# Teletex—A worldwide link among office systems for electronic document exchange

by D. J. Moore

***Teletex is a new international telecommunication service that provides direct electronic document exchange between such office text machines as electronic typewriters and word processors that are equipped with transmitting and receiving storages. Teletex is an international standard aimed at integrating office products and worldwide telecommunication. It represents a major step in the development of the office of the future. This paper traces the development of Teletex, describes its characteristics, and looks at how this service may be extended in the future.***

Teletex is a new international telecommunication service that allows its users to exchange documents electronically with a high degree of automation, speed, and accuracy among such office text machines as electronic typewriters and word processors that are equipped with transmitting and receiving storages. The document exchange occurs directly from the transmit storage of the sending text machine to the receive storage of the receiving text machine, independently of concurrent operator text entry or editing. A wide range of text presentation controls and graphics characters are available to satisfy almost all users of Latin-based alphabets. A wide range of communication networks may be used, with interconnection possible to such major existing text communication services as Telex.[1]

This paper briefly traces the evolution of Teletex and presents a comparison of Teletex with two existing mail services. This is followed by an examination of the Teletex technical characteristics, including the use of a seven-layer architectural model to aid in understanding its protocol. The final section offers a glimpse into the future of Teletex.

## Teletex evolution

In the mid-nineteenth century, the development of the telegraph brought the world into the era of electrical communications. The telephone first and then the radio were developed early in the twentieth century, and electronic communications became an accepted part of everyone's life. The concurrent introduction of the typewriter, mechanical at first and later electrical, brought mechanization into the office. With the introduction of communication into the typewriter field, the result was the beginning of electronic document exchange by way of Telex and the Teletypewriter Exchange (TWX)[2] devices.

The German government set up the Commission for the Development of the Telecommunication System (KtK) in 1974 to study the future of telecommunications in Germany. In 1976, the commission's published results[3] stated among other things that a new text communication service should be developed for a terminal that offers both text generation and communication capabilities, and uses the full character repertoire of the typewriter. Working groups were set up by the Deutsche Bundespost,[4] the German governmental agency for Postal, Telephone, and Telegraph (PTT), to perform the early studies for this new telecommunication service. The German government recognized, however, that international standards would be required to make this new service successful.

**As with many international standards, agreement on the detailed definition of the Teletex service required the effort and cooperation of the delegates from many countries.**

In 1976, the Swedish PTT, Televerket,[5] began work with a group of manufacturers to study the use of telecommunications in the offices of the 1980s. This was a two-year study and was termed Office 85. The study group concluded in its final report[6] that a new telecommunication service should be developed for an office machine containing word processing, communications, and document filing and retrieval.

Such studies pointed the way toward Teletex. The task of developing international standards for Teletex became the responsibility of the International Telegraph and Telephone Consultative Committee (CCITT).[7] As with many international standards, agreement on the detailed definition of the Teletex service required the effort and cooperation of the delegates from many countries. In 1980, the CCITT Plenary Assembly adopted the Teletex work performed by its study groups during the 1977–1980 period and published the results as the following series of recommendations:[8,9]

| | |
|---|---|
| Recommendation F.200 | Teletex Service |
| Recommendation S.60 | Terminal Equipment for Use in the Teletex Service |
| Recommendation S.61 | Character Repertoire and Coded Character Sets for Teletex |
| Recommendation S.62 | Control Procedures for the Teletex Service |
| Recommendation S.70 | Network Independent Basic Transport Service for Teletex |

The Deutsche Bundespost unveiled Teletex at the 1980 Hanover Fair using prototype terminals from five European manufacturers. The Hanover Fair is a major industrial products show held yearly in Hanover, Germany. Text transmission between Germany and the countries Sweden, Canada, and the United States demonstrated the international feasibility of Teletex.

After a trial period starting in 1981, the German Teletex service formally opened in June 1982. Many other European nations expect to have a Teletex service available by 1984. In North America, Teletex service has been announced by Canada's TransCanada Telephone System (TCTS)[10] and by the Western Union Corporation in the United States.[11]

Teletex can compete favorably against the postal service in providing many of the needs of the business world, but it may be years before many private individuals can justify economically the cost of a Teletex terminal.[12] Telex is widely used, but Teletex offers higher speeds, improved print quality, and lower transmission costs than Telex. Telex growth is expected to level off and then gradually decrease as Teletex becomes more widely used.[13] With European communications under the control of the PTTs and with few competing services, Teletex is expected to receive wide acceptance throughout Europe. In the United States, a more competitive atmosphere exists, and Teletex must compete against both private and governmental services.

### Why go to Teletex?

A comparison of the Teletex service with two document exchange predecessors, the postal system and the Telex service, provides insight into why many government and industry people are enthusiastic about the prospects of Teletex.

Postal systems provide near-worldwide coverage, allowing an exchange of physical correspondence between almost any two people on earth. Telex services provide exchanges of electronic correspondence between its subscribers, who number about one million worldwide. Teletex also provides for an exchange of electronic correspondence and has the ability to communicate between Teletex terminals, to all Telex terminals, and, by national decision, to other terminal types in use within a specific country.

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Postal systems provide one-to-three-day delivery within many countries, although longer delivery times may occur for international delivery. An express mail service is often available at extra cost. Telex uses a 7.5-unit code format (1 start bit, 5 information bits per character, 1.5 stop bits) transmitted at 50 bits per second to produce a 1000-character transmission in about 2.5 minutes. Teletex uses an 8-unit code format (8 information bits per character) transmitted at 2400 bits per second to produce a 1000-character transmission in about 3.3 seconds. Teletex has protocol overhead that substantially reduces the effective text transmission rate for short document lengths. Even so, a Teletex terminal can transmit a document of several pages in a fraction of a minute.

A typed letter sent through the postal system provides one standard of quality against which electronic correspondence must be judged. The Telex fifty-character graphics set consists of the letters of the alphabet A through Z (all upper case or all lower case, according to national decision), the numerals 0 through 9, the symbols $-?:().,'=/+$, three national-use graphics, and printer controls (carriage return, line feed, and space). The Teletex 309-character graphics set offers all elements of the Telex data stream plus both upper and lower case letters, many international letters (e.g., German sharp s, ß) and symbols (e.g., pound sign, £), diacritical marks (e.g., a-umlaut, ä), a wide range of format controls (e.g., subscript and superscript, backspace, and underline), and a choice of paper size and orientation, horizontal and vertical spacing. Telex has no error detection capability, whereas Teletex uses High-Level Data Link Control (HDLC) protocol[14] to ensure near-error-free transmission.

Transmission costs are difficult to compare because of wide variations in rate structures among countries and expenses among companies. A 1981 German study[13] by the Deutsche Bundespost gives a rough idea of the relative costs. All were presented in this study in German Deutsche marks (DM), but they are presented here in the U.S. currency using 2.25 DM to 1 U.S. dollar, the exchange rate in effect at the time of the study.

First class postage within Germany amounted to 27¢ in 1981, and an average of 67¢ per letter had to be spent within the companies studied for unique postal service expenses, such as the mailroom. The postal service comparison cost was thus 94¢ per letter. Telex transmission rates depend upon distance and time of day. Within Germany, these rates range from about 0.10¢ to 0.44¢ per second. Teletex transmission rates depend upon distance and time of day, and there is also a connect charge of about 2¢ per call. Within Germany, these rates range from about 0.16¢ to 0.62¢ per second. The three services incurred similar expenses involving document preparation and final disposition. Using this information, a cost comparison for document delivery was calculated and is shown in Figure 1. The transmission cost for Teletex is shown to be considerably less than the alternatives.

**Figure 1 Document delivery cost comparison (using Germany, 1981 rates)**

| Number of pages | Postal Service | Telex Service | | | Teletex Service | | |
|---|---|---|---|---|---|---|---|
| | | Time | Minimum | Maximum | Time | Minimum | Maximum |
| 1 | $0.94 | 3:45 | $0.22 | $1.02 | 0:08 | $0.03 | $0.07 |
| 2 | $0.94 | 7:30 | $0.44 | $2.00 | 0:14 | $0.04 | $0.11 |
| 4 | $0.94 | 15:00 | $0.89 | $4.00 | 0:27 | $0.06 | $0.19 |

Each page contains 1500 characters.

Time is the duration of document transmission in minutes and seconds.

Telex minimum cost occurs between 6 p.m. and 6 a.m.; maximum cost occurs between 6 a.m. and 6 p.m. and for communication of over 50 kilometers.

Teletex minimum cost occurs between 10 p.m. and 6 a.m.; maximum cost occurs between 8 a.m. and 6 p.m. and for communication of over 50 kilometers.

### Teletex terminal requirements

The CCITT recommendations provide the definition for a Teletex implementation that will ensure compatibility among different manufacturers and different nations. Although a nation may extend specific CCITT recommendations within its jurisdiction, its Teletex service must adhere to the CCITT recommendations at its jurisdictional boundaries. This section deals with the CCITT recommendations, some of which are basic to all terminals, some of which are optional, and some of which may vary by nation and by manufacturer. All Teletex terminals must share the following basic set of features so that these terminals have worldwide compatibility.

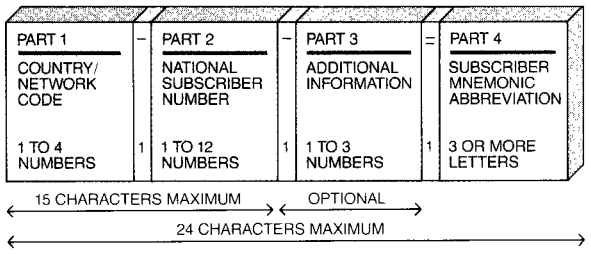
**When this basic set of Teletex features are used, there should be no major differences between sending a document to a terminal within the same city and sending it to another country.**

The Teletex terminal must allow text to be communicated from any Teletex user to any other Teletex user, both nationally and internationally. When this basic set of Teletex features are used, there should be no major differences between sending a document to a terminal within the same city and sending it to another country.

To ensure high quality in the Teletex service, a terminal attached to a circuit-switched data network must be able to accept calls at least 95 percent of the time. The factors contributing to quality degradation are the terminal's daily Teletex service usage and the size of the memory for receiving documents. Detailed statistical parameters are provided in the CCITT recommendations to aid in this evaluation. The quality-of-service requirements for terminals attached to other networks have not been established.

The Teletex service can be provided on any network authorized by a nation within its jurisdiction. To provide high-speed service, a network data rate of 2400 bits per second is recommended within a country and is required at international boundaries. At present, the nations planning to offer the Teletex

**Figure 2 Terminal identification**




service have announced their intentions for the following networks: the Circuit Switched Data Network (CSDN), the Packet Switched Data Network (PSDN), and the Public Switched Telephone Network (PSTN). International gateways[15] are to be provided to connect the networks of nations at their telecommunications boundaries.

**A Teletex terminal must be able to receive calls at all times—twenty-four hours per day, seven days per week.**

The Teletex terminal provides fully automatic call establishment and answering, although manual call establishment by a terminal's operator may be used when a terminal is connected to a Public Switched Telephone Network.

Each Teletex terminal is to be assigned a unique four-part terminal identification, as shown in Figure 2. Part 1 of the terminal identification identifies the country and, if necessary, the network within the country. Part 2 identifies the network address of the terminal and is to be assigned to a terminal by the PTT. Part 3, which was originally provided to allow terminal subaddressing, is optional, and its future use is currently under CCITT discussion. Part 4 is an abbreviated name that is used to identify the owner of the terminal. As an example, consider the following terminal identification:

91-5125559999=ABCCO

Here, the four parts are as follows:

Part 1 = 91 (9 indicates the telephone network and 1 indicates North America).
Part 2 = 5125559999 (512 is the area code and 5559999 is the local number).
Part 3 is not used in this example.
Part 4 = ABCCO (identifies the terminal as belonging to the ABC Company).

A Teletex terminal must be able to receive calls at all times—twenty-four hours per day, seven days per week. Certain portions of a terminal's electronics may be powered off when the terminal is unattended, but the remaining electronics must be capable of accepting a call and controlling the document reception and memory storage process.

Teletex requires the capability of simultaneous terminal usage and document reception. When a Teletex terminal is used as a conventional office machine, such a local-mode operation must not require interruption by the reception of a document from the Teletex service. There is no reason why a terminal operator has to be involved or even informed of document reception until this process is complete.

Each page of a document is considered to be independent for purposes of text format, text transmission, and error recovery. The protocol for each page transmission ends with the transmission of a checkpoint command to which the document receiver must return a corresponding checkpoint response. Checkpointing after each page ensures synchronization between the two terminals and tells the document sender that the document receiver has the page stored safely in terminal memory. To improve transmission efficiency, up to three pages may be transmitted without the receipt of corresponding checkpoint responses, as long as all checkpoint responses are received prior to the end of the document. This three-page convention may be changed by the mutual agreement of the two terminals involved, so as to accommodate differing terminal capacities and network delays.

In the sending mode, a Teletex terminal may be capable of sending only a subset of the Teletex graphic character and control set, but in the receiv-

ing mode, the Teletex terminal must be capable of storing and responding to the entire Teletex basic graphic character and control set. This requirement ensures that documents sent internationally can be received with the graphics of some thirty-five languages, as may be used by the document originator.

**A total of 309 graphics plus space are defined within this basic set of graphics, either by individual code points or by the use of two sequential code points.**

The Teletex terminal must be capable of handling the following basic Teletex page-format specifications:

- Vertical or horizontal paper orientation (with vertical as the default)
- Printable area of 210 mm × 280 mm, which is the area common to the International Organization for Standardization (ISO)[16] A4 (210 mm × 297 mm) and the North American 216 mm × 280 mm (8½ inch × 11 inch) paper formats
- Horizontal character spacing (pitch) of 10 characters per 25.4 mm (1 inch)
- Vertical line feed spacings of 0.5, 1, 1.5 and 2 (with 1 as the default) at 6 lines per 25.4 mm (1 inch)
- Single-level superscript and subscript functions, underlining, space, backspace, carriage return, line feed, and form feed

Figure 3 illustrates the basic set of graphics available in Teletex, which are read or specified by column number first, slash, followed by row number. For example, the division operator is designated [11/8]. A column/row pair is termed a *code point*. The graphics with code points between [12/1] and [12/15] represent zero-escapement graphics. These are similar to "dead keys" on many typewriters. For example, to represent "a grave" (à), the code point sequence [12/1] [6/1] is used. To represent "a grave underscore" (à̲), the code point sequence [12/12] [12/1] [6/1] is used. Figure 4 illustrates the valid graphics denoted by the use of zero-escapement graphics, with the exception of underscore, which can be used in conjunction with any graphics character. A total of 309 graphics plus space are defined within this basic set of graphics, either by individual code points or by the use of two sequential code points.

A Teletex terminal must be provided with storage for document transmission and reception functions, where the document storage capacity for received documents must be sufficient to meet the quality-of-service requirements. Once a page has passed a checkpoint, the receiver must be able to retain the information on that page, even in the event of a power failure. This capability includes such means as nonvolatile storage or battery backup for volatile storage.

**Figure 3 Teletex graphics set**

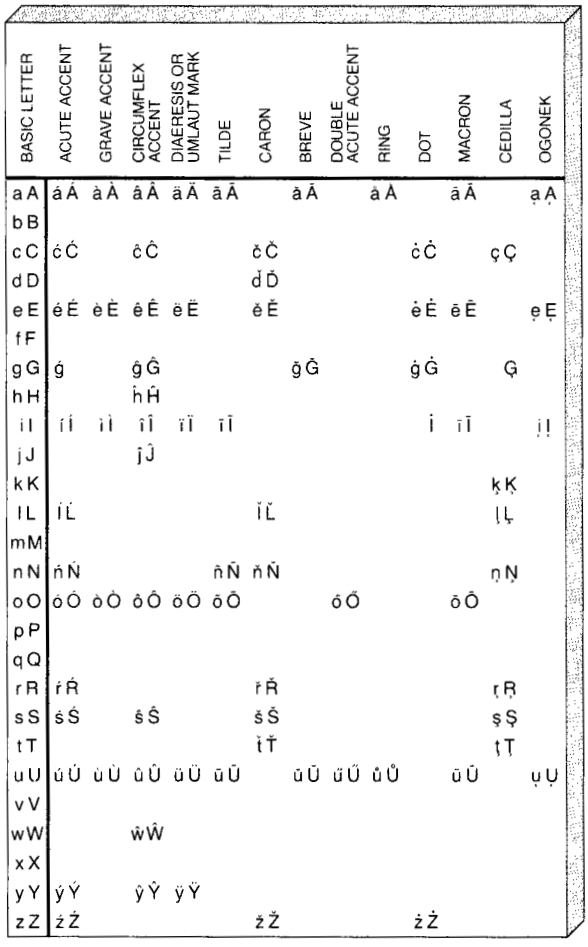
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | SP | 0 | @ | P | | p | | | | ° | | | Ω | κ |
| 1 | | | ! | 1 | A | Q | a | q | | | ¡ | ± | ` | | Æ | æ |
| 2 | | | " | 2 | B | R | b | r | | | ¢ | ² | ´ | | Đ | đ |
| 3 | | | | 3 | C | S | c | s | | | £ | ³ | ^ | | ª | ð |
| 4 | | | | 4 | D | T | d | t | | | $ | x | ~ | | Ħ | ħ |
| 5 | | | % | 5 | E | U | e | u | | | ¥ | µ | ¯ | | | ı |
| 6 | | | & | 6 | F | V | f | v | | | # | ¶ | ˘ | | IJ | ij |
| 7 | | | ' | 7 | G | W | g | w | | | § | · | ¸ | | Ŀ | ŀ |
| 8 | | | ( | 8 | H | X | h | x | | | ¤ | ÷ | ¨ | | Ł | ł |
| 9 | | | ) | 9 | I | Y | i | y | | | | | ² | | Ø | ø |
| 10 | | | * | : | J | Z | j | z | | | | | ° | | Œ | œ |
| 11 | | | + | ; | K | [ | k | | | | « | » | ¸ | | º | ß |
| 12 | | | , | < | L | | l | \| | | | | ¼ | ³ | | Þ | þ |
| 13 | | | - | = | M | ] | m | | | | | ½ | ˝ | | Ŧ | ŧ |
| 14 | | | . | > | N | | n | | | | | ¾ | ˛ | | Ŋ | ŋ |
| 15 | | | / | ? | O | ¤ | o | | | | | ¿ | ˇ | | ŉ | |

Code Point [5/15] has the meaning of "delimiter" when interworking with Videotex.

Code Point [12/9] has the meaning of "umlaut" if a distinction must be made between "diaeresis" and "umlaut."

Code Point [12/12] has the meaning of "nonspacing underline" and may be used with any Teletex graphic.

**Figure 4 Valid multi-code-point graphics**




A Call Identification Line is a four-part 72-character line of information that, as shown in Figure 5, identifies the following: the called and calling terminal, the time of call origination, and the document and page reference. The two terminals involved must exchange this reference information prior to the sending of a document. The document receiver may print the Call Identification Line as part of the document to provide a permanent record of this transmission information. When the transmission of a document is interrupted for any reason, the document receiver must print the Call Identification Line at the point of document transmission interruption, as well as at the point of document transmission resumption. The operator forms a single document from the segments of the interrupted document by matching the Call Identification Line information. For example, the following is a Call Identification Line, shown here in three segments, although the standard format is a single line:

91-5125559999=ABCCO
/91-5125558888=XYZCO
/83-02-15-14:00/008-001

where

Part 1 = 91-5125559999=ABCCO (the called terminal identification)
Part 2 = 91-5125558888=XYZCO (the calling terminal identification)
Part 3 = 83-02-15-14:00 (the date, February 15, 1983, and time, 14:00 or 2 p.m.)
Part 4 = 008-001 (the document, number 8, and page reference, page 1)

**A Teletex terminal must provide the capability of interworking with Telex service in both directions by means of a PTT-managed Conversion Facility.**

Through a procedure of receiving terminal validation, Teletex procedures ensure that a document is delivered to the desired terminal. To accomplish this, the terminal design must prevent its operator from changing its terminal identification. Once the call is established, the calling terminal must verify the terminal identification of the called terminal prior to document transmission.

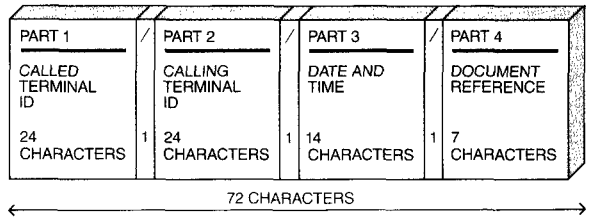
Visual and/or audible indicators must inform the operator about situations that require the operator's assistance. The following operator indicators are required:

- Terminal is now or is soon to be unable to store more received text into memory.
- Operator assistance is required (e.g., for change of printing element or for handling paper).

- Document has been received in memory.
- Document status is available in memory.

A Teletex terminal must provide the capability of interworking[17] with the Telex service in both directions by means of a PTT-managed Conversion Facility (CF). This feature provides a Teletex terminal with access to all Telex terminals throughout the world and allows a smooth transition, as Teletex gradually replaces Telex.

**Figure 5 Call Identification Line**




Called and Calling Terminal Identification defines the terminal and uses the format shown in Figure 2. If Terminal Identification is fewer than 24 characters, spaces are added to the right end, thereby enlarging the field to 24 characters.

Date and Time represent the time of call origination in terms of year (YY), month (MM), day (DD), hour (HH), and minute (MM). The 14-character Date and Time has the format YY-MM-DD-HH:MM.

Document Reference identifies a Document Reference Number (D) and a Page Number (P). The 7-character Document Reference may have the format DDD-PPP.

**The Teletex model formally separates the tasks required of a communication system and provides a protocol between the architectural layers and the end users.**

The CCITT has defined specific options that a manufacturer may choose to implement. Before using an optional CCITT feature, the terminals must exchange specific protocol information to ensure that both terminals share this optional CCITT feature. As with the basic functions, a nation may amend these optional CCITT functions within its own jurisdiction. The following are optional CCITT features:

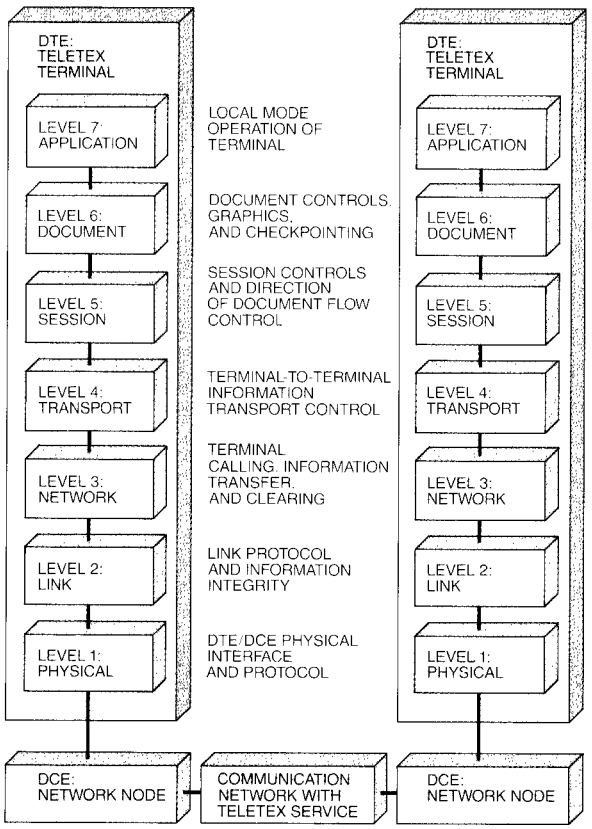
- ISO A4 printable area (210 mm × 297 mm)
- Use of the ISO 3535/A4 form for international trade[18]
- Horizontal character spacing of 12 and 15 characters per 25.4 mm (1 inch)
- Vertical line feed of one-line spacing at 8 lines per 25.4 mm (1 inch) and of 0.5, 1, 1.5, and 2-line spacings at 1 line per 5 mm
- Reverse line feed
- Alternative CCITT registered graphics character repertoires

The CCITT standardization includes a protocol for invoking private features. This private protocol provides freedom to the terminal designer for features that are not currently incorporated in the CCITT design and allows a nation to customize its Teletex service for its own particular needs. As with the optional CCITT features, the terminals must exchange specific protocols prior to the use of an optional private feature to ensure that both terminals share this feature.

### Teletex protocol

Teletex provides a division of the communication system functions into the seven-layer architectural model shown in Figure 6. This model is a subset of the Open System Interconnection (OSI) model,[19] except for Level 6. Level 6 in OSI is called the Presentation Layer and is more inclusive than the Teletex Document Layer. The Teletex model formally separates the tasks required of a communication system and provides a protocol between the architectural layers and the end users. As with the OSI model, Levels 1 through 4 are concerned with the transport of information, and Levels 5 through 7 are concerned with the processing and end use of this information.

**Figure 6 Seven-layer Teletex architectural model**




DTE—DATA TERMINAL EQUIPMENT
DCE—DATA CIRCUIT-TERMINATING EQUIPMENT

*Level 1: Physical.* The Physical Layer provides the mechanical, electrical, functional, and procedural characteristics needed to control the physical interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE).

The DTE is the terminal that is joined to the communication network and may be anything from a simple typewriter with memory and communication capability to an I/O device of a much larger communication system. The DCE is the hardware interface between the DTE and the network.

*Level 2: Link.* The Link Layer provides the Link Access Procedure (LAP) for information interchange across the link between the DTE and DCE for a packet-switched network and between DTEs for a circuit-switched or telephone network. The link access procedure provides error detection, data sequencing, and data flow control to ensure data integrity.

*Level 3: Network.* The Network Layer controls network calling and clearing and the transporting of information across the network. For packet networks, controls are provided for routing, flow controls, and reset and restart.

**Teletex may be used on any telecommunication network available to a nation.**

Teletex may be used on any telecommunication network available to a nation. Figure 7 illustrates the protocol for the three networks currently considered for Teletex. The protocol of Levels 1 through 3 for these networks is defined in the CCITT V-series[20] and X-series[21,22] recommendations.

The Packet Switched Data Network (PSDN) establishes a virtual circuit between DCEs over which blocks of digital data called packets are transmitted. The virtual circuit is time-shared by many terminals on a demand-usage basis, and a terminal uses the packet network's facilities only for the time that its packets are being transmitted.

PSDN uses the CCITT recommendation X.25 for the three lower-protocol layers. Level 1 is equivalent to either CCITT recommendation X.21 for digital modems or X.21 bis[23] for analog modems. Level 2 is the X.25 full-duplex HDLC protocol called Link Access Procedure B (LAP B), which grants control over the DTE/DCE interface to the terminal. Level 3 is the X.25 packet protocol.

The Circuit Switched Data Network (CSDN) is a digital-switched network where, once a call is established, the terminal has full use of the network circuit. Level 1 is either CCITT recommendation

X.21 for digital modems, X.21 bis for analog modems, or X.22 for digital multiplexors. Level 2 is the CCITT recommendation X.75 Single Link Procedure. This procedure is similar to LAP B of X.25, but allows a peer-to-peer relationship between terminals. Level 3 uses CCITT recommendation X.21 for call establishment and termination, and uses CCITT recommendation S.70 for the definition of a header to the HDLC frame. This header is designed to ease the task of identifying HDLC frames when connecting a circuit-switched network to a packet-switched network at a network gateway.

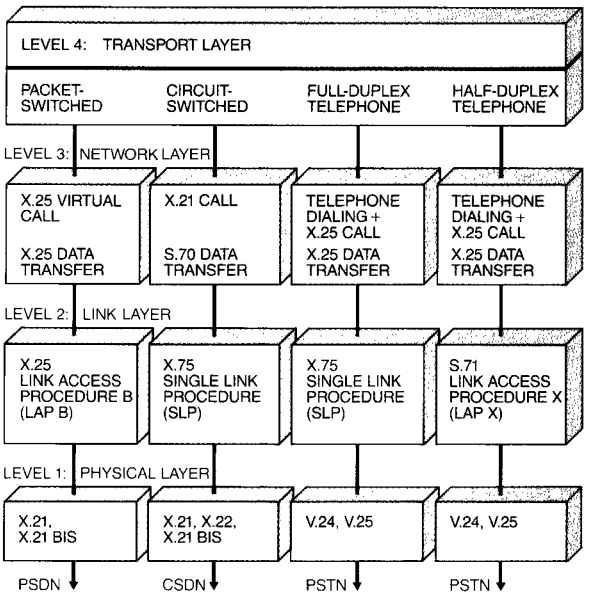
The Public Switched Telephone Network (PSTN) is the telephone network that is commonly available throughout the world. Although major trunk lines of this network may be digital, the terminal node remains analog. As with CSDN, a terminal has full use of the network circuit once the call is established.

**To provide access to the large number of Telex terminals throughout the world, each nation must develop a Conversion Facility.**

Level 1 is CCITT recommendation V.24 for the telephone interface definition and V.25 for auto-dial and auto-answering procedures. Level 2 is either the CCITT recommendation X.75 Single Link Procedure for full-duplex operation or the CCITT provisional recommendation S.71, LAP X, for half-duplex operation. LAP X is equivalent to LAP B plus right-to-talk logic to control the half-duplex nature of this circuit. Level 3 involves conventional telephone dialing (manual or automatic) plus the CCITT recommendation X.25 packet protocol. The packet protocol allows a simplified telephone-to-packet network interface at a network gateway.

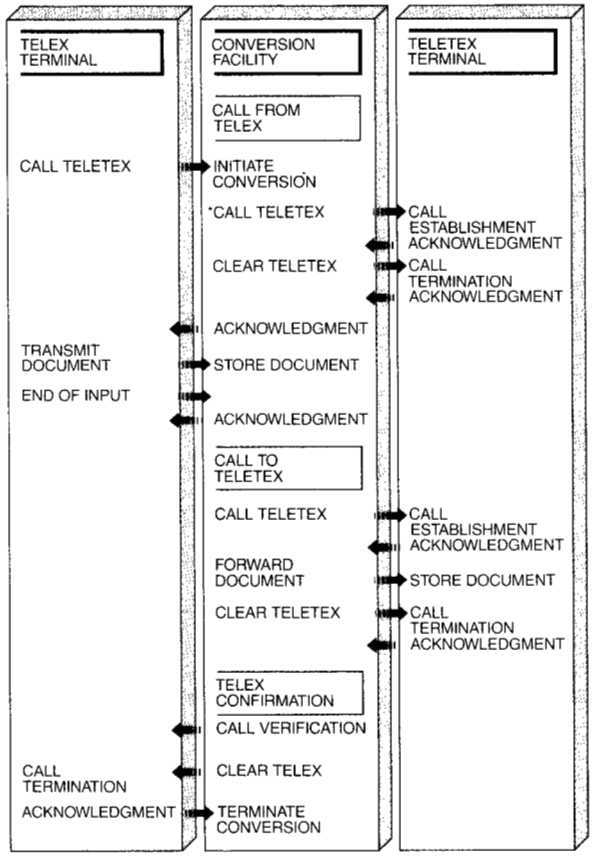
*Level 4: Transport.* The Transport Layer adapts the network-dependent information of Levels 1 through 3 to the network-independent interface presented to Levels 5 through 7, and is defined by CCITT recommendation S.70. Transport Layer connection and termination procedures are provided to allow an end-to-end transport connection over interconnected networks of differing characteristics. The transport connection may include a negotiation between calling terminal and called terminal for maximum Transport Layer information length. Once the network information length is known, the Transport Layer performs the data manipulation required to make the network-dependent format compatible with the network-independent Session Layer format.

**Figure 7 Teletex Levels 1 through 4 for PSDN, CSDN, and PSTN networks**




S.70 — Network Independent Basic Transport Service for Teletex
S.71 — LAP B Extended for Half-Duplex Physical Layer Facility (Provisional)
V.24 — Interface Definition Between DTE and DCE
V.25 — Auto-Call and Answering Telephone Network Control Procedure
X.21 — Public Data Network DTE/DCE Interface
X.21 bis — Public Data Network DTE Interface to Series V Modems
X.22 — Multiplexer DTE/DCE Interface
X.25 — Packet Mode Public Data Network DTE/DCE Interface
X.75 — Packet Mode International Circuit Interface

**Figure 8 Telex-to-Teletex interworking**




*THIS CALL IS OPTIONAL, AND ITS USE IS A NATIONAL OPTION.

*Level 5: Session.* The Session Layer is concerned with the logical connection between users, and is defined by CCITT recommendation S.62. Level 5 defines the session connection and termination procedure and the control over the direction of document transfer. Session connection involves a transfer of reference parameters from document sender to document receiver that become the source of information for the Call Identification Line. These parameters define the document sender's terminal identification, the date and time of call origination, and an optional session identification to uniquely define each session. Session identification is used for session linkage if a document is prematurely terminated and then continued in a later session. Session connection may also include a negotiation between sender and receiver for optional terminal capabilities (e.g., 12 and 15 pitch), for session capabilities [e.g., number of pages (checkpoints) that may be transmitted without waiting for a checkpoint response], and for optional private facilities. Document transfer direction control permits document transmission from the called terminal to the calling terminal. Session termination includes both normal and abnormal indications.

*Level 6: Document.* The Document Layer contains the controls and the text that are to be used to generate the document, and is defined by CCITT recommendations S.61 and S.62. Level 6 provides delimiters for document initiation and termination, suspension and continuation, and checkpointing on page boundaries for error recovery purposes. Document initiation may include a negotiation between sender and receiver for such optional terminal capabilities as document storage capacity and for optional private facilities. Document termination includes both normal and abnormal indications.

There are the following four types of documents carried by the Teletex service; their specific usage and format vary by country, but their general purpose is uniform:

- Normal Document is the standard document used to transfer user text in the Teletex service.
- Operator Document is a priority message from a Conversion Facility to the terminal operator. Some nations will use the Operator Document format to provide replies for Teletex directory information requests.
- Control Document is information sent by a terminal to control communication with the Conversion Facility. The message defines the type of terminal request (Telex interworking, date and time, directory service, etc.) and, if necessary, specific parameters regarding the request.
- Monitor Document is information sent from the Conversion Facility to be used internally by the terminal and not directly available to the operator. Although not yet fully defined, maintenance information, terminal identification, and date and time may be downloaded to the terminal in this manner.

*Level 7: Application.* The Application Layer defines the operating procedures required for the local use of the Teletex terminal and is not specifically a part of the Teletex protocol. This layer is involved with the noncommunication use of the

terminal (e.g., document creation and editing). Manufacturers develop unique Application Layers for their particular products, to allow the interaction of the terminal's text creation capability with its telecommunication capability.

### Telex interworking

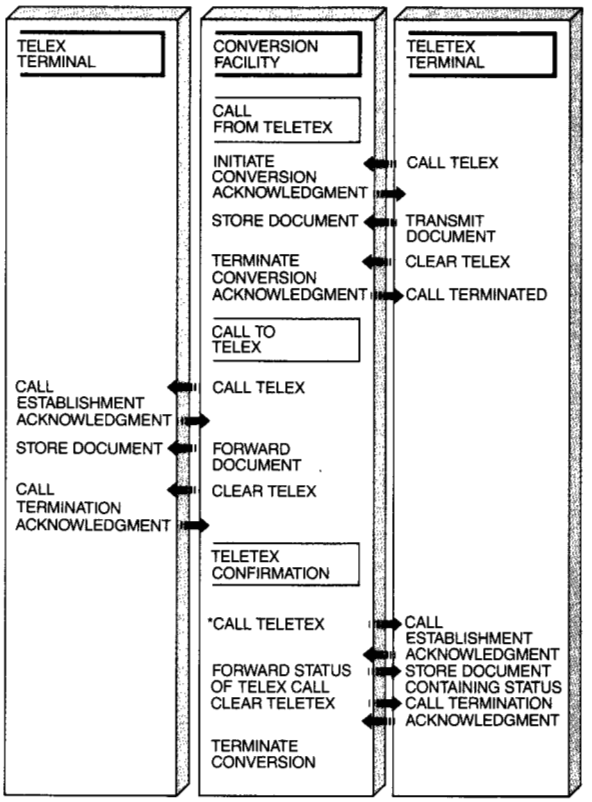
To provide access to the large number of Telex terminals throughout the world, each nation must develop a Conversion Facility (CF). A CF is a network-managed, store-and-forward device[24] that intercepts all calls between Teletex and Telex terminals and performs the necessary line speed matching. (Teletex is 2400 bits per second, and Telex is 50 bits per second.) CF also manages protocol and graphics code-point translation. To a Teletex terminal, the CF appears as another Teletex terminal; to a Telex terminal, the CF appears as another Telex terminal.

In Telex-to-Teletex communication, a document transmitted from a Telex terminal via a Conversion Facility to a Teletex terminal appears as a normal Teletex call to the Teletex terminal. No special handling is required. The text is limited to the character repertoire available to Telex, and letters are either all upper case or all lower case, depending upon the national Telex option. The CF converts the Telex protocol and data stream to the Teletex protocol and data stream. Since Telex does not use pagination, the CF generates the proper pagination controls (i.e., carriage return and form feed) and page-boundary checkpointing as required.

The Telex-to-Teletex interworking illustrated in Figure 8 performs as follows:

- Call from Telex: The Telex terminal establishes a call to the CF. Depending upon national requirements, the CF may immediately call the Teletex terminal to verify its operational state, and then terminate the Teletex call. The Telex terminal now transmits the document to the CF, where it is stored in the CF's memory.
- Call to Teletex: Upon complete reception of the document, the CF calls the Teletex terminal, forwards a Telex-to-Teletex-transformed version of the document to this terminal, and terminates the Teletex call.
- Telex confirmation: The CF returns a call verification indication to the Telex terminal and terminates the Telex call.

**Figure 9 Teletex-to-Telex interworking**




*IF A DOCUMENT WAS SUCCESSFULLY TRANSMITTED TO A TELEX TERMINAL THIS CALL IS OPTIONAL, AND ITS USE IS A NATIONAL OPTION.

In Teletex-to-Telex communication, a document prepared for transmission to the Telex terminal must be limited to the Telex graphics set (a subset of the Teletex graphics set) and to the 69-character Telex line length. Certain text limitations may be imposed to avoid misinterpretation of character combinations that are standardized for Telex. Other than these restrictions, a document transmitted from a Teletex terminal via a Conversion Facility to a Telex terminal appears as a normal Teletex call from a Teletex terminal.

The Teletex-to-Telex interworking illustrated in Figure 9 performs as follows:

- Call from Teletex: The Teletex terminal establishes a call to the CF and sends the document to the CF, where it is stored in the CF's memory. Once the entire document has been transmitted,

the Teletex terminal terminates the call, using normal Teletex procedures.

- Call to Telex: The CF calls the Telex terminal and forwards a Teletex-to-Telex-transformed version of the document to the Telex terminal. When the entire document has been transmitted, the CF terminates the Telex call.
- Teletex confirmation: The CF calls the Teletex terminal if the message cannot be successfully transmitted to the Telex terminal or if national requirements allow a successful document delivery confirmation call.

**Each nation provides a directory of its Teletex users to enable a terminal operator to obtain a document recipient's terminal identification.**

Certain countries allow interworking to terminals other than Telex, and the basic interworking procedure is similar.

### Directory service

Each nation provides a directory of its Teletex users to enable a terminal operator to obtain a document recipient's terminal identification. Depending upon national option, directory services may be published as a book, or may be accessed directly by a Teletex terminal through the Conversion Facility or through other data base services.

### National variations

Each nation offering Teletex has the freedom to extend the CCITT recommendation for use within its jurisdiction, so long as the service is compatible with that of other nations at its international gateways.

Some of the variations may be minor, such as the number of bytes of receive storage available when the operator is alerted, e.g., two kilobytes for Germany or four kilobytes for the United Kingdom. Some variations are extensive, such as that of allowing interworking with Teletypewriter Exchange (TWX) terminals in Canada and with the Public Message Switching Service (SPCM)[25] terminals in Spain. The European nations require a terminal to handle the ISO A4 paper format. Germany allows the construction of a graphic symbol from a letter overstruck with two diacritics; CCITT recommends the overstrike of only one diacritic. The United Kingdom allows three additional graphics when interworking with Telex terminals located within their country. Date and time are available from the network in Germany, from the Conversion Facility in Canada, and from the operator in the United Kingdom. Each nation has a unique protocol when dealing with its Conversion Facility.

In perspective, the national implementations of Teletex have much more in common than differences, and it is a tribute to the cooperative effort of the nations, recognizing a need to communicate, that so much of the Teletex protocol is uniform from country to country.

### Four examples of Teletex operation

Consider first a local Teletex call. Assume that the top left Teletex terminal of Figure 10, terminal TTX:A1 is to send a document to Teletex terminal TTX:A3. The TTX:A1 operator enters the document into the terminal and defines the terminal identification of the document's recipient as the network address of terminal TTX:A3. As the TTX:A1 operator returns to the normal typing tasks, terminal TTX:A1 automatically calls terminal TTX:A3, sends the document, terminates the call, and updates a document log status. Terminal TTX:A3 has automatically accepted the call, stored the document in its protected memory, and now alerts its operator that a received document is available. The TTX:A3 operator views its document log, and instructs the terminal to print the document. Note that the entire document transfer process is handled automatically by the two terminals involved.

In an example of an international Teletex call, terminal TTX:A1 sends a document to a Teletex terminal in another country, terminal TTX:B2. Except that terminal TTX:A1 must add an international dialing prefix and country code to the network address of terminal TTX:B2 as it establishes the call, everything else is the same as in the local Teletex call previously described.

The third example is that of a local Telex call. Here, Teletex terminal TTX:A1 is to transmit to Telex terminal TX:A2 within the country. Terminal TTX:A1 establishes the call to the Conversion Facility (CF) and identifies the network address of Telex terminal TX:A2. The method used to identify this address varies by country. For example, the Telex address is embedded within the CF network address in Germany, and the Telex address is sent to the CF within a Control Document prior to text transfer in the U.K. Teletex terminal TTX:A1 transfers the document to the CF and terminates the call. The transfer of the document to the Telex terminal from the CF is fully automatic and independent of the Teletex terminal.

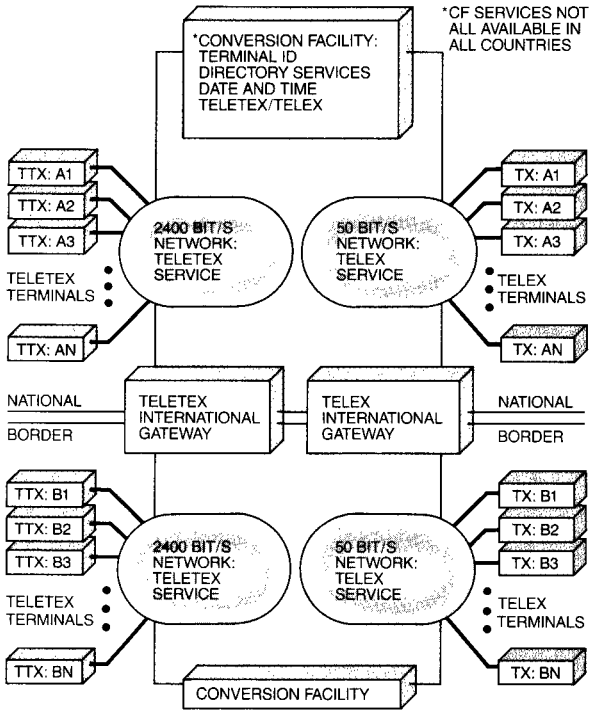
**There are three methods by which new capabilities may be added to the Teletex service: private protocol, national requirements, and CCITT recommendations.**

The last call is an international Telex call from Teletex terminal TTX:A1 to a Telex terminal in another country, terminal TX:B3. As in the previous example, the call is made by terminal TTX:A1 to the CF within its country, but now the network address of Telex terminal TX:B3 contains an international dialing prefix and country code. The CF makes the international call to terminal TX:B3 via the international Telex service, and performs the document transfer independently of the Teletex terminal.

### Concluding remarks

Teletex has just begun, and yet improvements and enhancements are already being considered. There are three methods by which new capabilities may be added to the Teletex service: private protocol, national requirements, and CCITT recommendations. A manufacturer or nation may offer a specific capability in the form of a private protocol that only terminals compatible with this protocol may use. Many new capabilities may start this way, but

**Figure 10 Teletex service example**




private protocol will allow only specified terminals to share this capability. New national capabilities may appear in the form of national variations to the CCITT recommendations. Although more terminals may share these capabilities, the problem of compatibility exists among nations. New CCITT capabilities will be proposed as modifications to the present CCITT recommendations. This approach allows a truly international implementation that will benefit all users.

There are a number of new capabilities under consideration for Teletex by various international standard groups that include the following:

- Mixed mode: the ability to combine the communication of text via existing Teletex protocol and noncharacter-coded information, such as drawings, pictures, logotypes, and signatures.
- Editable text: the ability to communicate documents in their original editable form as they are stored internally to a word-processing terminal. Teletex currently transmits a final-form version of a document as it would appear on a printed page.

- Videotex[26] interworking: the ability to provide access to Videotex data bases and thus allow a Teletex terminal to act as a Videotex terminal.
- Document routing: the ability to specify the person(s) to whom a document is to be sent, as well as any expected reply information.

Teletex has the potential to become a major force in telecommunications and to create a large business opportunity for communicating office machines. Teletex offers a relatively inexpensive and fast distribution, rich graphics set, and highly accurate alternative to postal and Telex services. Worldwide

**Teletex has the flexibility to extend its current capabilities and to provide for future needs by allowing additional features, by interworking with other services, and by utilizing new networks as they become available.**

Teletex terminal compatibility and interworking with Telex and other services provide access to over a million terminals. Automatic memory-to-memory communication frees the terminal operator from involvement in the document transmission and reception process. Teletex has the flexibility to extend its current capabilities and to provide for future needs by allowing additional features, by interworking with other services, and by utilizing new networks as they become available.

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I would like to recognize the contributions of André Henry, Larry Tate, and James Crutcher to the development of Teletex. They have represented IBM at various CCITT study group meetings over the years and have proposed numerous technical matters concerning Teletex. I also gratefully acknowledge the comments and criticisms of this paper by Terry Booth, Steve Cummings, Roger Forte, Keve Gabbert, and Carl Pingry.

### Cited references and notes

1. Telex is the name of a worldwide telecommunication service offered by Western Union that provides text communication between compatible terminals at 66⅔ words per minute, using a 50-character graphics set.
2. Teletypewriter Exchange (TWX) refers to North American telecommunications equipment that provides text communication between compatible terminals either at 60 words per minute using a 50-character graphics set or at 100 words per minute using a 95-character set.
3. *Kommission für den Ausbau des technischen Kommunikationssystems: Telecommunication Report*, Federal Ministry of Posts and Telecommunications, Bonn, Republic of Germany (1976).
4. The Deutsche Bundespost, the German Postal, Telephone, and Telegraph (PTT) government agency, regulates and oversees communication facilities within Germany. Most European nations use a PTT agency to provide this function.
5. The Televerket, the Swedish PTT, regulates and oversees communication facilities within Sweden.
6. *Teletex Terminal, Specification of Requirements*, Televerket, Sweden (1978).
7. The International Telegraph and Telephone Consultative Committee (CCITT) is a part of the International Telecommunication Union, an agency of the United Nations, and is responsible for international telecommunication service recommendations. The CCITT meets in four-year cycles culminating in a Plenary Assembly where the work of its study groups is voted upon and later published.
8. *Yellow Book, Volume II.4, Telegraph and Telematic Service Operations and Tariffs, Series F Recommendations*, CCITT Seventh Plenary Assembly, International Telecommunication Union, Geneva, Switzerland (1980).
9. *Yellow Book, Volume VII.2, Telegraph and Telematic Services Terminal Equipment, Series S, T Recommendations*, CCITT Seventh Plenary Assembly, International Telecommunication Union, Geneva, Switzerland (1980).
10. "CCG announces Teletex Service," news release by the Computer Communications Group (CCG) of the Trans-Canada Telephone System (TCTS), Ottawa, Canada (March 9, 1982).
11. "Europe's giant step in electronic mail," *Business Week*, pp. 106A–106E (May 17, 1982).
12. In this paper, the word "terminal" refers to the text-generating and communicating machine.
13. K. Schenke, R. Rüggeberg, and J. Otto, *Teletex, a New International Telecommunication Service for Text Communication*, Deutsche Bundespost, Bonn, Republic of Germany (1982).
14. High-Level Data Link Control (HDLC) is a set of protocols defined by the International Organization for Standardization (ISO) for carrying information over a link with error and flow control. Teletex uses the Asynchronous Balanced Mode (ABM) version of HDLC, as defined in CCITT recommendations X.25 and X.75.
15. A gateway is the network interface between networks of differing characteristics. The networks may differ in line speed, protocol, type (e.g., telephone vs packet), or other characteristic.
16. The International Organization for Standardization (ISO) develops standards for the international exchange of goods and services. ISO Technical Committee 97 is responsible for information processing standards.

17. Interworking is the facility of making a call between a terminal served by one service (such as Teletex) and a terminal served by another service (such as Telex).
18. This feature has provisional status and was approved by Working Party VIII/4 at Miami Beach, FL, June 7–11, 1982. A vote at the next Plenary Assembly is required for official status.
19. *Reference Model of Open Systems Architecture*, ISO Document ISO/TC97/DIS7498 (1982-10-22), available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.
20. *Yellow Book, Volume VII.1, Data Communication Over the Telephone Network, Series V Recommendations*, CCITT Seventh Plenary Assembly, International Telecommunication Union, Geneva, Switzerland (1980).
21. *Yellow Book, Volume VIII.2, Data Communication Networks; Service and Facilities, Terminal Equipment and Interface, Recommendations X.1–X.29*, CCITT Seventh Plenary Assembly, International Telecommunication Union, Geneva, Switzerland (1980).
22. *Yellow Book, Volume VIII.3, Data Communication Networks; Transmission, Signalling and Switching, Network Aspects, Maintenance, Administrative Arrangements, Recommendations X.40–X.180*, CCITT Seventh Plenary Assembly, International Telecommunication Union, Geneva, Switzerland (1980).
23. The word "bis" after a network interface name denotes a second version of the interface. If the third interface version should be defined, the word "ter" is used after the network interface name.
24. A store-and-forward device is a telecommunication network machine that has the ability first to store received information in a memory and then forward that information to the next recipient. The store-and-forward equipment involved in Teletex is the conversion facility.
25. The Public Message Switching Service (SPCM) is a telecommunication service that provides text communication between compatible terminals using a 91-character graphics set.
26. Videotex is a telecommunications service to link a television that contains modified electronics and a keyboard to a computer system so as to provide data base access.

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