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SERIES X: DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS
Public data networks – Interfaces

Procedures and methods for accessing a public data network from a DTE operating under control of a generalized polling protocol

ITU-T Recommendation X.42

ITU-T X-SERIES RECOMMENDATIONS

DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

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ITU-T Recommendation X.42

Procedures and methods for accessing a public data network from a DTE operating under control of a generalized polling protocol

Summary

This Recommendation defines procedures and a framework for providing access to a Public Data Network (PDN) by a DTE operating under the control of a generalized polling protocol, via the use of a Packet Assembly/Disassembly (PAD) device situated within (or associated with) the PDN. The PAD supporting the generalized polling protocol aspect is referred to as a "GPAD". The generalized polling environment provides support for access, along with basic requirements necessary within the PAD to enable the selection and modification of the protocol Aspect. This Recommendation has been developed in realization that a well-established base of DTEs operating under control of a generalized polled protocol needs to access a PDN. Also, procedures are defined that allow Internet Protocol (IP) enabled devices to access their corresponding networks over the generalized polling protocol defined under ITU-T Rec. X.42.

The revision is a result of comments received from implementers. Several clarifications are introduced that remove ambiguities in the areas of bit, field and frame sequencing; event conditions; and checksum algorithms.

Source

ITU-T Recommendation X.42 was approved by ITU-T Study Group 17 (2001-2004) under the ITU-T Recommendation A.8 procedure on 29 October 2003.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation X.42

Procedures and methods for accessing a public data network from a DTE operating under control of a generalized polling protocol

1 Scope

This Recommendation defines the procedures and methods for accessing a Public Data Network (PDN) from a DTE operating under the control of a generalized polling protocol via the use of a Packet Assembly/Disassembly (PAD) device situated within (or associated with) the PDN.

This Recommendation is the first of a set of Recommendations produced to facilitate asynchronous access to a PDN via Point-to-Multipoint (PMP) circuits. This Recommendation addresses the most important aspect of communications between the PAD and a subnetwork of terminals connected via PMP circuits – the multidrop data link protocol providing medium access arbitration, data link addressing and data protection for transmission over a PMP circuit.

For those terminal devices and PMP environments, which require expanded networking capabilities and which, in addition to PMP medium arbitration, transmission error detection, and station addressing, require transparent transmission of network layer PDUs within user data of X.42 information frames, an encapsulation class of procedures is defined.

In the case of IP-based networks, an X.42 PAD is therefore considered as a network edge device, which provides connectivity between PMP-based, IP-enabled terminals and IP-based devices on the opposite side of the network. There exist large networks of terminals connected to PDNs, characterized by low data throughput requirements both in terms of channel bandwidth and packet per second rate. Such a traffic profile mandates the need for a reduction of cost sensitive network architecture components, which traditionally grow as a function of the number of remote terminals. In a practical sense, this amounts to a requirement for various forms of concentration and clustering of switching equipment, tail circuits, virtual communications channels and trunks, such that the total number does not grow in direct proportion to the number of end users terminals. Major savings in cost and resource utilization can be achieved when effective sharing of data communications channels is applied.

The majority of the networks which utilize PMP technology are implemented using inexpensive analogue circuits and asynchronous data transmission. This configuration is prevalent in many transaction processing applications with request/response type traffic, consisting of a small number of short bidirectional messages.

To be economically viable, applications running over PMP circuits typically require very low unit cost data communications. Such low costs can only be achieved through major economies of scale leading to a lower telecommunications resource usage. These PDN resources, in the case of those complying with ITU-T Rec. X.25, are:

- multidrop ports;
- Telecommunications modems;
- X.25 DTEs, with an efficient concentration ratio of PAD X.25 DTEs to the total number of terminals;
- X.25 SVCs, with an efficient concentration ratio of X.25 SVCs to the total number of terminals;
- Call Establishment Requests, with a low ratio of total number of call requests to the total number of terminals; and
- Non-informational traffic, as the request/response characteristics of the traffic inherently induces piggy-back acknowledgments.

This Recommendation directly addresses these needs by providing simple, low complexity and bandwidth-efficient network resource management. Introduction of this protocol aspect enables a low cost offering, and opens PDN transport to a broad existing terminal base. See Figure 1.

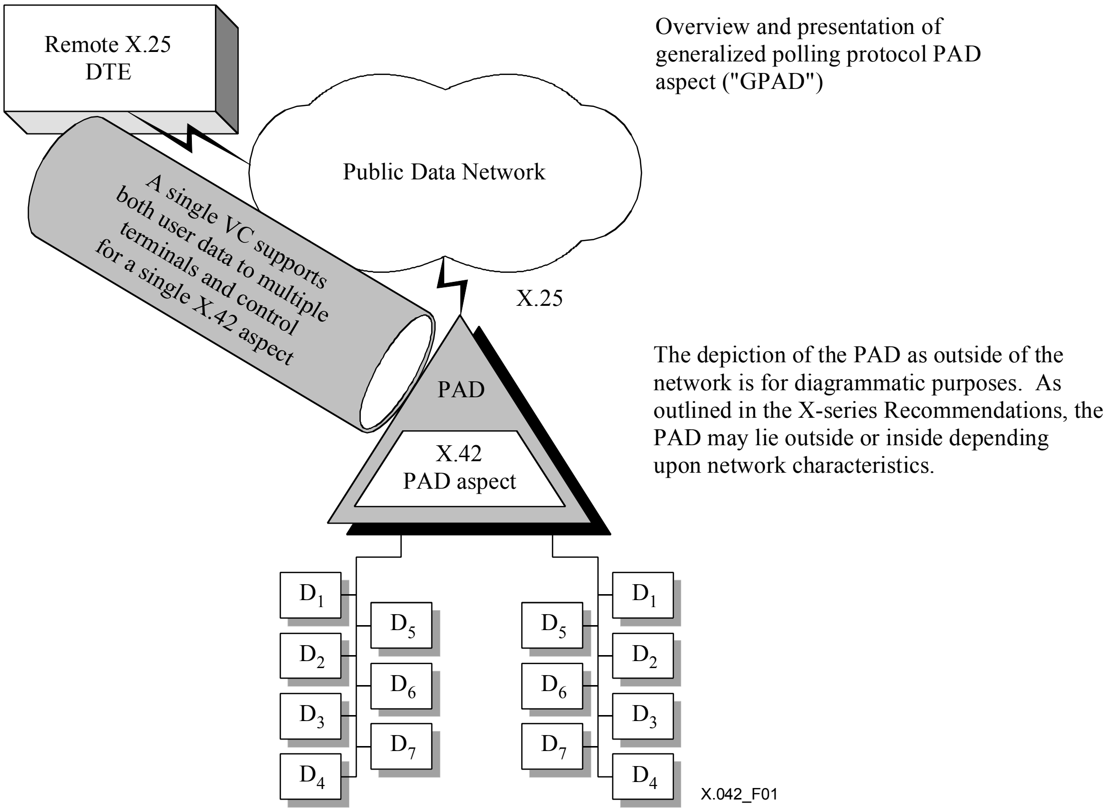


Figure 1/X.42 – GPAD environment

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation X.3 (2000), *Packet Assembly/Disassembly facility (PAD) in a public data network*.

– ITU-T Recommendation X.5 (1996), *Facsimile Packet Assembly/Disassembly facility (FPAD) in a public data network*.

– ITU-T Recommendation X.8 (1994), *Multi-aspect PAD (MAP) framework and service definition*.

– ITU-T Recommendation X.25 (1996), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit*.

– ITU-T Recommendation X.28 (1997), *DTE/DCE interface for a start-stop mode Data Terminal Equipment accessing the Packet Assembly/Disassembly facility (PAD) in a public data network situated in the same country*.

– ITU-T Recommendation X.29 (1997), *Procedures for the exchange of control information and user data between a Packet Assembly/Disassembly (PAD) facility and a packet mode DTE or another PAD*.

– ITU-T Recommendation X.38 (1996), *G3 facsimile equipment/DCE interface for G3 facsimile equipment accessing the Facsimile Packet Assembly/Disassembly facility (FPAD) in a public data network situated in the same country*.

– ITU-T Recommendation X.39 (1996), *Procedures for the exchange of control information and user data between a Facsimile Packet Assembly/Disassembly (FPAD) facility and a packet mode Data Terminal Equipment (DTE) or another FPAD*.

– ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The basic model*.

– ITU-T Recommendation X.213 (2001) | ISO/IEC 8348:2002, *Information technology – Open Systems Interconnection – Network service definition*.

– ITU-T Recommendation X.263 (1998) | ISO/IEC TR 9577:1999, *Information technology – Protocol identification in the Network Layer*.

– ITU-T Recommendation X.340 (1993), *General arrangements for interworking between a Packet-Switched Public Data Network (PSPDN) and the international telex network*.

3 Definitions

This Recommendation defines the following terms:

3.1 access information path: The communication link between a DTE and a GPAD.

3.2 access interface: A physical interface where a DTE is connected to a GPAD to use the functions it provides.

3.3 binary numbers: Base 2 numbers, represented by the digits 0 and 1 followed by the letter "b".

3.4 broadcasting: Global addressing or delivery of messages via the outbound information path, utilizing an address unique from all other addresses assigned to terminals on a particular GPAD port such that it is recognized by all terminals as its own. Broadcasting is always Unsolicited. Broadcasting does not generate any inbound acknowledgment traffic.

3.5 byte complement: Defined by complementing all eight bits of a byte.

3.6 drop: A station/terminal device connected to a PMP circuit operating in secondary mode.

3.7 generalized polling protocol packet assembly/disassembly facility: A facility that provides an access to a Public Data Network for a DTE which operates under control of a generalized polling protocol.

3.8 hexadecimal numbers: Base 16 numbers, represented by the digits 0 to 9 and A to F followed by the letter "h".

3.9 host DTE: The remote DTE that provides the upper layers of applications required to fully utilize the X.42 Generalized polling protocol access to the PDN (GPAD) functionality in specific application environments.

3.10 inbound information path: Data transfer from the terminal to the GPAD.

3.11 outbound information path: Data transfer from the GPAD to the terminal.

3.12 PAD aspect: A term that represents the logical function of a PAD operating with a specific protocol used by the DTE connected to a GPAD.

3.13 **port**: A representation of the attachment of a PMP circuit to a GPAD instance.

3.14 **solicited exchange traffic**: Solicited exchange consisting of one inbound (request) and one outbound (response). The terminal sends a request only when it is polled (i.e., unsolicited inbound data transfer is illegal).

3.15 **traffic**: Any data stream being sent by, or received by a terminal, may be considered as "traffic". Two types of traffic exist: Solicited Exchange Traffic and Unsolicited message Traffic.

3.16 **unsolicited message/traffic**: Data transfer activity directed outbound to individual terminals, asynchronous with respect to the request/response exchange traffic. Individual unsolicited outbound transfer requires inbound acknowledgements.

3.17 **upper layer information**: Defined as the actual user information conveyed in the information field of a frame.

4 Abbreviations

This Recommendation uses the following abbreviations:

AIP	Access Information Path
BIF	Broadcast Information Frame
CRC	Cyclic Redundancy Check
CRC-16	16-bit Cyclic Redundancy Check
DCE	Data-terminating Circuit Equipment
DLL	Data Link Layer
DRC	Diagonal Redundancy Check
DTE	Data Terminating Equipment
FCS	Frame Check Sequence
GPAD	Generalized Polling Protocol Accessed Packet Assembly/Disassembly Device
IP	Internet Protocol
ISIF	Inbound Solicited Information Frame
LRC	Longitudinal Redundancy Check
NLPID	Network Layer Protocol Identifier
NUA	Network User Address
OSIF	Outbound Solicited Information Frame
OUIF	Outbound Unsolicited Information Frame
PAD	Packet Assembly/Disassembly facility
PDN	Public Data Network
PDU	Protocol Data Unit
PMP	Point-to-Multipoint
PSDN	Packet Switched Data Network
TCP	Transmission Control Protocol
UDP	User Datagram Protocol

5 GPAD framework

A GPAD provides the means for terminals to access a PDN via multipoint circuits. A GPAD operates within the following framework:

- 1 to M ports are connected to one GPAD instance;
- 1 to N terminals are connected to one port and form a PMP circuit;
- a maximum of N × M terminals access the network via one GPAD instance;
- one GPAD instance is uniquely identifiable by its NUA (X.121 address); and
- there is exactly one X.25 SVC per GPAD instance (see Figure 2).

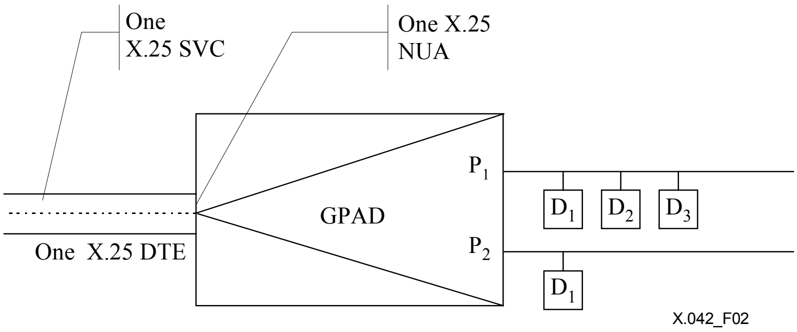


Figure 2/X.42 – GPAD minimal configuration

The minimum architecture of the subsystem from the GPAD point of view is as follows (see Figures 3 and 4):

- X.25 is considered a subnetwork access protocol (between the GPAD and the host);
- X.42 is considered a subnetwork access protocol (between the GPAD and the terminals);
- DTEs connected to one or more multipoint lines that all terminate at the same GPAD instance are considered one multipoint subnetwork; and
- the multipoint subnetwork associated with one GPAD instance is connected to the host via one X.25 SVC, and the GPAD instance is uniquely associated with and identifiable by one X.25 NUA (X.121 address) on the PDN (i.e., GPAD instance = one SVC = one NUA).

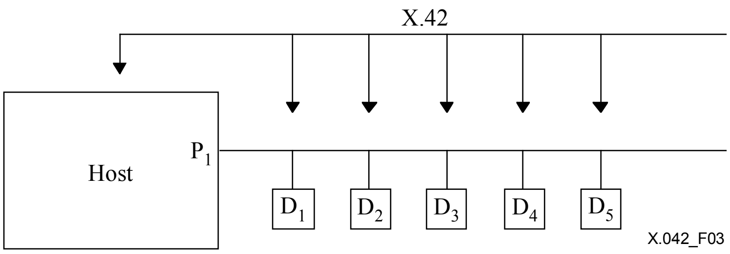


Figure 3/X.42 – GPAD minimum architecture – Traditional multipoint

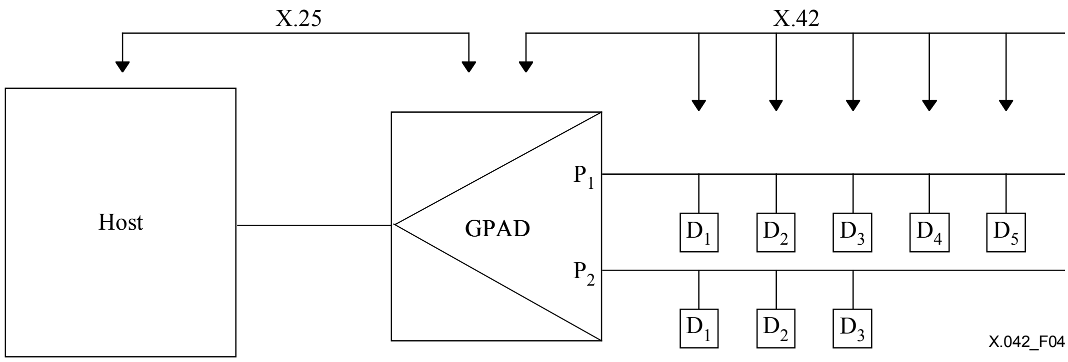


Figure 4/X.42 – GPAD minimum architecture – Networked implementation

5.1 Assumptions

Within the GPAD architecture, a need exists for functions, services and components which make the GPAD a complete operational unit, and facilitate a practical implementation. Such functions, services and components are presented in this Recommendation in their most fundamental form. Wherever possible, alternatives to increase the scope are referenced "... for further study...", and as such may be subject to expanded and/or additional Recommendations:

- For the purpose of this Recommendation, the provision of routing and relaying functions to the GPAD between connection end points (the host and the terminal) is based upon a simple multiplexing functionality possible over X.25. From a GPAD perspective, no restriction is placed upon the type of network layer protocol that delivers such function to higher layers (for the purpose of establishing an end-to-end communications channel). However, the reduction to a simple multiplexing function as proposed within this Recommendation (i.e., one that provides access to multiple terminals on a GPAD subnetwork over a single X.25 SVC channel) provides the foundation for more advanced capabilities.
- No inference should be taken due to the methods and procedures outlined herein in regard to data transfer link layer establishment over the PDN. This matter is left to the scope of other Recommendations and/or upper layers of National implementations.
- For the purpose of this Recommendation, no assumptions are made as regards the protocol information frame (I-Frame) sequencing and no procedures for link establishment or termination are recommended.
- For the purpose of this Recommendation, it is affirmed that the X.25 Q-bit functionality is adopted to provide in-call signalling over which the GPAD control/management protocol PDUs can be passed. Alternative methods for the provision of a separate channel for control/management are for further study.
- Basic configuration and management/maintenance tables necessary to operate a minimum GPAD, along with suggested values, can be found in Annex C. The utilization of a remote GPAD Management function to provide an interface into the GPAD configuration and maintenance tables, thus supplying access to basic parameters for the GPAD, X.25 and GPAD-PMP subnetwork entities, is presumed to be a matter left for National implementation. It is envisioned, however, that the potential support for the routing/relaying function of the Internetwork layer and its configuration parameters may be subject to future Recommendations (much in line with ITU-T Recs X.3 and X.5).
- In Encapsulation Mode, the fragmentation and reassembling mechanisms of the higher layer protocol shall be used. The maximum transmission unit (MTU) length shall be configurable and shall be implementation dependent.

This Recommendation provides a concise definition of the multipoint data link protocol limited in functionality to medium arbitration, data link addressing, error detection and start/stop, octet oriented transmission.

Internal organization and the information path architecture of a GPAD operating the X.42 protocol are shown in Figures 5, 6 and 7.

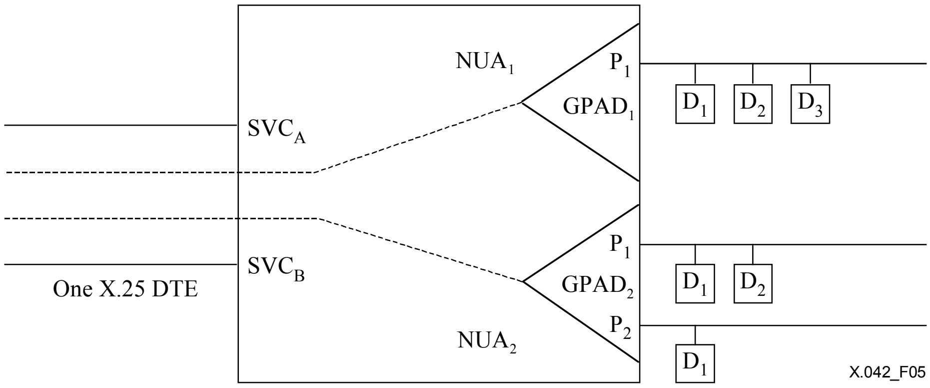


Figure 5/X.42 – PAD expanded configuration – Two GPAD instances

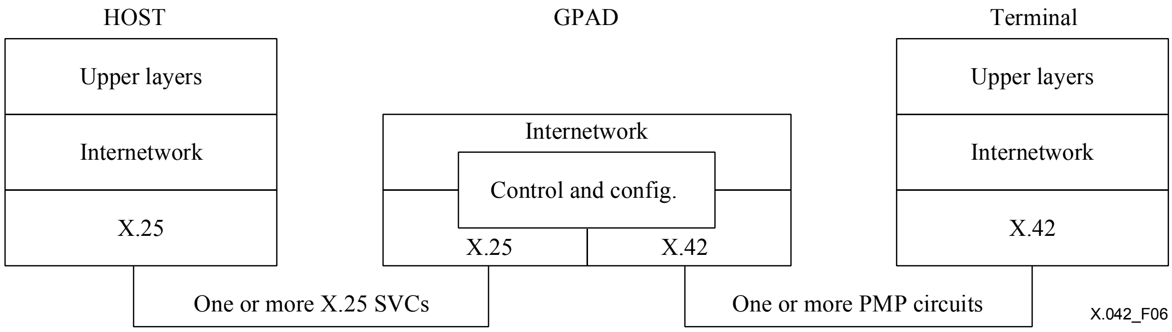


Figure 6/X.42 – Internal organization of the GPAD

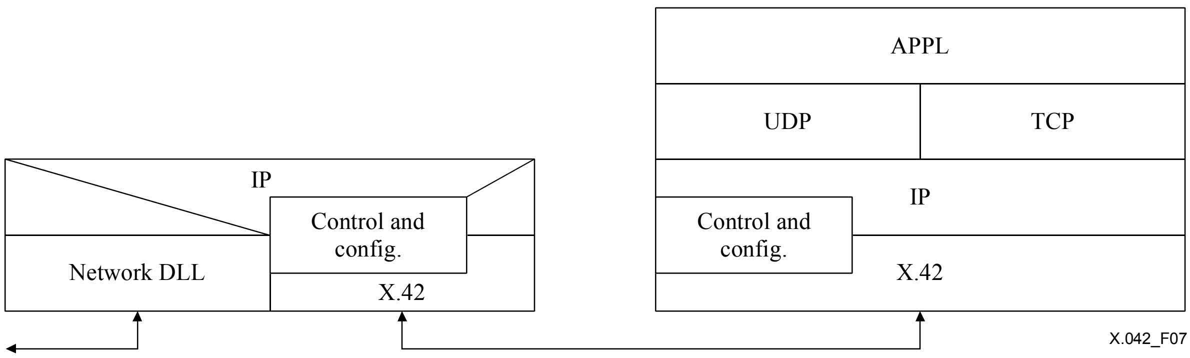


Figure 7/X.42 – Internal organization of GPAD terminal IP-enabled; X.42 encapsulation mode procedure class

6 General configuration

6.1 Data stations

The communication between a GPAD and its terminals exhibits the behaviour of a standard unbalanced link configuration. In such a primary/secondary architecture, two types of data stations are defined for control purposes:

- The primary station (GPAD) assumes responsibility for the organization of data flow, secondary station frame acknowledgment, error detection, and handling of the unrecoverable data flow conditions. The primary station sends command PDUs and receives response PDUs, but does not support any form of link layer connection establishment/termination and flow control to the terminals.
- The secondary station (terminal) sends response PDUs and receives command PDUs, but does not support any form of link layer establishment/termination and flow control. The secondary station supports some elements of frame acknowledgement and error detection (see 7.6).

6.2 Transmission considerations

6.2.1 Bit order

All control octets (i.e., octets which are not part of the information field) are transmitted low-order bit first (i.e., the first bit of the octet has the weight 2^0). The order of bits within the octets of the information field is not specified, but shall be held transparent end-to-end.

6.2.2 Start/Stop transmission

Each octet has eight data bits, no parity bits, and is delimited by single start and stop bits. Mark-hold (continuous logical 1 condition) is used to provide inter-octet time fill.

6.3 Protocol sequence

The primary station communicates with secondary stations one at a time. The atomic unit of communication between the primary station and a selected secondary station is referred to as a single protocol sequence. Only the primary station and selected secondary station are allowed to transmit during a protocol sequence. The beginning and end of each protocol sequence is delimited by LINK and/or ACK characters (see 7.1.1 and 7.1.2).

The protocol can be described as a chain of sequences, connected by linkage control characters, LINK and/or ACK. The trailing linkage character determines the validity of the sequence from the primary station's viewpoint, and also serves as the leading linkage character to the following sequence. These characters are only sent by the primary station.

7 Elements of procedure

7.1 Definition of PDUs and PDU components

7.1.1 LINK – Begin new sequence

The LINK character begins a new protocol sequence (an atomic protocol exchange) between the primary and the secondary stations. The LINK character may only be sent by the primary station.

7.1.2 ACK – Acknowledge

The ACK character acknowledges the last transmission from the secondary station, completes the current protocol sequence, and begins a new one. The ACK character may only be sent by the primary station.

7.1.3 ACB – Address Control Byte

The Address Control Byte contains the secondary station's unique poll address and the PDU type. The ACB may assume the following roles, based upon the PDU type.

7.1.3.1 PAD – Poll Address

Identifies the polled or responding secondary station and the PDU type.

Inbound The secondary station responds to a poll when it is ready to send inbound information. PAD is a part of the Inbound Solicited Information Frame (see 7.1.10.1).

Outbound The primary station seeks to initiate a new protocol sequence leading to either the transmission of an Inbound Solicited Information Frame (see 7.1.10.1) or Empty Poll sequence (see 7.2.2).

7.1.3.2 PAC – Poll Address Complement

Identifies the responding secondary station and the PDU type. PAC completes an Empty Poll sequence.

Inbound The secondary station informs the primary station that it does not have any information to send at the time of the poll.

Outbound Not used.

7.1.3.3 SAD – Select Address

Identifies the selected or responding secondary station and the PDU type.

Inbound The secondary station previously selected to receive the Outbound Solicited Information Frame (see 7.1.10.2) in this protocol sequence confirms a successful transmission. SAD completes the protocol sequence.

Outbound The primary station selects the secondary station for the transmission of the Outbound Solicited Information Frame (see 7.1.10.2). SAD is a part of the Outbound Solicited Information Frame.

7.1.3.4 SAC – Select Address Complement

Identifies the responding secondary station and the PDU type.

Inbound Notifies the primary station that the Outbound Solicited Information Frame was corrupt. SAC completes the protocol sequence.

Outbound Not used.

7.1.3.5 UAD – Unsolicited Address

Identifies the selected or responding secondary station and the PDU type.

Inbound The secondary station previously selected to receive the Outbound Unsolicited Information Frame (see 7.1.10.3) in this protocol sequence confirms a successful transmission. UAD completes the protocol sequence.

Outbound The primary station selects the secondary station for the transmission of an Outbound Unsolicited Information Frame. UAD is a part of the Outbound Unsolicited Information Frame.

7.1.3.6 UAC – Unsolicited Address Complement

Identifies the responding secondary station and the PDU type.

Inbound Notifies the primary station that the Outbound Unsolicited Information Frame was corrupt. UAC completes the protocol sequence.

Outbound Not used.

7.1.3.7 BRO – Global Address (Broadcast)

Identifies all secondary stations and the PDU type.

Inbound Not used.

Outbound The primary station selects all secondary stations associated with one PMP circuit for the transmission of an Broadcast Information Frame (see 7.1.10.4). BRO is a part of the Broadcast Information Frame.

7.1.4 ESC – Escape

Also referred to as an exception or complement character.

The ESC character is used as a means to effect binary code transparency of the information transfer. When any character of the information frame, including ACB and FCS characters, has the same value as one of the special protocol characters (see 7.4.1), the ESC character is inserted into the transmission stream preceding the data character in question, and the binary complement of the data character follows. The receiving station discards the ESC character and binary complements the following character.

7.1.5 ENQ – Enquire last transmission

ENQ may be sent by the primary station if the last transmission from the secondary station was interpreted as incorrect or corrupt. ENQ shall only be sent when the expected secondary station transmission was SAD, SAC, UAD or UAC.

X.42 PAD shall be pre-configured with maximum number of ENQs per inbound transmission sent and with the appropriate ENQ timeout.

7.1.6 ETX – End of text

This character is the last character of every PDU containing an information field.

7.1.7 CRC – Cyclic Redundancy Check

A 16-bit Cyclic Redundancy Check of all octets of the information frame, including all data from ACB to ETX inclusive. The CRC is calculated on the actual data, before the binary code transparency rules are applied (see 7.1.4).

7.1.8 LRC – Longitudinal Redundancy Check

Logical Exclusive OR (XOR) sum of all octets of the information frame, including all data from ACB to ETX inclusive. It is calculated on the actual data, before the binary code transparency rules are applied (see 7.1.4).

7.1.9 DRC – Diagonal Redundancy Check

Logical Exclusive OR (XOR) sum of all octets of the information frame, including all data from ACB to ETX inclusive. It is calculated in succession of one bit rotation of the current value of the sum to the right. DRC is calculated on the actual data, before the binary code transparency rules are applied (see 7.1.4).

7.1.10 Information PDUs

Format encoding for the PDU frames are found in 8.1.2.2.

7.1.10.1 ISIF – Inbound Solicited Information Frame

ISIF is sent by the secondary station in response to a PAD with a PAD matching secondary station address.

7.1.10.2 OSIF – Outbound Solicited Information Frame

OSIF is sent by the primary station and contains selected secondary station address. It is normally sent in response to a previous ISIF.

7.1.10.3 OUIF – Outbound Unsolicited Information Frame

OUIF is sent by the primary station and contains selected secondary station address. It may be sent at any time.

7.1.10.4 BIF – Broadcast Information Frame

BIF is sent by the primary station and contains global secondary station address. It may be sent at any time.

7.2 Procedures

7.2.1 Polling

7.2.1.1 Polling sequence

Polling shall be performed exclusively by the primary station. Polling is an operation which allows the primary station to interrogate selected secondary stations for inbound transmissions, and arbitrate access to the shared medium by multiple users. All inbound transmissions are initiated by a successful poll. The polling order is based on an algorithm, ideally, specific to the application being supported by the devices. The implementation of the GPAD is transparent to the specifics of the algorithm – just so as some order is adhered to. The inclusion of a standard or default algorithm (utilized when no application-specific order is provided) is for further study.

A single poll is defined as a transmission of a PAD by the primary station. It may result in one of three outcomes:

- Inbound Solicited Information Frame sequence (see 7.2.3);
- Empty Poll sequence (see 7.2.2);
- Poll Timeout sequence (see 7.4.2).

7.2.1.2 Normal and slow poll

The frequency of polling individual secondary stations shall be a function of a station's consistency in responding to polls. At least two levels of priority shall be provided to distinguish between stations which responded on their last poll and those that did not (see 7.4.2). The respective secondary stations shall be grouped into normal and slow poll pools. Exclusion of the offending stations is necessary to protect the overall performance of the PMP circuit.

7.2.1.3 Poll priority option

The primary station may administer a more elaborate poll priority to account for variance in the number of missed polls. Other factors may be taken into consideration to dedicate priorities between the secondary stations, for example:

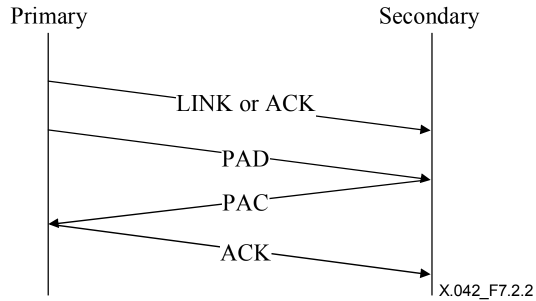
- time elapsed since last successful poll;
- total accumulated time during which the secondary station has not responded to polls;
- total number of offending stations on the PMP circuit.

7.2.1.4 No Poll option

In Selective Poll mode of operation (see 9.3), the primary station shall put an individual secondary station into a no-poll pool for the duration of period of time between the transmission of ISIF and the transmission of OSIF.

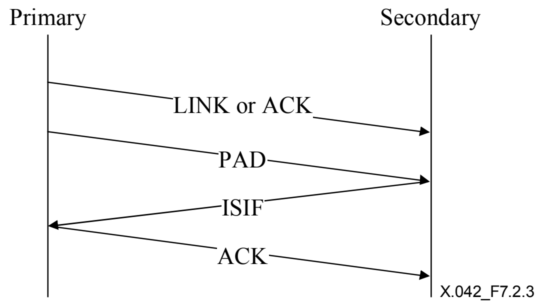
7.2.2 Empty Poll sequence

The secondary station uses this sequence to inform the primary station that it does not have any information to send at the time of the poll.



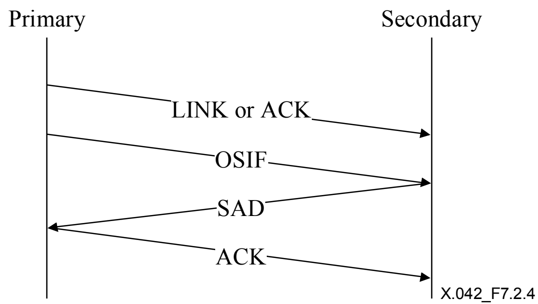
7.2.3 Inbound Solicited Information Frame (ISIF) sequence

The secondary station uses this sequence as a positive response to a poll, sending inbound information.



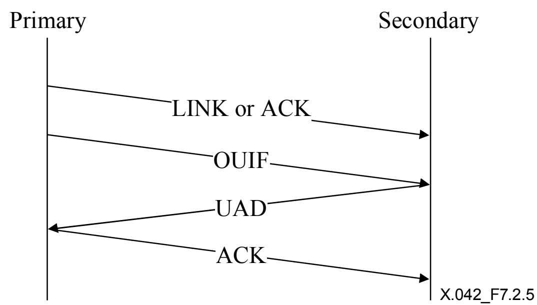
7.2.4 Outbound Solicited Information Frame (OSIF) sequence

The primary station uses this sequence to send outbound information to a secondary station in accordance with 9.3.1 and 9.3.2.



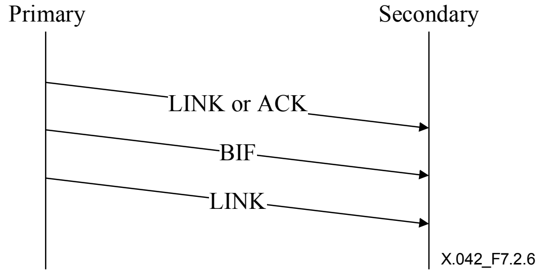
7.2.5 Outbound Unsolicited Information Frame (OUIF) sequence

The primary station uses this sequence to asynchronously send outbound information to a secondary station.



7.2.6 Broadcast Information Frame (BIF) sequence

The primary station uses this sequence to broadcast information to multiple secondary stations.



7.3 Full/Half-duplex considerations

Under normal situations, the support of terminals conforming to this Recommendation will operate under half-duplex transmission mode. However, nothing within this Recommendation precludes the use of full duplex transmission. Specific care and attention to order-of-receipt and protocol sequence violations/interrupts, must be realized. Accordingly, the impact in the application of full duplex technology to this Recommendation conforming systems is left for further study.

7.4 Timeout function considerations

7.4.1 General

In order to detect a no-reply or lost reply condition, each station shall provide a timeout function. The expiration of the timeout function shall initiate appropriate exception handling procedures.

7.4.2 Poll Timeout

The Poll Timeout value shall depend on the polling pool (see 7.2.1.2 and 7.2.1.3) the individual station is assigned to. Faster poll pool stations shall have longer Poll Timeout values, and slower poll pool stations shall have shorter Poll Timeout values. The value of this timeout is considered application specific. See also Annex C.

Start/Restart condition	PAD sent by the primary station.
Stop condition	PAD or PAC received by the primary station. If PAD is received, it is received as a part of the Inbound Solicited Information Frame.
Action	Secondary station poll priority shall be affected. The secondary station is moved to a lower polling priority pool.

7.4.3 Intercharacter timeout

Start/Restart condition	A character received by the primary or the secondary station as a part of an information frame (see 7.1.10). Start/restart applies to all but the last frame character (which is the second octet of FCS).
Stop condition	The next frame character received.
Action	The information frame shall be discarded. Negative acknowledgment shall be sent by the secondary station (SAC, UAC), or a new protocol sequence shall be initiated by the primary station (LINK is transmitted).

7.4.4 Acknowledgment timeout

Start/Restart condition	An information frame transmission is completed.
Stop condition	SAD, SAC, UAD or UAC received by the primary station. ACK received by the secondary station.

Action	The primary station shall start a new protocol sequence. The secondary station's poll priority shall be affected. The secondary station is moved to a lower polling priority pool. Secondary station shall wait for a new protocol sequence.

7.4.5 Response timeout

The response timeout takes effect only in the Selective Poll Mode of operation (see 9.3).

Start/Restart condition	ISIF transmission is completed.
Stop condition	OSIF transmission to the secondary station in question is completed.
Action	Primary station will move the secondary station in question from the no-poll pool to the normal poll pool (of any priority which allows polls).

7.5 Link end points association

No link establishment or shutdown is defined between the primary and the secondary stations. A protocol sequence is the only logical association between the end points of the data transmission, and lasts for the duration of the atomic data exchange. The protocol sequence is always initiated by the primary station (with LINK or ACK characters, see 7.1.1 and 7.1.2).

7.6 Error detection and recovery

All PDUs containing an information field (see 7.1.10) also contain a Frame Check Sequence (FCS) (see 8.1.2.1.3).

The FCS is recalculated by the receiving station, and upon the discovery of data corruption the entire frame is discarded. Recovery from errors is accomplished as follows:

7.6.1 Inbound Solicited traffic

Upon discovery of an FCS error, the primary station will initiate a new protocol sequence by transmitting LINK.

7.6.2 Outbound Solicited/Unsolicited traffic

Upon discovery of an FCS error, the secondary station will transmit a negative acknowledgment PDU (SAC or UAC). Upon receipt of this negative acknowledgment, the primary station will initiate a new protocol sequence by transmitting LINK.

7.6.3 Broadcast

The error detection functions are based on the FCS. There is no error recovery provision for broadcast transmission. No inbound negative acknowledgment transmission is allowed.

7.7 Addressing conventions

A station individual address uniquely identifies a station within one PMP circuit. The broadcast address shall be recognized by all secondary stations.

8 Structure and encoding of Protocol Data Units (PDUs)

8.1 PDU types

8.1.1 Basic Elements of Information Frames

An information frame consists of:

- An Address Field (which always contains an Address Control Byte, and, optionally, contains an Extended Address Byte);

- A Network Layer Protocol Identifier (NLPID) (Encapsulation Mode only);
- An Information Field; and
- A Frame Check Sequence.

The length of the Address Field may be one or two bytes long, depending whether the Extended Address (EAD) is present. The length of the NLPID is one byte. The length of the Information Field is variable and may be limited.

8.1.1.1 ACB – Address Control Byte

ACB provides the means for local addressing of stations, and for qualifying polls and information frames.

When the Station Address field so indicates, the ACB may be followed by an extended address byte (EAD).

The bit labels that define subfields of the ACB and EAD are defined as follows:

S = Address Control Byte type indicator bit

A = Address field bit

X = Extended Address field bit

E = 0 and is reserved (for future use).

R = 1 and is reserved (for future use).

The ACB configurations are depicted in Figures 8 and 9.

8	7	6	5	4	3	2	1	Bit / Byte
E	S	S	A	A	A	A	A	1

Figure 8/X.42 – ACB simple address configuration

8	7	6	5	4	3	2	1	Bit / Byte
E	S	S	A	A	A	A	A	1
X	R	X	X	X	X	X	X	2

Figure 9/X.42 – ACB extended address configuration

The coding values for the subfields of the ACB and EAD are depicted in Figures 10, 11 and 12.

ACB type	SS value
PAD	10b
SAD	01b
UAD	11b

Figure 10/X.42 – ACB type coding values

Address type	AAAAA value
Normal	0h – 1Dh
Simple/extended address indicator	1Eh
Broadcast (all stations)	1Fh

Figure 11/X.42 – Simple station address coding values

XRXXXXXX value	40h – FEh

Figure 12/X.42 – Extended station address coding values

Given PAD, SAD, and UAD, the following ACBs are additionally defined in Figure 13.

ACB	Defined as
PAC	Binary complement of PAD
SAC	Binary complement of SAD
UAC	Binary complement of UAD

Figure 13/X.42 – PAD, SAD, and UAD definition

For simple addresses, PAC, SAC, and UAC are created by complementing all 8 bits of the ACB including the E and SS bits. For extended addresses PAC, SAC and UAC are created by complementing all 8 bits of the EAD.

8.1.1.2 Station Address Field

The station address is a binary number, in the range 0-29. Value 30 is reserved extended address indicator. Value 31 (all 1's) is designated as a global/broadcast address.

8.1.1.3 Extended Address Field (optional)

The station extended address, if present, is a 7-bit binary number in the range 0-127. The EAD byte is formed by left shifting the most significant bit of the station extended address to form an 8-bit binary number. The second most significant bit of the EAD is set to 1. The EAD is an 8-bit binary number, in the range 64-254.

8.1.1.4 Network Layer Protocol Identifier (NLPID)

In Encapsulation Mode, all information frames contain a Network Layer Protocol Identifier, which shall be used as a protocol discriminator under conditions when multiple network protocols are encapsulated in ITU-T Rec. X.42.

The values of NLPID shall be consistent with those set forth in ITU-T Rec. X.263.

8.1.1.5 Information Field

The information field is a sequence of bytes. The maximum length of the information field may be limited, and is implementation dependent.

8.1.1.6 Frame Check Sequence

The Frame Check Sequence is computed over all bytes of the information frame, including all data from ACB to ETX, inclusive. The CRC is calculated over the actual data before the binary transparency rules are applied.

The FCS may utilize one of two different algorithms, as a matter of local configuration:

- LRC and DRC; or
- CRC-16.

The length of the FCS is two bytes.

8.1.2 Information frames

8.1.2.1 Types of information frames

The information frames contain the station address, message type, information content, and the FCS section.

EAD is optional and present when the Station Address in the ACB is set to 30.

NLPID is present only if the Procedure Class is set to Encapsulation Mode.

Fields in frames of all frame types are ordered to begin with the ACB and to end with one or more FCS.

8.1.2.1.1 ISIF – Inbound Solicited Information Frame

Simple address mode:

PAD	NLPID	INFORMATION	ETX	FCS1	FCS2

Extended address mode:

EAD	NLPID	INFORMATION	ETX	FCS1	FCS2

8.1.2.1.2 OSIF – Outbound Solicited Information Frame

SAD	EAD	NLPID	INFORMATION	ETX	FCS1	FCS2

8.1.2.1.3 OUIF – Outbound Unsolicited Information Frame

UAD	EAD	NLPID	INFORMATION	ETX	FCS1	FCS2

8.1.2.1.4 BIF – Broadcast Information Frame

BRO	NLPID	INFORMATION	ETX	FCS1	FCS2

8.1.2.2 Sequencing of information frames

There is no frame sequence enforcement inherent to this Recommendation. It is assumed that ordering of higher layer data will be maintained by the higher layers.

In Selective Poll Mode, means are provided to enforce certain inbound/outbound traffic rules.

In Encapsulation Mode specific rules are adopted for selection of X.42 information frames to carry higher layer traffic.

8.2 Data transparency

The information field may contain octets with any bit combination. Since this Recommendation uses specific control characters for link supervisory purposes, and those control characters may occur in the data stream, a control octet escape rule is imposed to ensure binary code data transparency (see 7.1.4).

8.2.1 Protocol characters

The following protocol control characters are recognized and are transmitted with any necessary binary code transparency:

Protocol control character	Hex value
LINK	09h
ACK	06h
ESC	0Fh
ETX	03h
ENQ	05h

Figure 14/X.42 – Protocol control characters and their coding values

8.2.2 Control character escape sequences

In place of the protocol control (see 8.2.1) characters, the following sequences are transmitted to effect binary code transparency:

Protocol control character	Hex value
LINK	0Fh F6h
ACK	0Fh F9h
ESC	0Fh F0h
ETX	0Fh FCh
ENQ	0Fh FAh

Figure 15/X.42 – Protocol control characters' escape sequence coding values

9 Classes of procedures

9.1 X.42 PAD configuration

An X.42 PAD may follow several polling and traffic enforcement schemes as well as several frame selection modes. For the purpose of this Recommendation, it is assumed that the X.42 PAD (primary station) and the terminals (secondary stations) may have the ability to be configured to operate with:

- Multiple, simultaneous, variable intensity, polling regimes: fast poll, slow poll, no-poll, and variable priority poll;
- ISIF outstanding flag;
- ISIF outstanding timeout;
- Poll Timeout;
- Poll Priority;
- Procedure Class selection flag.

Each drop on an X.42 PAD shall be individually configurable for Procedure Class.

9.2 Normal Poll Mode class

In the Normal Poll Mode of operation, neither the primary station nor the secondary stations shall infer any static or dynamic association between the polling sequence and the Information Frame traffic. The sequence of the Information Frames, as well as the intensity of the traffic in the direction of the secondary and primary stations, is fully controlled by the upper layer. The protocol activity is limited to the medium arbitration, data transfer, and error detection.

Changes in the polling method and/or schedule resulting from the no-reply conditions, apply normally.

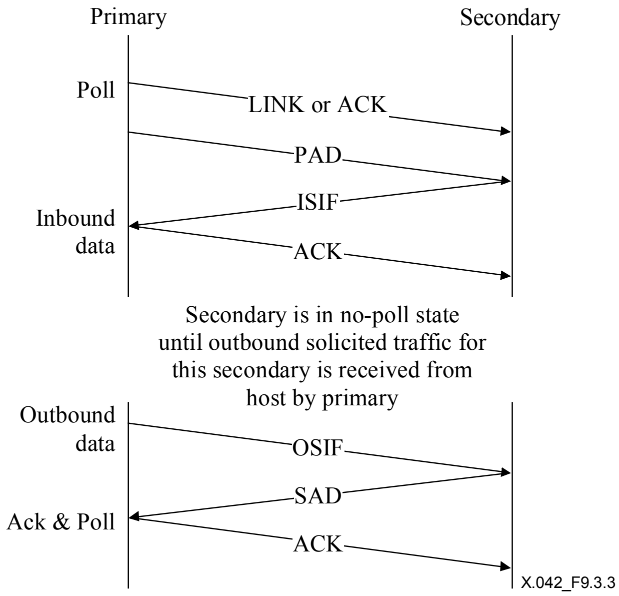
9.3 Selective Poll Mode class – Description of procedures

9.3.1 Polling

Once a solicited inbound message is transmitted to the primary station, both the primary and the secondary stations enter an outstanding inbound message state. The primary station recognizes and maintains such state separately for every secondary station, and will put an outstanding secondary station into the no-poll state. The primary station will then wait for any outbound solicited traffic to occur to that particular secondary station. Only once that takes place will the secondary station be moved back into the normal poll state, and scheduled to be polled again in its due time. Response timeout (see 9.3.5.1) is the second condition upon which the resumption of polling will take place.

9.3.2 Solicited Inbound/Outbound Exchange sequence

All ISIFs need to be satisfied by OSIFs, one at a time.



9.3.3 Unsolicited Frame sequence

An unsolicited message will be accepted by the selected secondary station in any state of its inbound/outbound exchange with the primary station, and the message will be passed to the upper layer upon arrival (i.e., without waiting for the completion of the solicited exchange).

9.3.4 Broadcast Frame sequence

A broadcast message will be accepted by all secondary stations in any state of their inbound/outbound exchange with the primary station, and will be passed to the upper layer upon arrival (i.e., without waiting for the completion of the solicited exchanges).

9.3.5 Error conditions

9.3.5.1 Response timeout

A response timeout is a condition resulting from the lack of OSIF transmission matching previously transmitted ISIF and allowing the ISIF-outstanding flag to be reset. When operating in the Selective Poll Mode of operation, it is primary station's responsibility to maintain the record of all ISIF transmission, ISIF-outstanding flags, and corresponding timeouts.

Upon the expiration of the response timeout the following actions shall take place:

- Primary station will move the secondary station in question from the no-poll pool to the normal poll pool (of any priority which allows polls) whereby the secondary station will become eligible for polls again.
- It is envisioned that the secondary station shall notify the upper layer that no matching OSIF arrived. The means of such notification are not a subject of this Recommendation.
- If primary station's timeout expired before the secondary station's, once the secondary station is polled, it shall stop its response timer. It is left for further study as to the potential applicability of this timer to this layer of protocol communications.
- If secondary station's timeout expires before the primary station's, the secondary station shall continue to wait for a poll.

9.3.5.2 FCS error

Inbound FCS error shall result in an origination of a new protocol sequence.

Outbound FCS error shall result in a negative acknowledgment and an origination of a new protocol sequence.

9.4 Poll priority mode class

May also apply to 9.2 and 9.3. See also 7.2.1.2 and 7.2.1.3 for further references.

Primary station will adjust the polling priority of secondary stations when they time out on polls or acknowledgments. It is left for further study if the values used in polling timers may be subject to a table entry in this Recommendation (and its annexes and/or a separate Recommendation).

9.5 Encapsulation Mode Class – Description and procedures

In the Encapsulation Mode Class of Operation, the X.42 PAD and the associated terminals shall follow the following rules.

9.5.1 Network Layer Protocol Identifier present

The NLPID will be used to discriminate network protocols operating above, and encapsulated within, the X.42 layer.

9.5.2 CRC-16 FCS

While operating in the Encapsulation Mode, the concatenated bytes one and two of the FCS shall be calculated according to CRC-16 algorithm (see ITU-T Rec. V.42).

9.5.3 Frame selection

The higher layer PDUs will be encapsulated in the following frames:

Traffic direction	X.42 Frame
X.42 PAD to terminal	OUIF
Terminal to X.42 PAD	ISIF

Figure 16/X.42 – Higher layer PDUs encapsulation

9.5.4 Frame procedure

An X.42 PAD and attached terminals configured in the Encapsulation Mode will operate in a state less manner. All X.42 PDUs will be independent datagrams.

9.5.5 Error handling

Transmission errors shall be handled according to general rules of this Recommendation. In particular under X.42 frame loss rules, higher communications layers shall be responsible for processing of retransmissions and managing retransmission timeouts and counters.

9.5.6 Broadcast

When all terminals associated with one X.42 port belong to a common Procedure Class, the higher layer broadcast addressing functions shall be converged with X.42 layer broadcast facility.

10 Proxy operation

For further study. See Annex D.

Annex A

Point-to-Multipoint (PMP) network

The following definitions apply to multipoint/multidrop technology within telephony systems:

A.1 multipoint: A configuration, topology or layout, designed to transmit data on a common circuit among locations served by several central offices of telephone company.

A.2 multipoint line: A single, interoffice communications line that connects to more than one central office.

A.3 multidrop: A communication arrangement whereby multiple devices share a common transmission channel, bridged at the central office.

A.4 multidrop line: An interoffice communication line that includes at least one central office termination which connects to more than one end-user termination.

A Point-to-Multipoint (PMP) network, which is also called a multidrop network, refers to an arrangement where multidrop lines are interconnected with multipoint lines to create a star architecture with a large number of remote drops (sometimes called legs) and a small number of main (master) circuits concentrated in one physical location. The transmit data on the main circuit are received by all remote drops. The transmit data of the remote drops are received only by the main circuit.

The multidrop network facilities can be either analogue or digital. In the analogue design, the circuits are bridged in summing amplifiers producing one out of all remote drop signals. The digital equivalent uses individual line termination units, output signal of which is logically OR'ed in local exchanges or wiring centers.

Annex B

Explanatory notes on the implementation of frame check sequences

B.1 Longitudinal Redundancy Check (LRC)

Assuming the first octet of data to be checksummed is in position data[0] and that the last octet of data is in position data[number_of_octets – 1], use the following pseudo code to calculate LRC of data[0 – number_of_octets].

residual_value = 0;

for (i = 0; i < number_of_octets; i++);

residual_value = residual_value .xor. data[i].

B.2 Diagonal Redundancy Check (DRC)

Assuming the first octet of data to be checksummed is in position data[0] and that the last octet of data is in position data[number_of_octets – 1], use the following pseudo code to calculate DRC of data[0 – number_of_octets].

residual_value = 0;

for (i = 0; i < number_of_octets; i++);

residual_value = rotate_right_one_bit (residual_value) .xor. data[i].

Annex C

Table C.1/X.42 – Typical X.42 GPAD configuration parameters

GPAD configuration parameter	Range of considered value(s) (Note)
1) Maximum number of terminals per PMP circuit	30
2) Maximum number of terminals per GPAD	(Number of PMP circuits) (Note) 157
3) Poll list configuration	An ordered list of terminal addresses; one entry per terminal:
3a. Operational mode	Normal mode Selective Poll Mode Poll Priority Mode Encapsulation Mode
3b. Checksum mode	LRC/DRC CRC-16
3c. Response timeout	If operational mode set to Selective Poll Mode
4) Timeout values	
4a. Normal poll timeout	1 s/(actual number of terminals on the PMP circuit) It is recommended that the terminals occupying lower priority polling pools operate under shorter than the normal poll timeout
4b. Intercharacter timeout	10 (Note) (character transfer time)
4c. Acknowledgment timeout	1 s/(actual number of terminals on the PMP circuit)
5) Maximum length of X.42 information frame (MTU)	Implementation dependent
NOTE – For further study.	

Table C.2/X.42 – X.42 GPAD configuration and management commands

Action	Comments
1) Initialize port	Restart Level 1 of the PMP circuit
2) Configure poll list	List order is application dependent
3) Add/delete terminal to/from poll list	Deletions should be preceded by disabling the terminal
4) Terminal polling enable/disable	Should only be executed while the terminal is not participating in a protocol sequence
5) Port poll enable/disable	Should allow all current protocol sequences of all effected terminals to terminate
6) Display fast poll, slow poll, no poll terminals	Implementation dependent
7) Display poll priority	Implementation dependent
8) Define poll algorithm	Implementation dependent
9) Define timeouts values	Implementation dependent
10) Configure X.25 DTE (Calling NUA, and other X.25 Level 2 and 3 parameters)	Implementation dependent
11) Configure Internetwork protocol	Implementation dependent
12) Reset GPAD	Resets the GPAD back to power-on configuration
13) Reset port	Resets a port on GPAD back to power-on configuration

Annex D

Proxy Operation – X.42 PAD with proxy terminal IP code

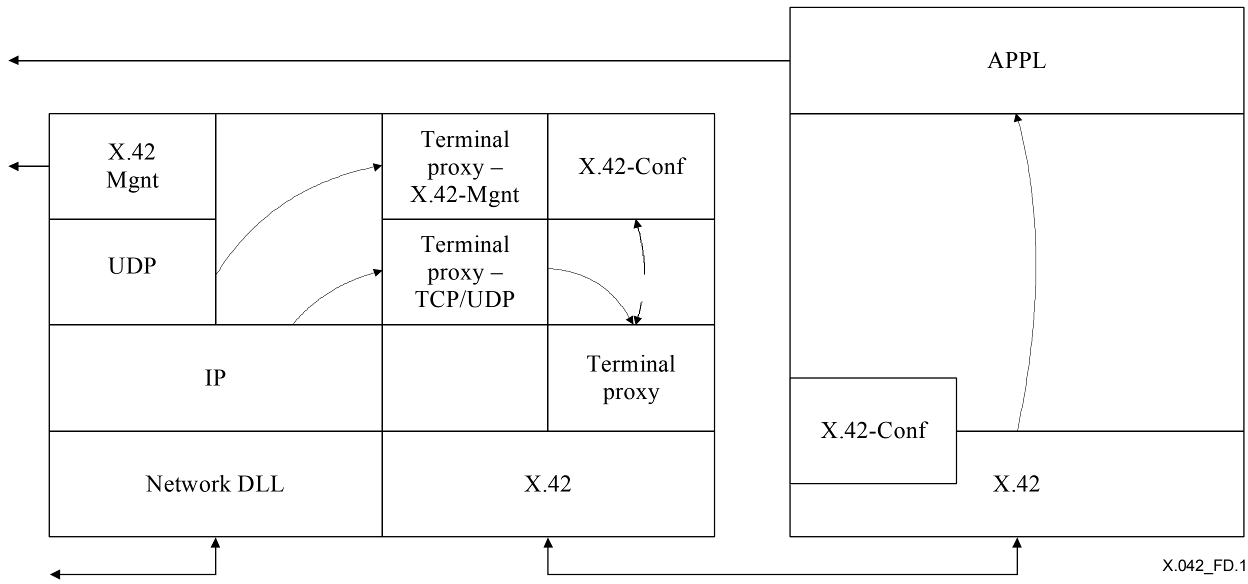


Figure D.1/X.42 – X.42 PAD with IP addressable terminals

The X.42 PAD Proxy is an entity providing a termination of the IP network on behalf of PMP based terminals which require IP addressability but do not have native IP software stack.

The Proxy will act as a logical conduit between the application software of the terminal and its entry point to its designated, virtual IP environment on the PAD.

The Proxy will use ITU-T Rec. X.42 to transport the application layer data between the terminal and the PAD by emulating the service access point between the application layer and the TCP/UDP layer of the terminals with the native IP code present.

From the standpoint of the PAD, in its effort to deliver a TCP/UDP/IP PDU to a PMP based, IP-addressable terminal, the Proxy represents the final destination. The Proxy function responsible to deliver application data to the terminal application layer will invoke the X.42 procedures to accomplish physical data transfer.

Appendix I

The following diagrams are provided for clarification and informational purposes only. As an appendix to this Recommendation, these diagrams provide information for the reader that may be considered useful when adding support for this Recommendation to existing systems and/or when implementing new system architectures.

As ITU-T Rec. X.42 focuses on the interface between the GPAD and polled DTEs, some assumptions have been taken regarding the actual application host system (see 5.1). In the following diagrams, the assumptions have been considered and included in references to the host system. Readers should be aware that different assumptions may apply depending upon the specific application being supported by this Recommendation and/or further enhancements/promulgation of related Recommendations.

Five different scenarios are presented in the following diagrams:

Figure I.1

- Solicited inbound and outbound information exchange between a host and terminal T_1.
- Empty poll sequence between GPAD and terminal T_2.

Figure I.2

- Unsolicited confirmed information sent from host to terminal T_1.
- Broadcast information sent from host to terminals T_1 and T_2.

Figure I.3

- Unsolicited outbound transmission error between GPAD and terminal T_1, and successful recovery.

Figure I.4

- Timeout on response from host during solicited inbound information exchange between host and terminal T_1.
- Empty poll sequence between GPAD and terminal T_2.

Figure I.5

- Solicited inbound transmission error between terminal T_1 and GPAD, and successful recovery.

Comments and clarification for each scenario are presented with the diagrams where necessary.

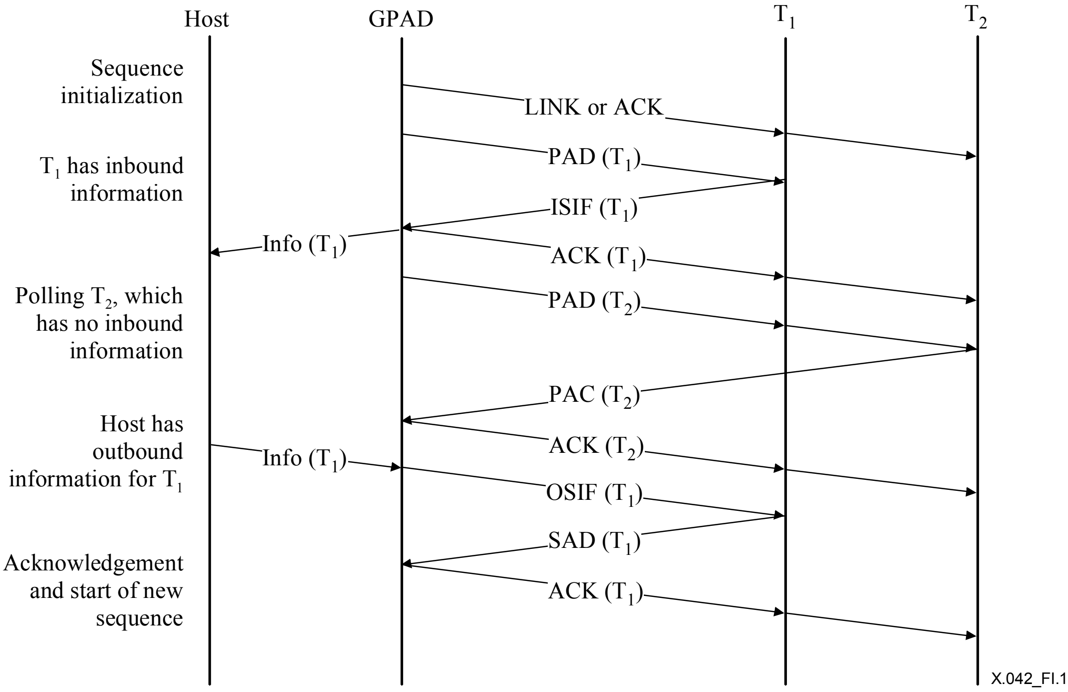


Figure I.1/X.42 – Solicited inbound/outbound exchange

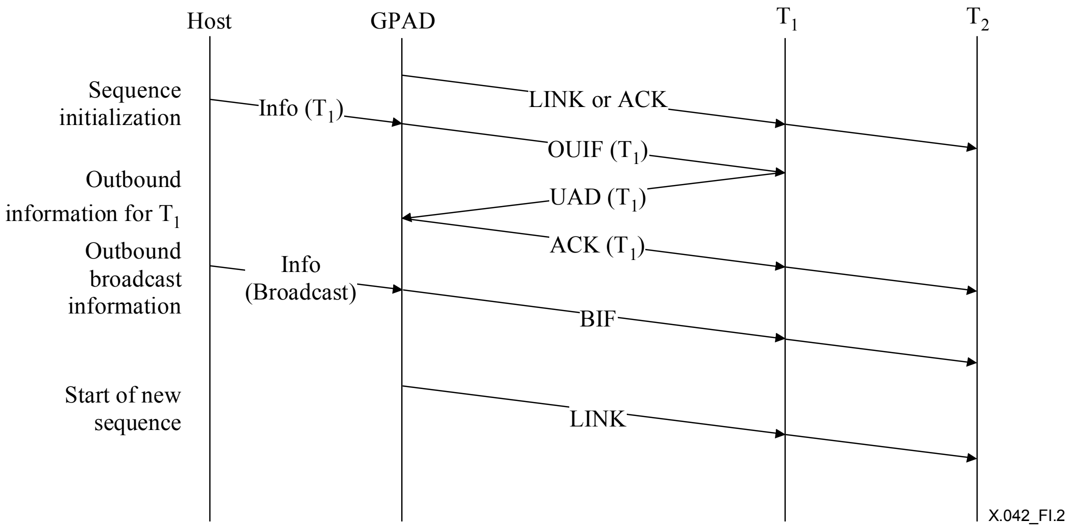


Figure I.2/X.42 – Unsolicited outbound transmission

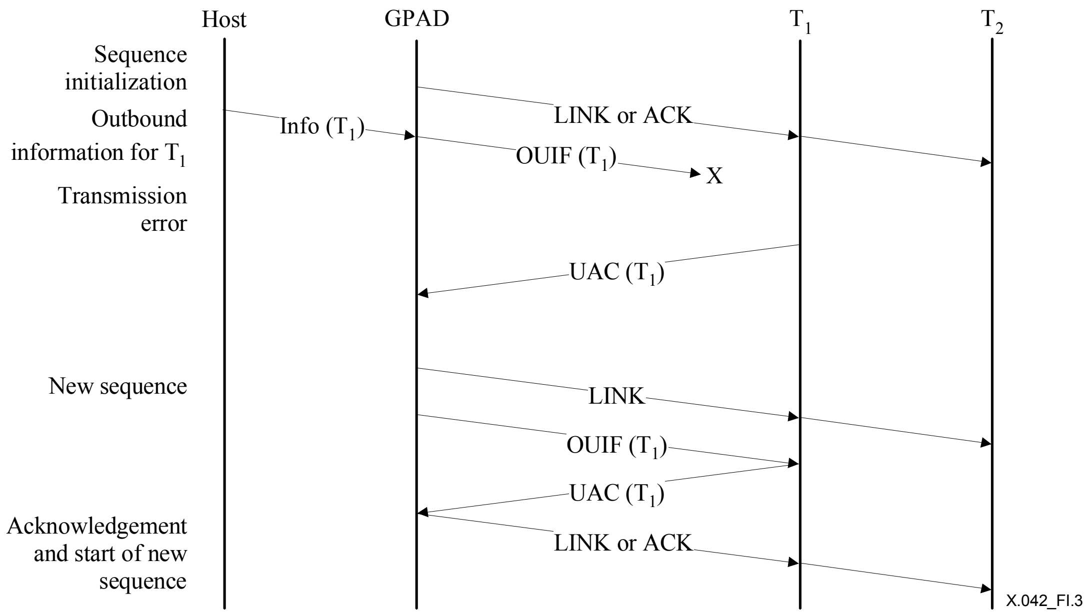


Figure I.3/X.42 – Unsolicited outbound transmission error

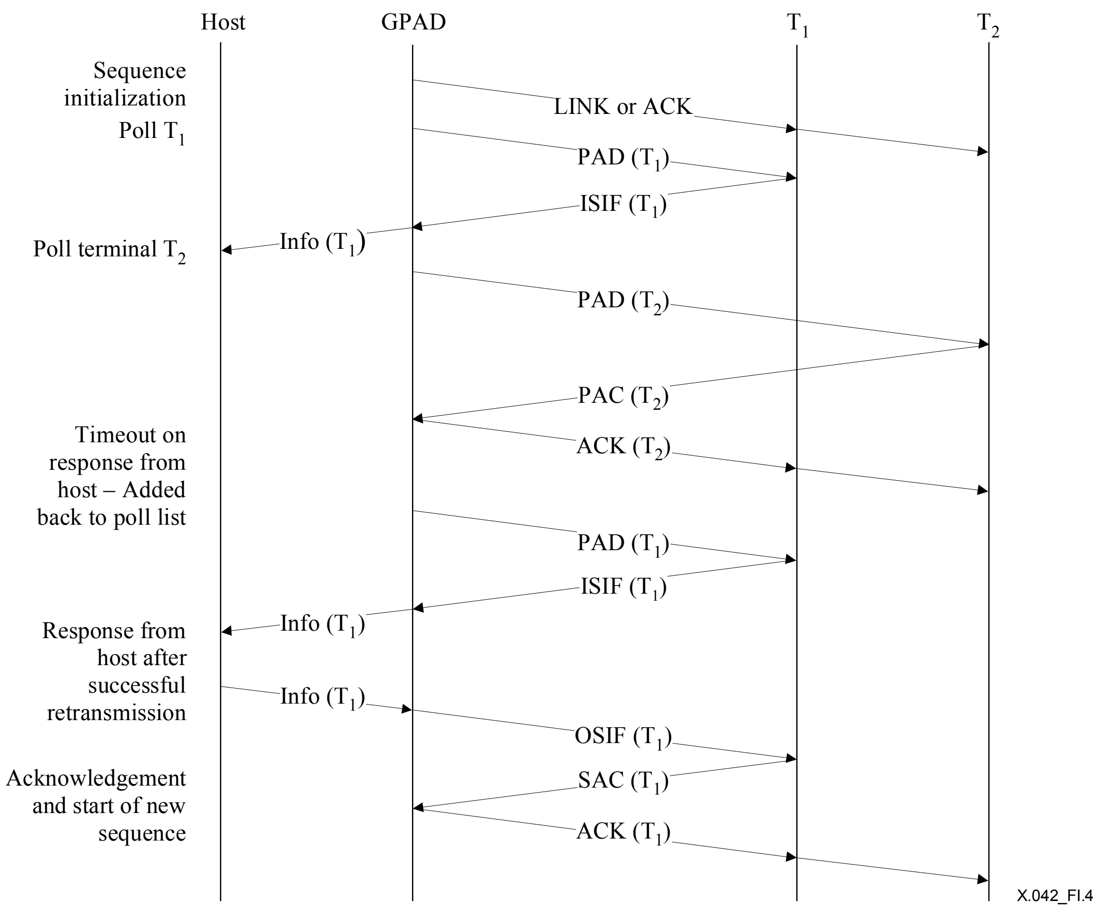


Figure I.4/X.42 – Solicited inbound response timeout

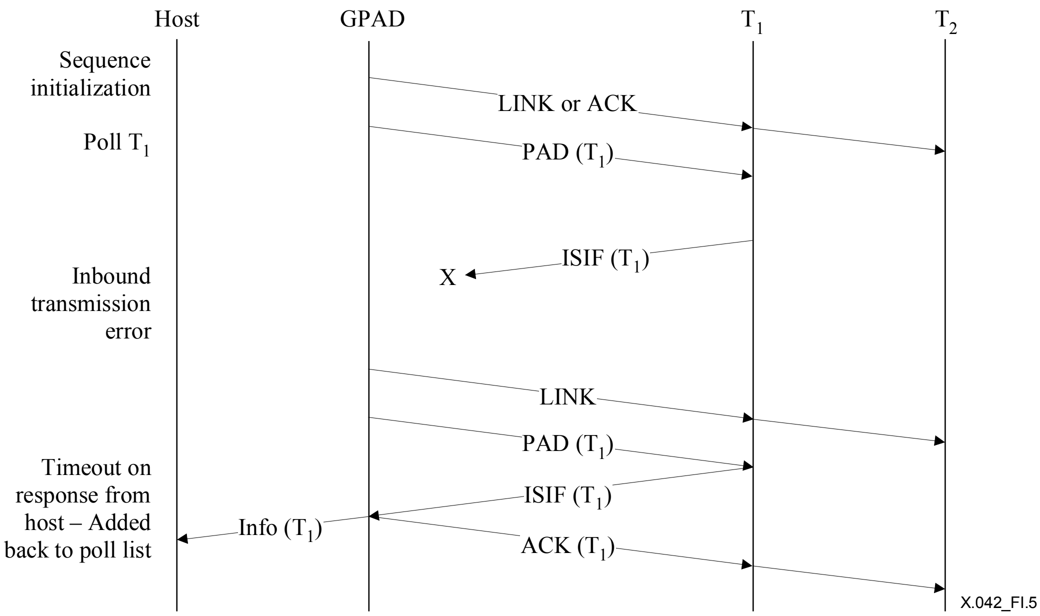


Figure I.5/X.42 – Solicited inbound transmission error

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