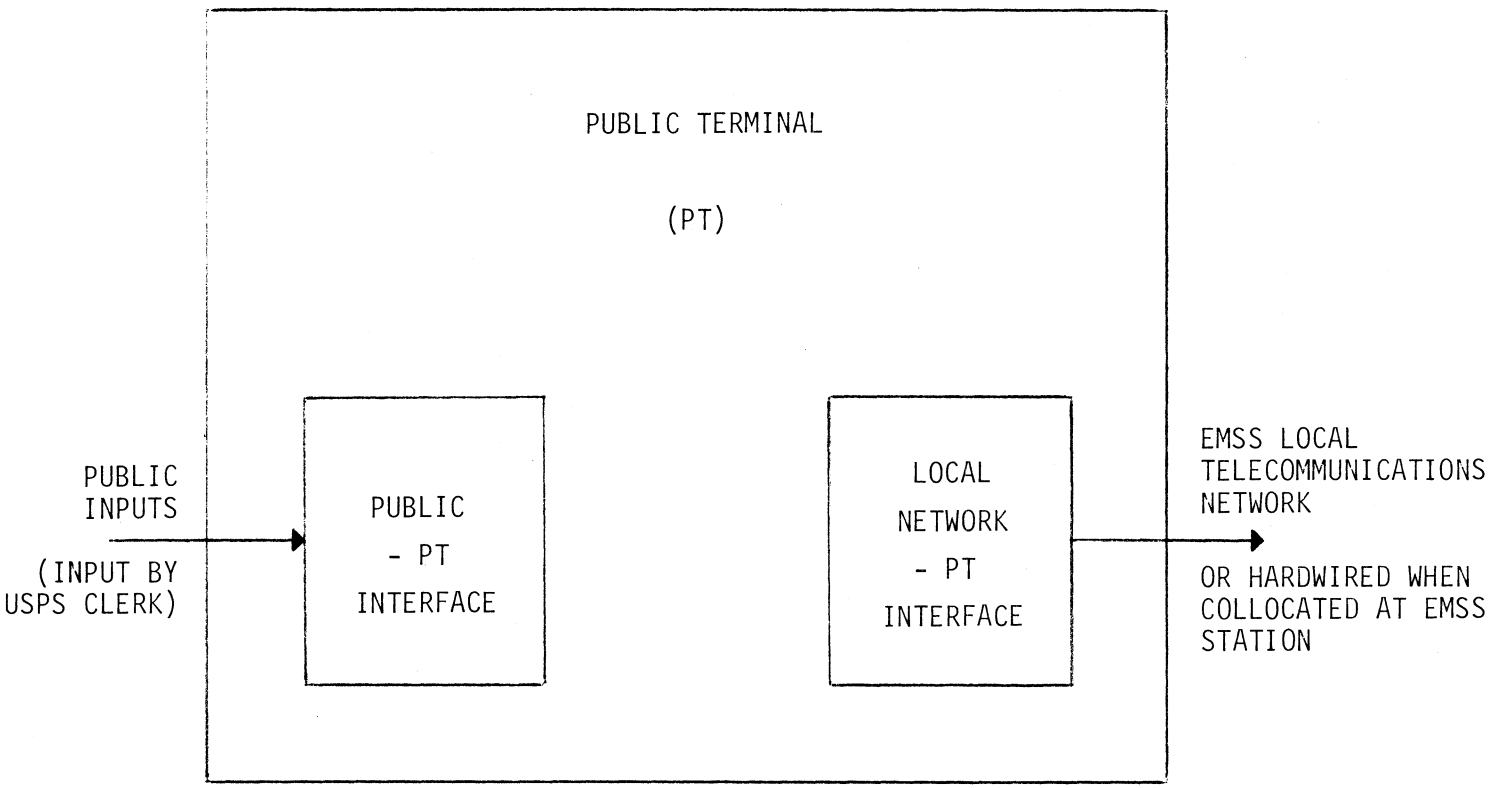

Figure 5. The EMSS public terminal and its interfaces.

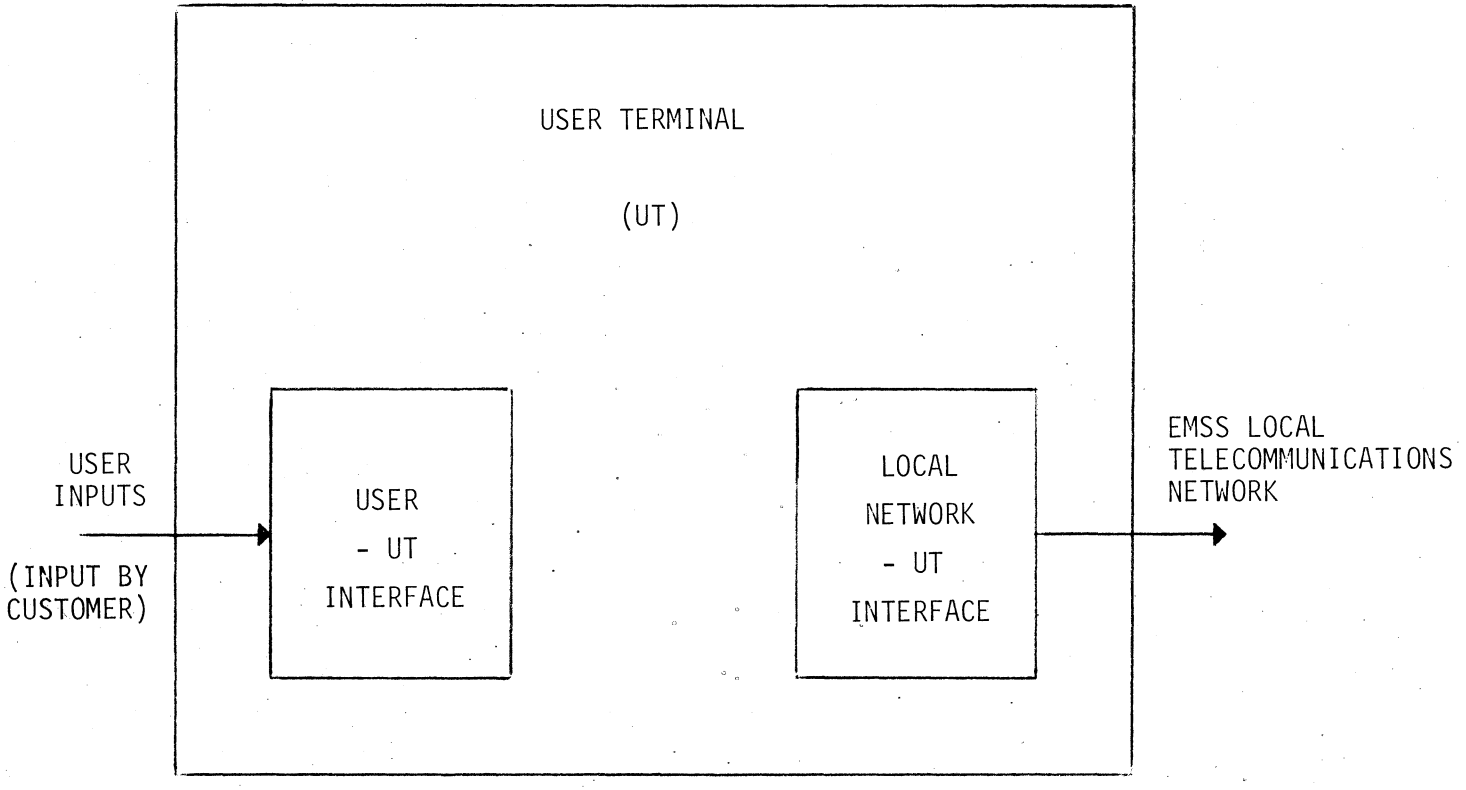

Figure 6. The EMSS user terminal and its interfaces.

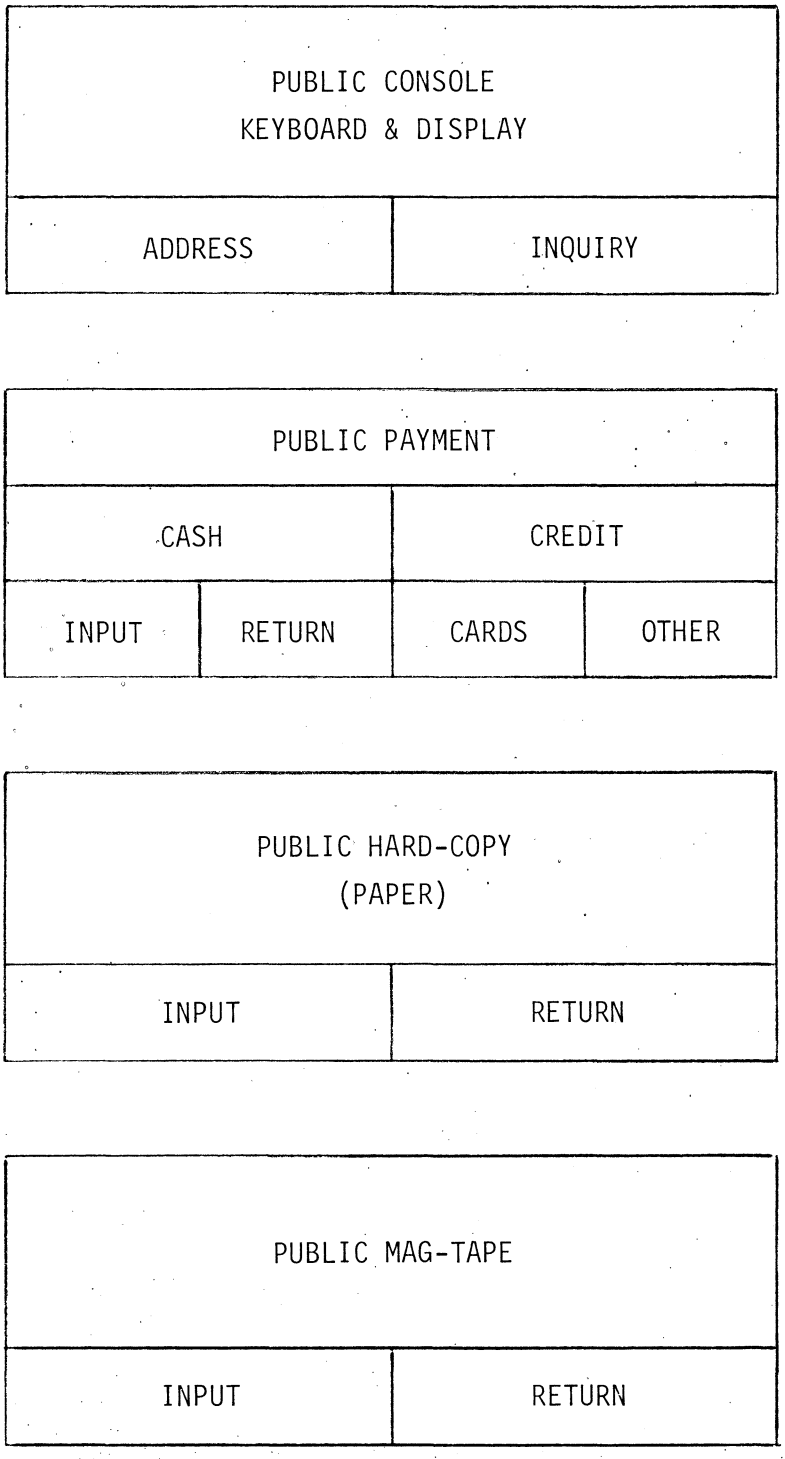

Figure 7. Potential elements of the public-PT interface.

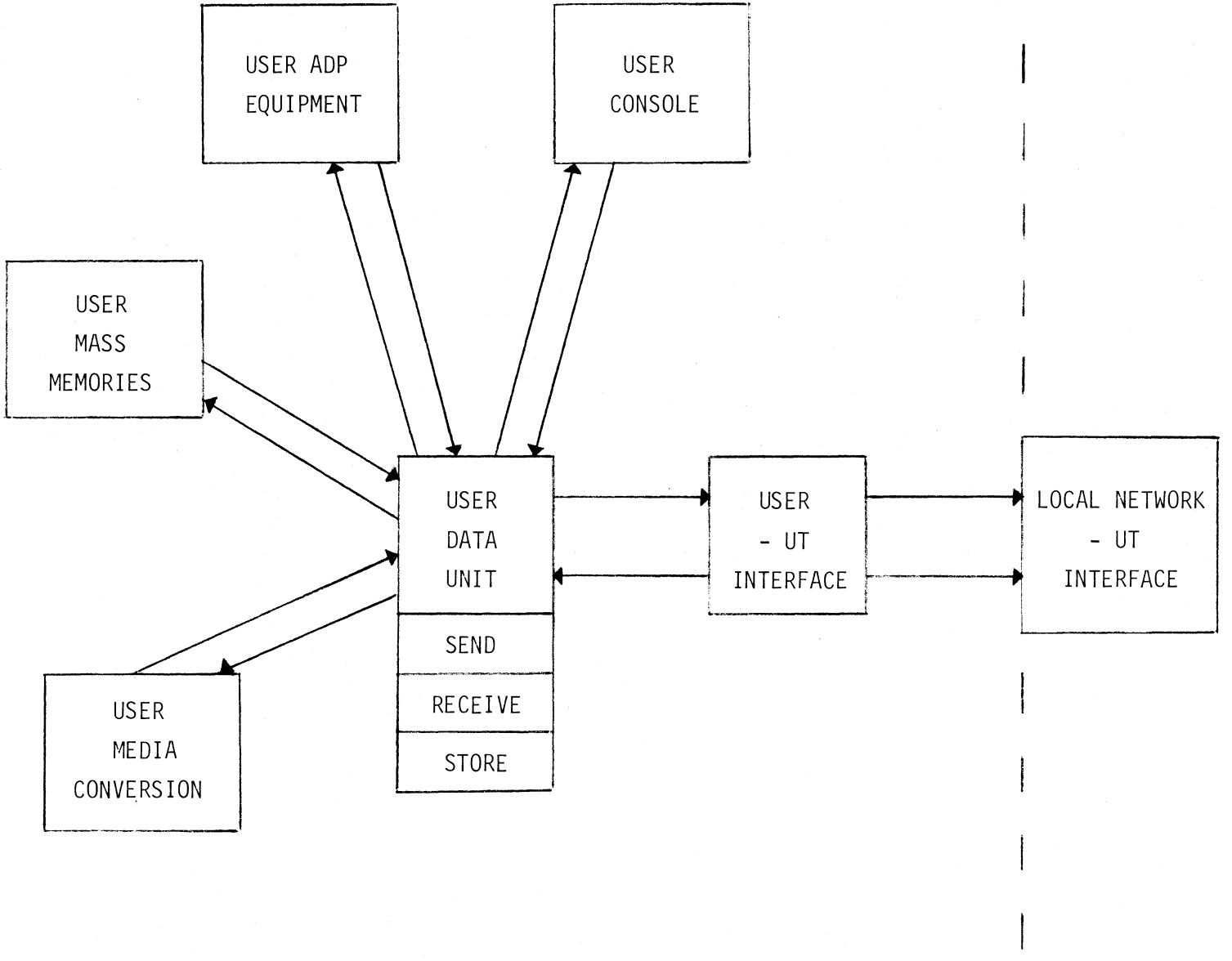

Figure 8. Local network interface with user-owned and operated equipment.

Protocol and interface standards need to be determined for public and user terminals to bridge the PT, UT, and local telecommunication interfaces to the stations.

2.4 Local Telecommunications Network

Local networks are expected to be leased by the USPS from communications carriers and owned or leased by USPS customers. The lease arrangements can cover local telecommunications links (also known as station lines or local loops), switching services, concentration and multiplexing equipment, data sets or modems, line conditioners, plus other required elements.

The contracted services can be either private line (also called dedicated, nonswitched, or full-time) or measured use (dial-up or switched) services. This common line and terminal separation can be applied to both public and user terminals (Figure 9).

The local subnetwork is assumed to be configured with terrestrial lines. In addition to wire lines, coaxial cables, and other terrestrial transmission paths, the EMSS local networks may contain multiplexers, concentrators, various space-division (SD) or time-division (TD) switches, and other required control and signal processing equipment.

Individual local networks are expected to be relatively small with simple structures. Figure 9 suggests a star topology with the EMSS station as the center of the star. The star topology will probably be preferred. Other topologies and control techniques are possible and, if practical, should be considered in developing standards.

Figure 10 shows a multipoint or multidrop line that serves a group of public terminals. Bridge taps connect individual PT's to the line. A sequential polling technique is used to control the multiple terminal access to the station.

2.5 Message Media Input/Output

For the initial EMSS, the messages would be input to the system via two modes, customer-prepared media and local network telecommunications (Figure 11). The message output would be in paper hard copy only for either type of input.

Customer-prepared media for input would be acceptable in the form of magnetic tape, diskette, and paper hard copy. These media would be picked up by USPS carrier or delivered by the customer to a USPS facility (Figure 2). The messages on these media are to be converted to electronic form at the EMSS facilities for

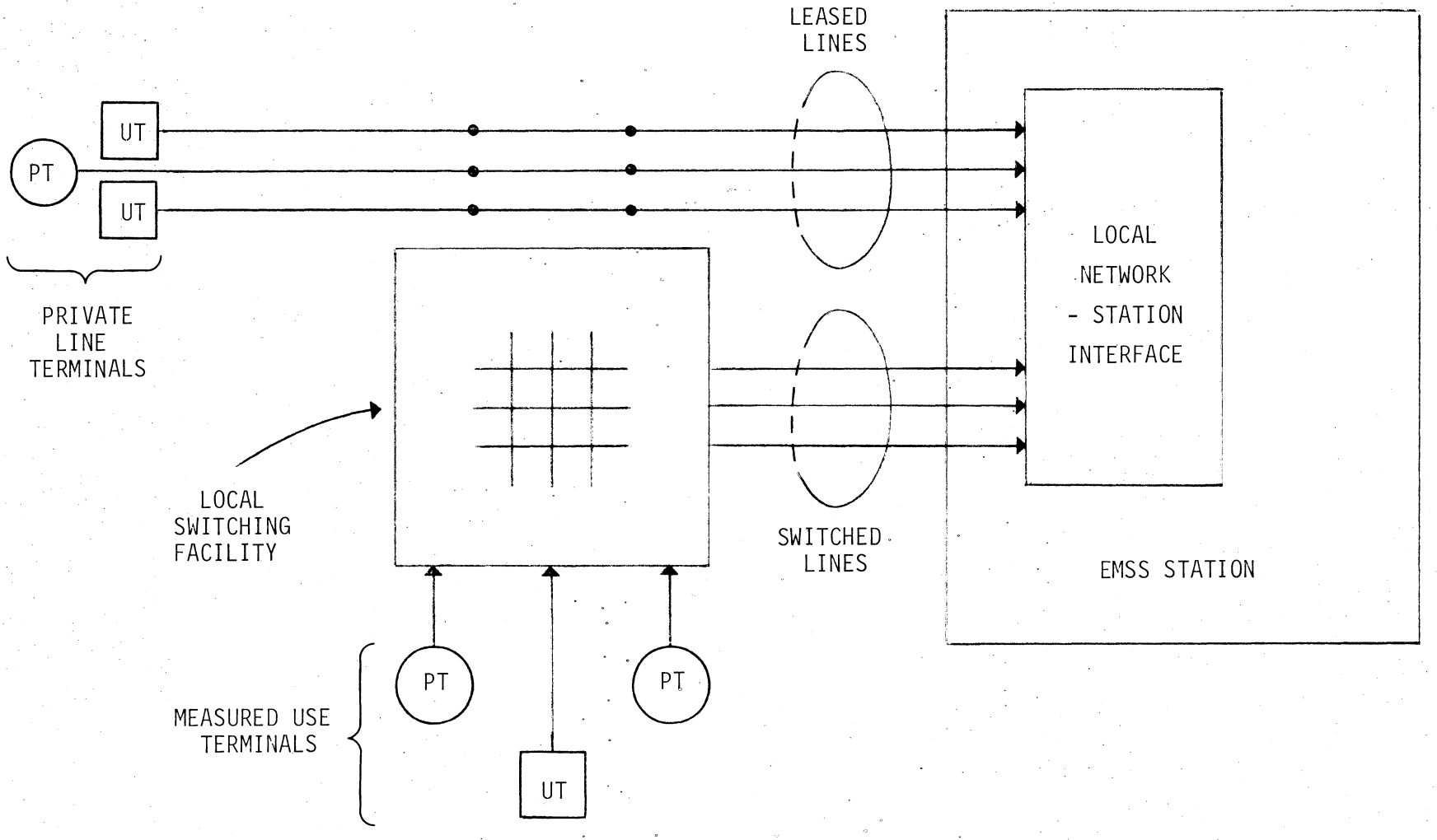

Figure 9. Leased and switched lines.

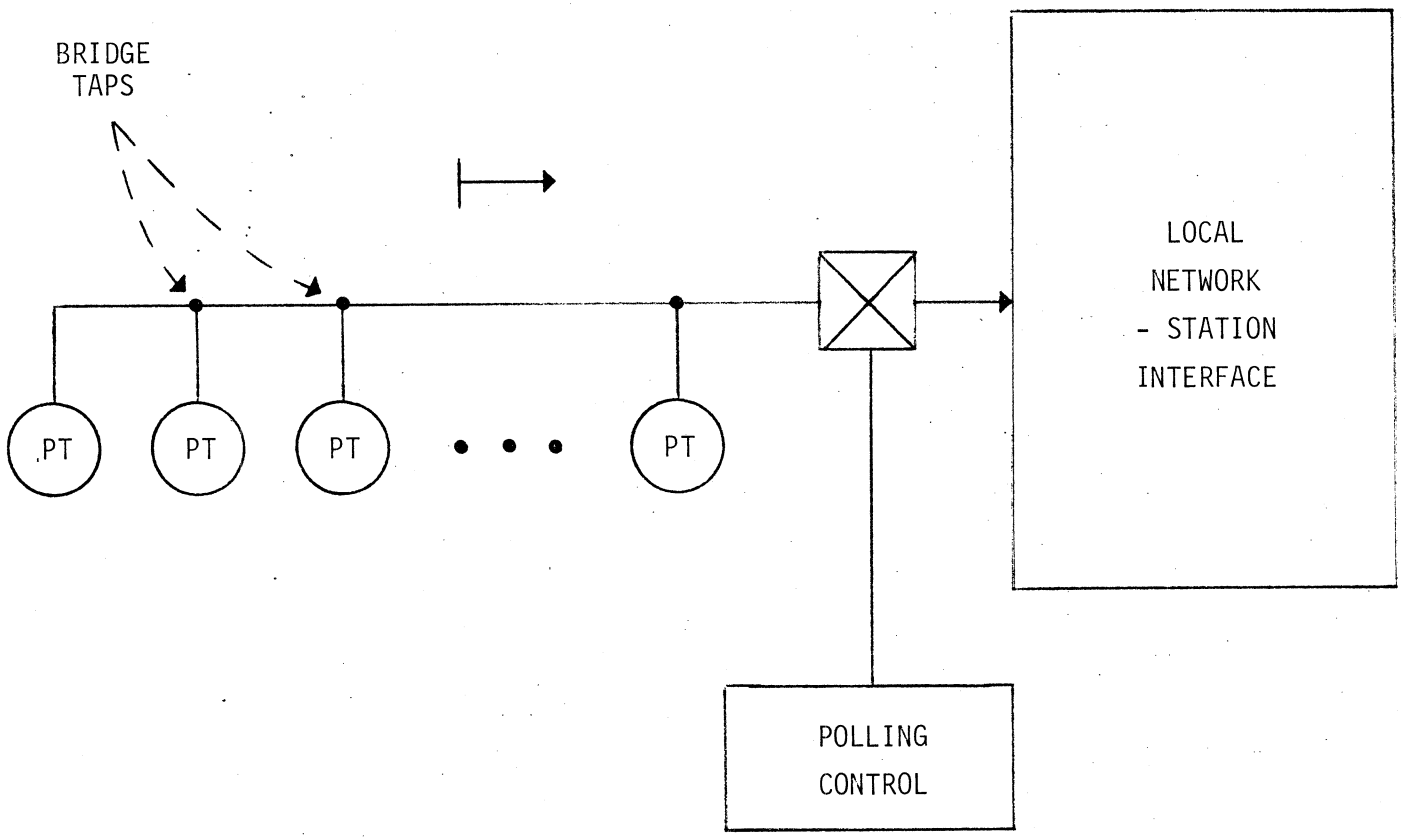

Figure 10. Polling-controlled multipoint line for public terminals, half-duplex or simplex.

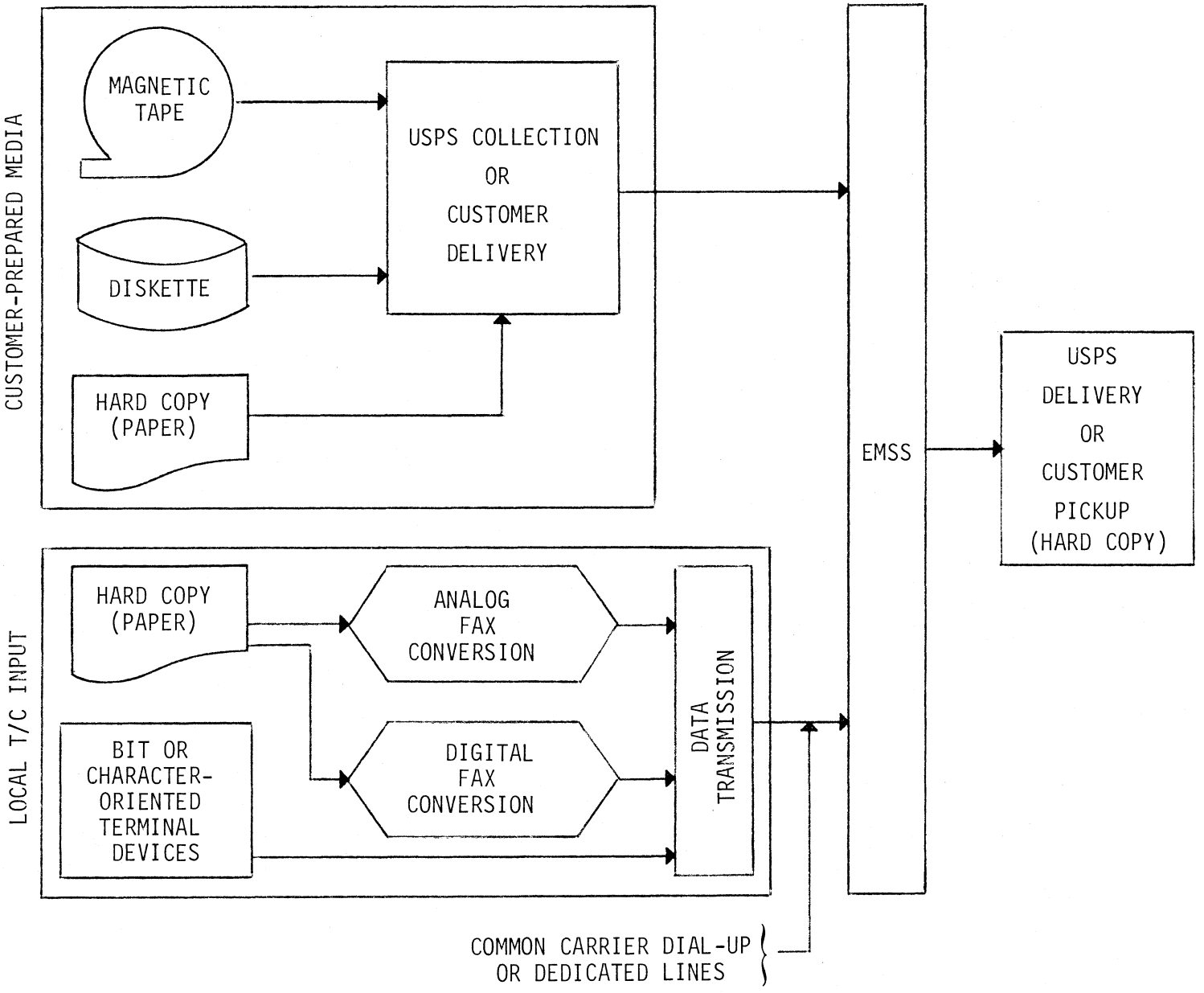

Figure 11. Message media input and output.

transmission to other EMSS locations. Development of technical interconnection standards does not apply in this aspect of message input, but media standards will be required.

The telecommunications input mode receives input from analog facsimile, digital facsimile, and bit- or character-oriented devices via common carrier transmission lines.

3. APPLICATION STANDARDS FOR EMSS

3.1 System Implementation Relationship

The USPS EMSS electronic input interface is planned to utilize common carrier dial-up and leased lines. This approach is in keeping with the Administration guidelines as previously noted. The framework of developing this new system capability will make use of existing standards and protocols where practical. A discussion of current system protocol structures and related general standards is presented in Section 3.2. The protocol structures for processing electronic data will need to handle basic symbol format, header information, message data, and will need to make provisions for specific USPS EMSS needs such as customer identification and message protection provisions. For the purpose of this report only a generalized approach will be discussed. Follow-on reports will include specific recommendations as the study progresses.

3.2 Functions of Communication Protocols

Protocols are rules or procedures which enable an orderly exchange of information between communication terminals. They may be implemented in hardware, in software, or by manual means. The protocol establishes three fundamental areas for communications. They are the standard data element, necessary conventions, and standard communication path. The protocol further specifies data representation, data format, speed of transmission, and special control messages for system operation.

With the great variety of equipment currently in use, a large number of variables must be considered to permit effective communications between terminal and station equipment. Protocols facilitate the process of data communications by forming the rules for exchanging the desired information. Coding, or layering of functions to be performed, serves as a structure for protocol formulation.

The communication link is usually accessed via a data modem to interface with the transmission and switching elements shown in Figure 12. The data terminal equipment (DTE) provides the interface to the system user and/or operator and the data circuit terminating equipment (DCE).

Figure 13 shows the layered Open System Interconnection reference model being developed (ISO, 1980). Several variants have evolved in the process of developing data communication systems. Figure 14 provides a sample set of protocol terminology currently in use by Hewlett-Packard* (Schwager, 1978), IBM* (Cypser, 1978; Corr and Neal, 1979), and the International Organization for Standardization (ISO, 1980). Note each system architecture follows the same basic functional approach but uses different sets of words to describe the processes for each system. The goal is that each layer is functionally separate and self-contained to permit changes to be made in one layer without affecting the other layers. In practice this goal is not always achieved (Green, 1980).

Table 1 provides a brief synopsis of the functions that are performed at each layer. Table 2 provides examples of the functions performed in each of the layers in the system structure. This structure will be used in developing the requirements for EMSS interface requirements. Taking this one step further, Figure 15 shows a block representation of how a message would be formed and the associated contribution of each protocol layer. The header blocks are not shown in relative size to the message. Each overhead field is normally small compared to the number of bits contained in the message. In practice, several messages can be grouped or batched to reduce the percentage of control bits required. Table 3 provides a representative listing of standards covering the first three layers. As the program study continues, this table will be expanded in depth to indicate the number of layers used relative to potential equipment.

As work in the identification of standards progresses, it may not be necessary to list all of the applicable standards as shown in Table 3. For example, RS-449 specifies RS-422-A and RS-423-A as part of the requirements. Therefore, listing RS-422-A and RS-423-A is not necessary.

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*Certain commercial names are identified in the paper to specify or describe adequately some of the known protocol layers. In no case does such identification imply recommendation or endorsement by the National Telecommunications and Information Administration, nor does it imply that the standard identified is necessarily the best available for the purpose.

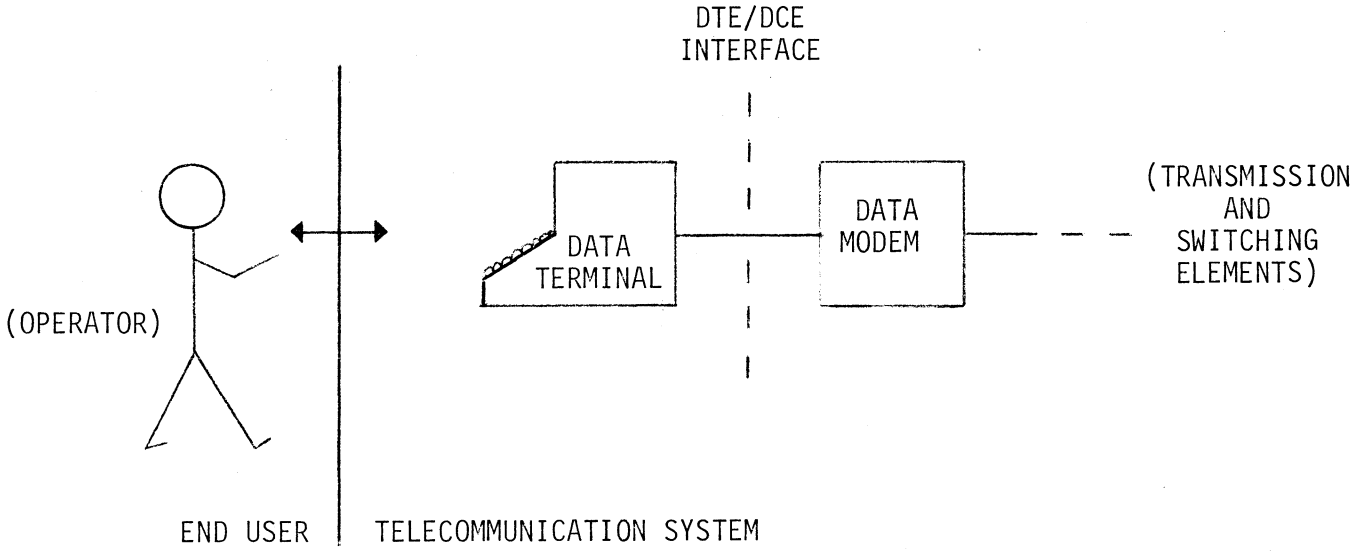

Figure 12. Operator/terminal interface.

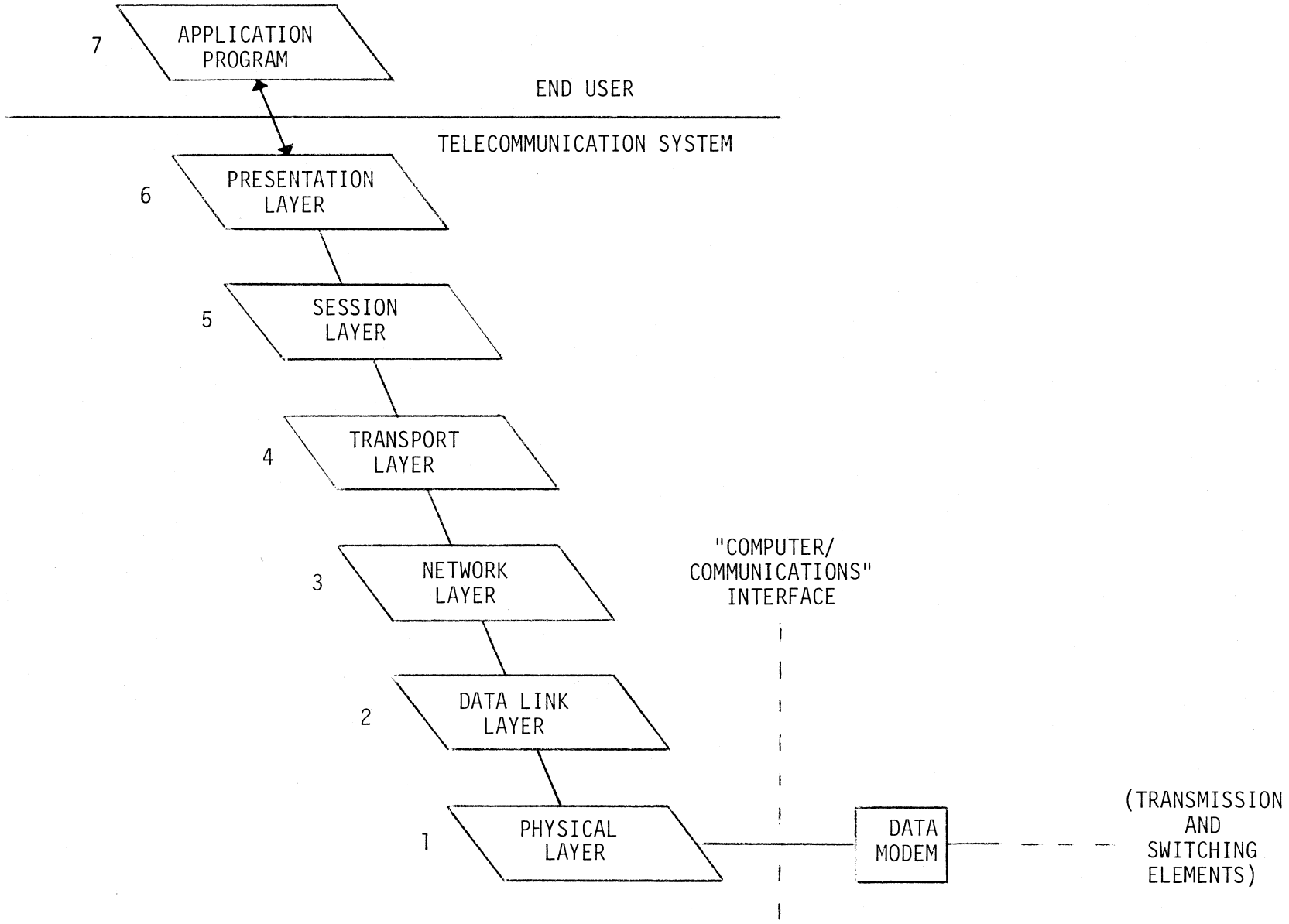

Figure 13. Application program/access method interface.

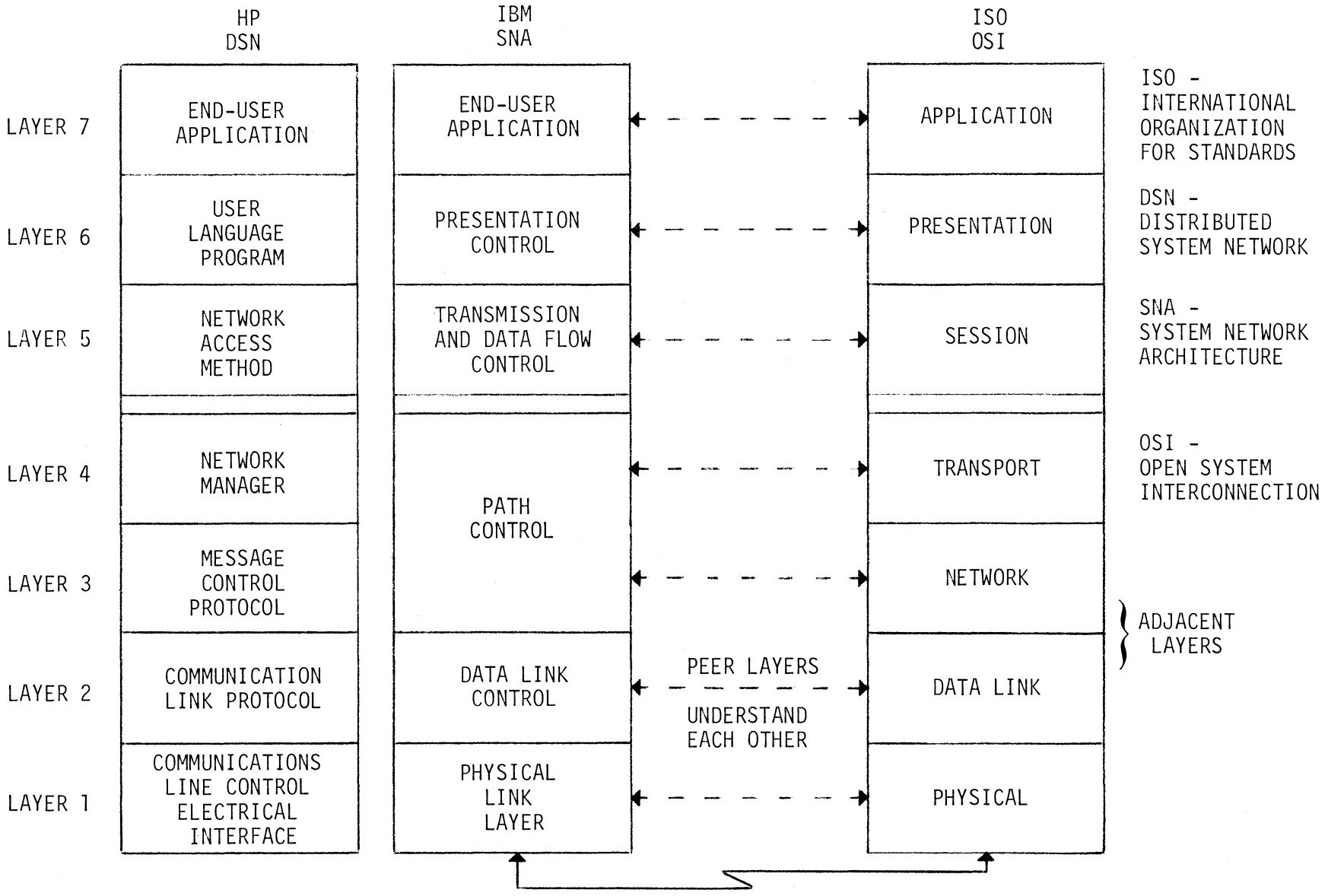

Figure 14. Nomenclature for equivalent HP, IBM, and ISO interface protocol layers.

Table 1. General Purposes of Layers

Layer 7 - Application	-	Protocols of this layer directly serve end user by providing service to application.
Layer 6 - Presentation	-	Services for management of entry, exchange, display and control of structured data, (entry only for messages to USPS).
Layer 5 - Session	-	Assists in the support of interactions between stations with respect to synchronizing and delimiting; activating/deactivating input to a port.
Layer 4 - Transport	-	Provides control of data transportation from origination customer to USPS destination station (not intermediate). Relieves higher levels from concern with data transportation.
Layer 3 - Network	-	Generate path header to control message blocking and link routing for a connection path between a pair of stations or tandem stations.
Layer 2 - Data Link	-	Generate link header/trailer to control data flow on link (e.g., phone line, fiber optics) to station.
Layer 1 - Physical	-	Permits usage of a variety of physical interconnections with different control procedures.

Based on ISO definitions with application to USPS electronic messages. (ISO/TC97/SC16 Working Document)

Table 2. Functions of Layers

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

Layer 6 - Presentation
- o Languages
  - Basic, Fortran, Cobol, Pascal
- o Tape, Disc Formats
- o Facsimile
- o Text
- o Controls

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

Layer 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

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

Layer 2 - Data Link (Character-Oriented: ANSI X3.28, BISYNC,
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

Layer 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 }

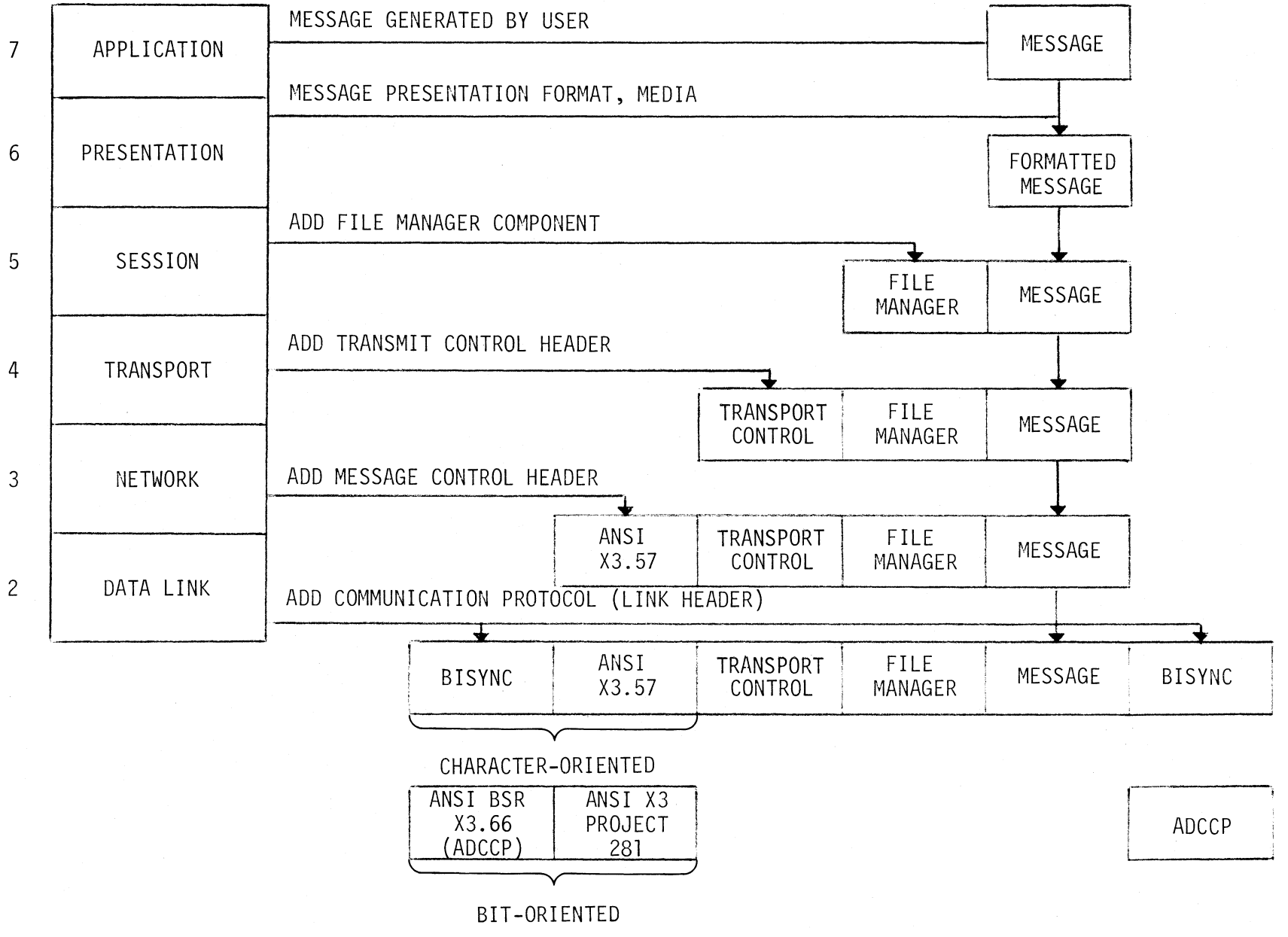

Figure 15. Message assembly, disassembly (after Schwager, 1978).

Table 3. Partial List of Standards

LAYER 1 - PHYSICAL

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

LEVEL 2 - DATA LINK

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

LEVEL 3 - NETWORK

A.	Character-Oriented:		ANSI X3.57
B.	Bit-Oriented	:	ANSI X3 Project 281 ISO/TC97/SC6 Project 24

3.3 Determination of Protocols Required

Because of the wide variety of equipment, types of messages, and customer services, it is essential that overall system requirements, operations, and capabilities be adequately assessed. Table 4 provides a brief listing of the decisions that will need to be made and areas that must be reviewed. Table 4 is not intended to be a complete listing of all areas to be evaluated, but provides the categories that will be addressed during initial system evaluation.

In addition to the many decisions, considerable effort will be required in conducting customer interviews, interfacing with common carriers and equipment manufacturers. This must be done to provide adequate system coverage, provide for system growth and interface with a large variety of equipment types. This work will have to be closely coordinated with national and, in some cases, international standards organizations. Protocol determination will have to deal specifically with the EMSS application and its special requirements. This approach will insure maximum commonality with current standards and the utilization of a wide range of equipment currently in operation within industry.

4. SUMMARY

Providing a telecommunication interface with public terminals and private user terminals through common carriers requires consideration of many existing standards. Interconnection standards cannot be unduly discriminatory against any carrier able and willing to connect to the USPS electronic mail system. They must be designed to permit simultaneous interfacing of multiple communications carriers with the EMSS stations. Standards will have to be analyzed to determine applicability, degree of overlapping coverage, existing industry usage, on-going changes in existing standards, and new standards under development. This information will provide the initial data base for establishing interface parameters. Comparison of existing standards and USPS interfaces will identify the areas for new developments.

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Table 4. Some Decisions for Communications Standards

Protocols	Transmission Media
System Dependent	Public, Private
System Independent	Analog, Digital
Bit-oriented	Dedicated, Shared
Character-oriented	
Message Communication Method	**Connection to EMSS**
Manual Data Entry	Dedicated
Acoustic Couplers	Polled
Line Speed - Low, Medium, High	Demand
Coax Cable	Time Slotted
Direct Coax Cable	Reservation
Coding	**Switching**
ASCII	Circuit
EBCDIC	Message
Other	Packet
Clocking	
Synchronous	
Asynchronous	

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report describes the effort which will be undertaken to determine telecommunication standards necessary for interconnection to the United States Postal Service (USPS) planned long-range Electronic Mail Service System (EMSS). This work is in compliance with an Administration Policy Statement which requires that organizations desiring to input messages into a future USPS EMSS via telecommunications means can do so if the interconnection standards are satisfied.

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

communication protocols; Electronic Mail Service System (EMSS); telecommunication standards; United States Postal Service (USPS)

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