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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Future networks

General technical architecture for public packet telecommunication data network

Recommendation ITU-T Y.2613

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Recommendation ITU-T Y.2613

General technical architecture for public packet telecommunication data network

Summary

Recommendation ITU-T Y.2613 specifies the technical architecture of a public packet telecommunication data network (PTDN) which can meet all the requirements described in Recommendation ITU-T Y.2601, including the format of the data link frame and network packet, as well as the OAM and interworking methods with other packet bearer networks.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y.2613	2010-03-16	13

Keywords

FPBN, interworking, link layer, network layer, OAM, PTDN, routing.

FOREWORD

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Recommendation ITU-T Y.2613

General technical architecture for public packet telecommunication data network

1 Scope

Public packet telecommunication data network (PTDN) is a packet data network designed for the NGN transport stratum, which should be secure, trustworthy, controllable, and manageable. It can meet all the requirements described in [ITU-T Y.2601]. This Recommendation defines the technical architecture of PTDN, including the format of the data link frame and network packet, as well as the OAM and interworking methods with other packet bearer networks.

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 I.432] Recommendation ITU-T I.432 (1993), *B-ISDN user-network interface – Physical layer specification*.

[ITU-T Q.921] Recommendation ITU-T Q.921 (1997), *ISDN user-network interface – Data link layer specification*.

[ITU-T Y.2601] Recommendation ITU-T Y.2601 (2006), *Fundamental characteristics and requirements of future packet based networks*.

[IEEE 802.3] IEEE 802.3 (in force), *Information technology – Telecommunications and information exchange between systems – local and metropolitan area networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access method and Physical Layer Specifications*.

3 Definitions and terms

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 address [ITU-T Y.2601]: An address is the identifier for a specific termination point and is used for routing to this termination point.

3.1.2 control plane [b-ITU-T Y.2011]: The set of functions that controls the operation of entities in stratum or layer under consideration, plus the functions required to support this control.

3.1.3 data plane [b-ITU-T Y.2011]: The set of functions used to transfer data in the stratum or layer under consideration.

3.1.4 identifier [ITU-T Y.2601]: An identifier is a series of digits, characters and symbols or any other form of data used to identify subscriber(s), user(s), network element(s), function(s), network entity(ies) providing services/applications, or other entities (e.g., physical or logical objects).

NOTE – Identifiers can be used for registration or authorization. They can be either public to all networks, shared between a limited number of networks or private to a specific network (private identifiers are normally not disclosed to third parties).

3.1.5 management plane [b-ITU-T Y.2011]: The set of functions used to manage entities in the stratum or layer under consideration, plus the functions required to support this management.

3.1.6 name [b-ITU-T Y.2611]: A name is the identifier of an entity (e.g., subscriber, network element) that may be resolved/translated into an address.

3.1.7 user plane [ITU-T Y.2601]: A classification for objects whose principal function is to provide transfer of end-user information: user information may be user-to-user content, or private user-to-user data.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 public packet telecommunication data network (PTDN): A packet data network designed for the NGN transport stratum, which should be secure, trustworthy, controllable, and manageable, can meet all the requirements described in [ITU-T Y.2601]. PTDN is a hierarchical network, which can be subdivided into several network layers.

4 Abbreviations

This Recommendation uses the following abbreviations:

BECN	Backward Explicit Congestion Notification
DLCI	Data Link Connection Identifier
FDI	Forward Defect Indication
FECN	Forward Explicit Congestion Notification
GFP	Generic Framing Procedure
HDLC	High-level Data Link Control
IP	Internet Protocol
IWF	InterWorking Function
LCN	Logical Channel Number
LC-ID	Logical Channel ID
OAM	Operation, Administration and Maintenance
PDN	Public packet Data Network
PTDN	Public packet Telecommunication Data Network
QoS	Quality of Service
TE	Terminal Equipment
URL	Uniform Resource Locator
VC	Virtual Circuit/Virtual Connection

5 Reference model

The reference model of PTDN is shown in Figure 5-1.

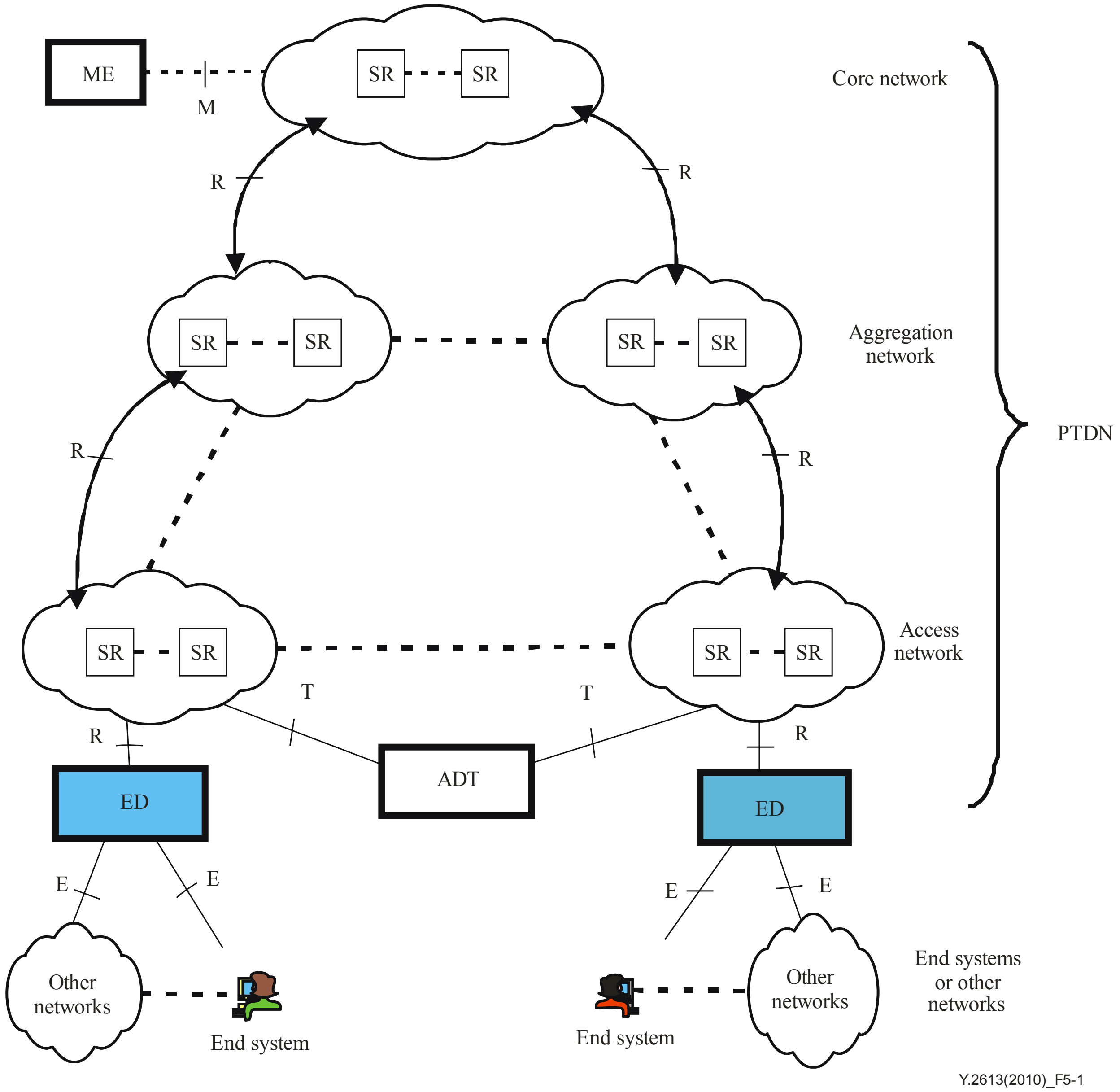


Figure 5-1 – Reference model of PTDN

PTDN is a hierarchical network, which consists of access network, aggregation network, and core network. Moreover, access network, aggregation network and core network are hierarchical networks too, which can be subdivided into several network layers.

SRs (PTDN nodes) connect each other by Interface R.

MEs (management elements) connect to the SRs by Interface M.

EDs (edge devices) are located on the boundary of PTDN. Through Interface E, an ED can serve as an adapter between the end systems or other networks (e.g., IP network, ATM network) and PTDN network. Thus above the EDs, there are the trustable network domains. EDs can also support the mobility of end systems or other networks.

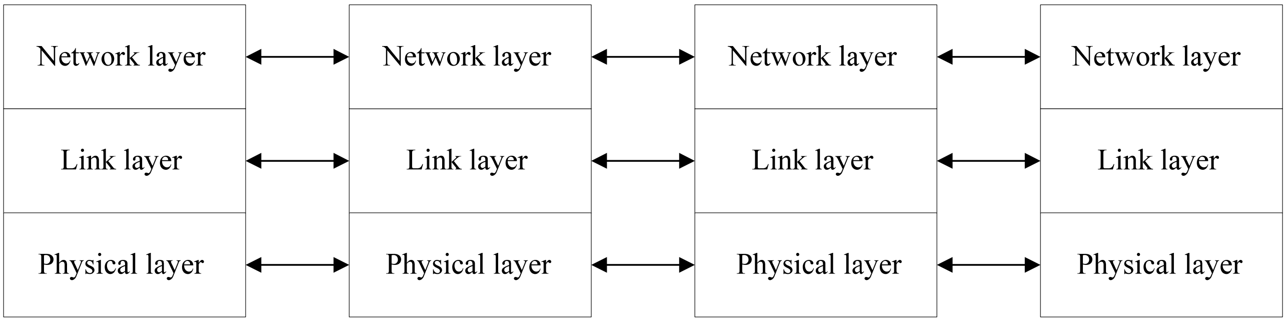
ADTs (address translators) are responsible for the mapping or translation of IP addresses (or other network addresses) to PTDN addresses. ADTs cooperate with EDs to achieve the activities of address mapping/translation by Interface T.

PTDN supports connection-oriented mode and connectionless mode.

5.1 Connection-oriented mode

5.1.1 Control flow in connection-oriented mode

In connection-oriented mode, the control flow can set up or tear down the virtual circuit for the data plane, as shown in Figure 5-2.

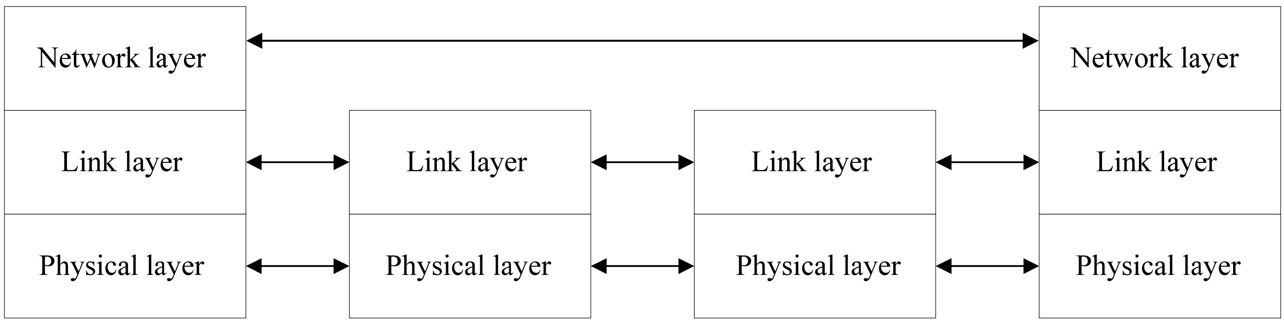


Where: ⟷ control flow

Figure 5-2 – Control flow transportation in connection-oriented mode

5.1.2 Data flow in connection-oriented mode

In connection-oriented mode, the data flows are forwarded in a logic channel in the link layer, as shown in Figure 5-3.



Where: ⟷ data flow

Figure 5-3 – Data flow transportation in connection-oriented mode

5.2 Connectionless mode

5.2.1 Control flows in connectionless mode

In connectionless mode, the control flows are forwarded per-hop in the control plane of the network layer according to the source address and destination address, as shown in Figure 5-4.

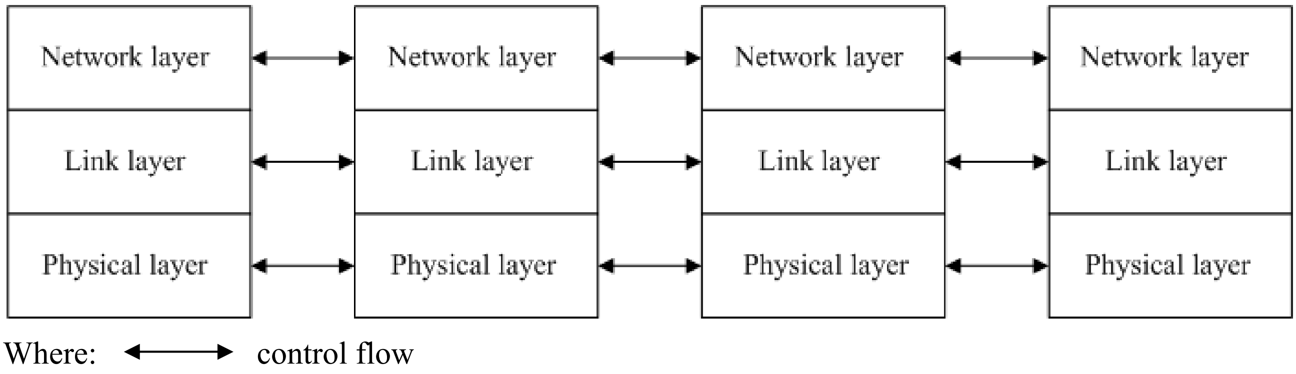


Figure 5-4 – Control flow transportation in connectionless mode

5.2.2 Data flow in connectionless mode

In connectionless mode, data flows are forwarded per-hop in the data plane of the network layer according to the source address and destination address, as shown in Figure 5-5.

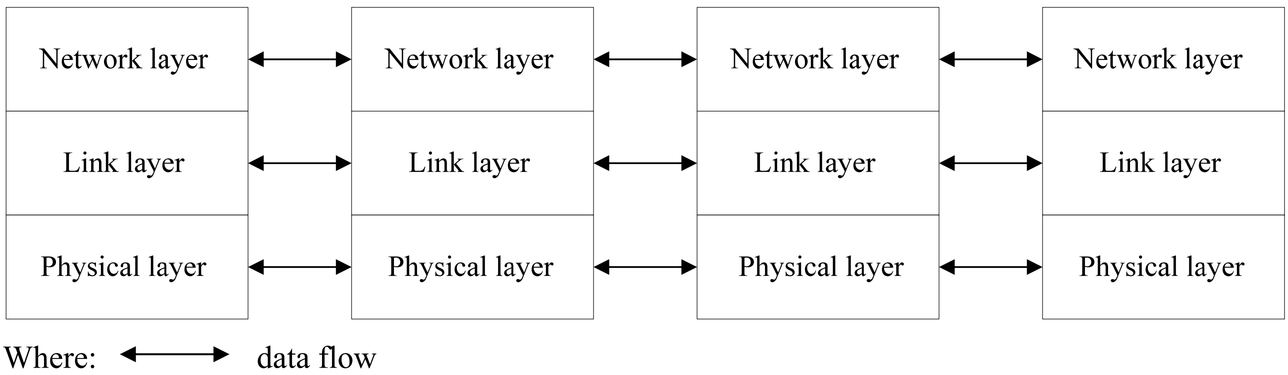


Figure 5-5 – Data flow transportation in connectionless mode

6 Link layer

The link layer is used to provide point-to-point multiplexing and/or packet encapsulation. In connection-oriented mode, data packets are encapsulated and multiplexed based on LC-ID. In connectionless mode, link layer only implements data packets encapsulation.

6.1 Data framing

The packets are encapsulated into a frame before forwarding. There are three methods of encapsulation:

1) The flag sequence delimiter encapsulation: HDLC adopts this technology, the flag is 01111110. The data packet and upper control signalling will be carried between two flags.

2) Header error control, length delimiter encapsulation: GFP and ATM adopt this technology. Usage of this technology is described in clause 4.3 of [ITU-T I.432].

3) Preamble and start frame delimiter encapsulation: The packets of Ethernet network will be encapsulated by this technology. Usage of this technology is described in [IEEE 802.3].

Any kind of the encapsulation methods can be adopted in PTDN.

6.2 Point-to-point multiplex

The link layer uses the logical channel for each pair to support point-to-point multiplexing. The logical channel should be identified by the logical channel number, i.e., logical channel ID (LC-ID). LC-ID is locally valid and used in the connection-oriented mode.

6.3 Frame format and field definitions

To help understand the structure of the link layer frame format, the flag sequence delimiter encapsulation is used as an example here. According to this method of encapsulation, the link layer frame of PTDN contains four parts: flag sequence, frame header, information section, and cyclic redundancy check (CRC). The link layer frame format is shown in Figure 6-1.

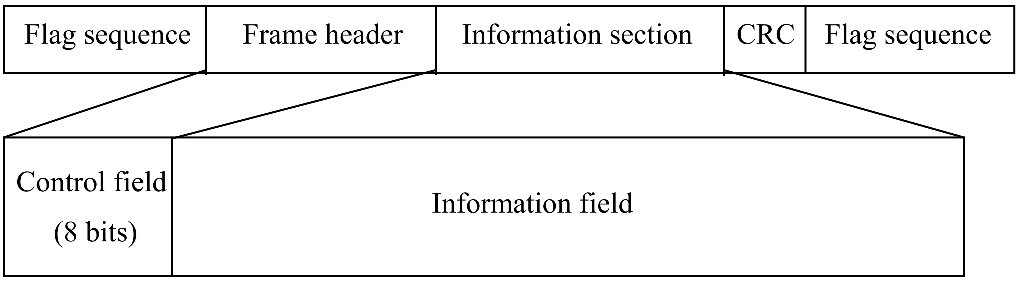


Figure 6-1 – Link layer frame format

6.3.1 Flag sequence

All frames start and end with the flag sequence consisting of one 0 bit followed by six contiguous 1 bits and one 0 bit. The flag preceding the frame header is defined as the opening flag. The flag following the cyclic redundancy check (CRC) field is defined as the closing flag. The closing flag may also serve as the opening flag of the next frame, in some applications. However, all receivers must be able to accommodate receipt of one or more consecutive flags.

6.3.2 Frame header

The frame header contains the control field. The control field identifies the type of frame which will be either a command or response. Three types of control field formats will be specified: information transfer format (I format), supervisory functions format (S format), and control functions format (C format). The control field formats are as shown in Figure 6-2:

Frame type	Command	Response	8	7	6	5	4	3	2	1
Information transfer (I format)	I		0	0	0	0	0	0	0	0
	UI		0	0	0	0	0	0	1	1
Supervisory (S format)	RR	RR	0	0	0	P/F	0	0	0	1
Link control (C format)	SABME		0	1	1	P	1	1	1	1
		DM	0	0	0	F	1	1	1	1
	DISC		0	1	0	P	0	0	1	1
		UA	0	1	1	F	0	0	1	1
		FRMR	1	0	0	F	0	1	1	1

Figure 6-2 – Control field format

Poll/Final (P/F) bit: The P/F bit serves a function in both command frames and response frames. In command frames, the P/F bit is referred to as the P bit. In response frames, it is referred to as the F bit. The P bit set to 1 is used by a data link layer entity to solicit (poll) a response frame from the peer data link layer entity. The F bit set to 1 is used by a data link layer entity to indicate the response frame transmitted as a result of a soliciting (poll) command.

For the procedure for the use of the P/F bit, refer to clause 5 of [ITU-T Q.921].

6.3.2.1 I format

The information transfer (I) format is used to perform the connection-oriented or connectionless information transfer between layer 3 entities. The connection-oriented information is carried by connection-oriented information transfer frame, and the connectionless information is carried by the connectionless information transfer frame. The connection-oriented and connectionless information transfer frame are identified by control field, e.g., if the information from other networks (e.g., IP network) is confirmed to be transferred by connection-oriented mode based on the access control table, the value of control field is set to '00000000'; if the information from other networks (e.g., IP network) is confirmed to be transferred by connectionless mode based on the access control table, the value of control field is set to '00000011'.

6.3.2.2 S format

The supervisory (S) format is used to perform data link supervisory control functions such as: indicating whether the link is ready or not. A timer is used to determine whether to send an S frame, the S frame is sent if the timer expires. If the value of this timer is set to 0, then the S frame does not have to be sent. The timer represents the maximum time allowed without frames being exchanged. The default value of the timer is 10 seconds.

6.3.2.3 C format

The control (C) format is used to provide additional data link control functions. The related commands and responses contain the SABME, DM, DISC, UA and FRMR. The detailed information is described in clause 6.4.3.

6.3.3 Information section

Information section of a frame, when present, follows the control field (see clause 6.3.2) and precedes cyclic redundancy check (see clause 6.3.4 below). The contents of the information section consist of an integer number of octets. Depending upon the transmission mode, the information section structure is also different. The structure of the connection-oriented information field is specified in clause 6.3.3.1, and the structure of the connectionless information field is specified in clause 6.3.3.2.

6.3.3.1 Connection-oriented information section

There are two types of frames in connection-oriented information section: data frame and control frame. Both types of frames are encapsulated as I format frame, and the value of the control field should be set to 00000000B.

The connection-oriented frame structure is specified in Figure 6-3. The value of control field should be set 00000000B, and the connection-oriented information section contains the address field and the information subfield.

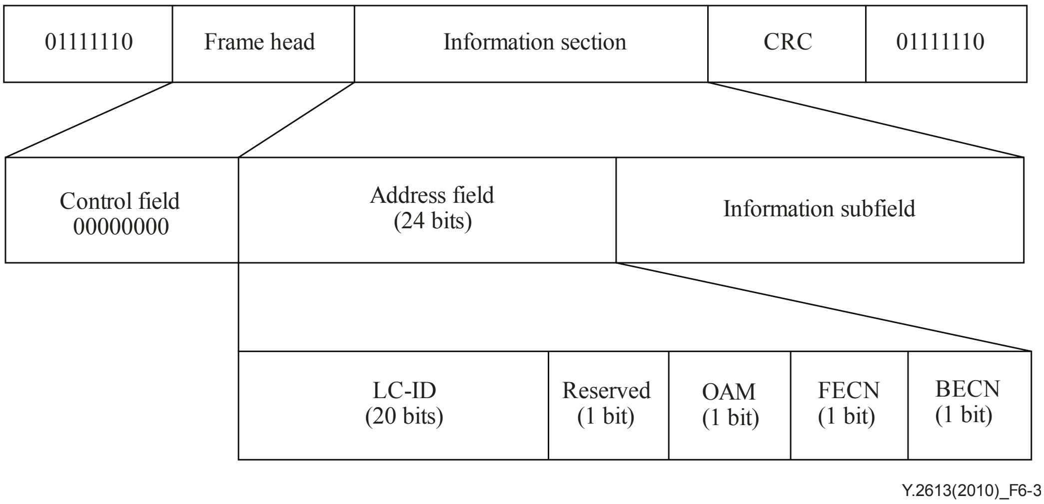


Figure 6-3 – The connection-oriented frame structure

6.3.3.1.1 Address field

The address field contains the logical channel ID (LC-ID), Reserved, OAM indication, forward and backward explicit congestion notifications (FECN and BECN). The length of the address field is 24 bits.

6.3.3.1.1.1 Logical channel ID (LC-ID) field

LC-ID identifies a logic channel in virtual circuit. LC-ID specifies a data link layer entity to/from which information is delivered/received and which is to be carried in frames by data link layer entities. The value of LC-ID is locally valid. The value of LC-ID is distributed by upper layer control signalling (e.g., [b-ITU-T Q.931]). The length of LC-ID field is 20 bits.

6.3.3.1.1.2 Reserved field

The reserved field is set to 0.

6.3.3.1.1.3 OAM field

The OAM field is used to indicate the OAM frame, this field is set to 1 to indicate the frame is an OAM frame; this field is set to 0 to indicate the frame is a user frame. The length of the OAM field is 1 bit.

6.3.3.1.1.4 Forward explicit congestion notification field (FECN)

This field is set by a congested network to notify the user that congestion avoidance procedures should be initiated, where applicable, for traffic in the direction of the frame carrying the FECN indication. This field is set to 1 to indicate to the receiving end-system that the frames it receives have encountered congested resources. This field may be used by destination controlled transmitter rate adjustment. The length of FECN field is 1 bit.

6.3.3.1.1.5 Backward explicit congestion notification field (BECN)

This field is set by a congested network to notify the user that congestion avoidance procedures should be initiated, where applicable, for traffic in the opposite direction of the frame carrying the BECN indicator. This field is set to 1 to indicate to the receiving end-system that the frames it transmits may encounter congested resources. This field may be used by source controlled transmitter rate adjustment. The length of BECN field is 1 bit.

6.3.3.1.2 Data frame structure

If the value of LC-ID field is not equal to 0, the connection-oriented information frame is the data frame. The connection-oriented data frame structure is specified in Figure 6-4.

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>Octet</th><th></th></tr>
<tr><td colspan="8">Flag(8)</td><td>1</td><td></td></tr>
<tr><td colspan="8">Control field(8)</td><td>2</td><td></td></tr>
<tr><td colspan="8">Upper LC-ID(8)</td><td>3</td><td rowspan="3">Address Field</td></tr>
<tr><td colspan="8">Middle LC-ID(8)</td><td>4</td></tr>
<tr><td colspan="4">Lower LC-ID(4)</td><td>Rsvd(1)</td><td>OAM (1)</td><td>FECN (1)</td><td>BECN (1)</td><td>5</td></tr>
<tr><td colspan="8">Information subfield</td><td>6
N-3</td><td></td></tr>
<tr><td colspan="8">Frame check sequence (FCS) 1st octet</td><td>N-2</td><td></td></tr>
<tr><td colspan="8">Frame check sequence (FCS) 2nd octet</td><td>N-1</td><td></td></tr>
<tr><td colspan="8">Flag(8)</td><td>N</td><td></td></tr>
</table>

Figure 6-4 – Connection-oriented data frame structure

6.3.3.1.3 Control frame structure

If the LC-ID field is equal to 0, the connection-oriented information frame is the control frame.

The OAM, FECN and BECN fields are meaningless in the control frame. They should be set to 0 for transmission, ignored on reception. The connection-oriented control frame structure is specified in Figure 6-5.

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>Octet</th><th></th></tr>
<tr><td colspan="8">Flag(8)</td><td>1</td><td></td></tr>
<tr><td colspan="8">00000000B (Control field)</td><td>2</td><td></td></tr>
<tr><td colspan="8">00000000B (Upper LC-ID)</td><td>3</td><td rowspan="3">Address Field</td></tr>
<tr><td colspan="8">00000000B (Middle LC-ID)</td><td>4</td></tr>
<tr><td colspan="4">0000B (Lower LC-ID)</td><td>Rsvd(1)</td><td>0</td><td>0</td><td>0</td><td>5</td></tr>
<tr><td colspan="8">Information subfield</td><td>6
N-3</td><td></td></tr>
<tr><td colspan="8">Frame check sequence (FCS) 1st octet</td><td>N-2</td><td></td></tr>
<tr><td colspan="8">Frame check sequence (FCS) 2nd octet</td><td>N-1</td><td></td></tr>
<tr><td colspan="8">Flag(8)</td><td>N</td><td></td></tr>
</table>

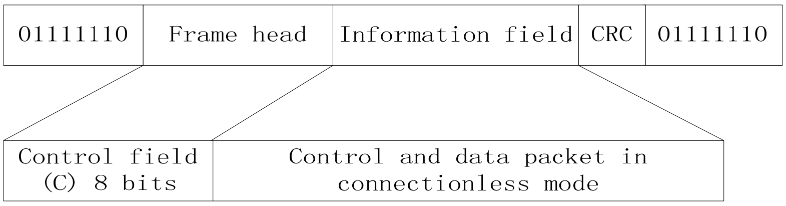
Figure 6-5 – Connection-oriented control frame structure

6.3.3.1.4 Information subfield

The information subfield consists of integer numbers of octets.

6.3.3.2 Connectionless information field

The frames working in connectionless mode are encapsulated as UI frames whose control field value is equal to "00000011B". As an example using HDLC, the frame format in connectionless mode can be described as in Figure 6-6, where the flag field value should be equal to "01111110B":



8 7 6 5 4 3 2 1	Octet
Flag(8)	1
Control(8)	2
Reserved(8)	3
Information subfield	4
….	….
….	N-3
Frame check sequence (FCS) 1st octet	N-2
Frame check sequence (FCS) 2nd octet	N-1
Flag(8)	N

Figure 6-6 – Frame format in connectionless mode

Connectionless information field contains reserved field and information subfield.

6.3.3.2.1 Reserved field

The reserved field will be defined and used in the future. Now its value should be set to 0.

6.3.3.2.2 Information subfield

The information subfield consists of integer numbers of octets. The content of information subfield is network packet, including packet header and payload.

6.3.4 Cyclic redundancy check (CRC) field

The CRC field will be a 16-bit sequence. It will be the ones complement of the sum (modulo 2) of:

a) the remainder of $x^k (x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the CRC, excluding bits inserted for transparency; and

b) the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the product of x^{16} by the content of the frame existing between, but not including, the final bit of the opening flag and the first bit of the CRC, excluding bits inserted for transparency.

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all 1s and is then modified by division by the generator polynomial (as described above) on the address, control and information fields; the ones complement of the resulting remainder is transmitted as the 16-bit CRC.

As a typical implementation at the receiver, the initial content of the register of the device computing the remainder is preset to all 1s. The final remainder, after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits and the CRC, will be 0001110100001111 (x^{15} through x^0, respectively) in the absence of transmission errors.

6.4 Control and management

According to Figure 6-2, the control field identifies the type of frame which is either a command or a response. Control and management command/response includes information transfer command, link supervisory command/response, and link control command/response. The details are as shown below.

6.4.1 Information transfer command

The information transfer command is to transport data packet. In connection-oriented mode, the function of the transfer command is to encapsulate and multiplex data packets. In connectionless mode, the function of transfer command is to encapsulate data packets.

6.4.2 Link supervisory command and response

The link supervisory command and response is used to perform data link supervisory control functions.

6.4.3 Link control command and response

6.4.3.1 Set asynchronous balanced mode extended (SABME) command

The SABME unnumbered command is used to start multiple frame acknowledged operation.

A data link layer entity confirms acceptance of an SABME command by the transmission at the first opportunity of a UA response. The transmission of an SABME command indicates the clearance of all exception conditions.

6.4.3.2 Disconnect (DISC) command

The DISC unnumbered command is used to terminate the multiple frame operation.

No information field is permitted with the DISC command. The data link layer entity receiving the DISC command confirms the acceptance of a DISC command by the transmission of a UA response. The data link layer entity sending the DISC command terminates the multiple frame operation when it receives the acknowledging UA or DM response.

6.4.3.3 Disconnected mode (DM) response

The DM unnumbered response is used by a data link layer entity to report to its peer that the data link layer is in a state such that multiple frame operation cannot be performed. No information field is permitted with the DM response.

6.4.3.4 Unnumbered acknowledgement (UA) response

The UA unnumbered response is used by a data link layer entity to acknowledge the receipt and acceptance commands (SABME or DISC). Received commands are not processed until the UA response is transmitted. No information field is permitted with the UA response.

6.4.3.5 Frame reject (FRMR) response

The FRMR unnumbered response may be received by a data link layer entity as a report of an error condition not recoverable by retransmission of the identical frame.

- The receipt of a command or response that is undefined;
- The receipt of a frame with an information field which exceeds the maximum established length.

7 Network layer

The network layer is used to provide end-to-end communications. It is necessary to provide routing mechanisms to set up the end-to-end forwarding path. There are two types of modes supported in PTDN, the connectionless mode and the connection-oriented mode.

In connectionless mode, a network node forwards packets according to the destination address based on the routing table.

In the connection-oriented mode, a network node forwards data packets according to the virtual circuit. Control packet is forwarded according to the destination address.

7.1 Network address

In PTDN, network address is a kind of global public address, which can be used to implement the end-to-end data packets delivery.

In the connection-oriented mode, network address can only be used in the control plane to establish a virtual circuit between the source and the destination, or to disconnect the existing virtual circuit.

In connectionless mode, network address can be used in the control, management and data planes. In the control plane, network address is used to deliver control commands and responses. In the management plane, network address is used to deliver management commands and responses. Then in the data plane, data packets can be forwarded based on network address and the established routing table.

In PTDN, network address structure is hierarchical, which at least includes Country ID, Region ID, Network Provider ID, and some extensive IDs. The length of PTDN address is variable.

7.2 Packet format and field definitions

7.2.1 Connectionless mode

7.2.1.1 Common fields

The common fields should be included by all the PTDN packets, which contain version field, packet type field, address length field, source address field, and destination address field. The packet format is described in Figure 7-1.

8	7	6	5	4	3	2	1	Octet
Version				Packet type		Address length		1
…..								… N*1
Source address								… N*1+n*2
Destination address								N*1+n*2+1 … N*1+n*2+n*2+1

Figure 7-1 – Packet format in the connectionless mode

NOTE 1 – The position of source address field and destination address field in the data packet, control packet and management packet are different.

NOTE 2 – The length of source address field and destination address field is defined by the address length field.

7.2.1.1.1 Version field

The version field is used to identify the version of the PTDN packet. Now the Version field is set to 1. The length of the field is 4 bits.

7.2.1.1.2 Packet type field

The packet type field is used to distinguish the control packet, management packet and data packet.

The length of the field is 2 bits. The value of the packet type field is as follows:

- 00 reserved
- 01 control packet
- 10 management packet
- 11 data packet

7.2.1.1.3 Address length field

The address length field is used to indicate the length of PTDN address. The address length field is 2 bits; the value of the address length is as follows:

- 00 reserved
- 01 the length of address is 64 bits
- 10 the length of address is 96 bits
- 11 the length of address is 128 bits

7.2.1.1.4 Source address field

The source address field is the source address of the PTDN network. The length of the source address is indicated by the address length field.

7.2.1.1.5 Destination address field

The destination address field is the destination address of the PTDN network. The length of the destination address is indicated by the address length field.

When the packet is the multicast data packet, the destination address field is a multicast address.

7.2.1.2 Data packet

The data packet structure is described in Figure 7-2.

<table>
<tr><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>Octet</td></tr>
<tr><td colspan="4">Version(4)</td><td colspan="2">Packet type(2)</td><td colspan="2">Address length(2)</td><td>1</td></tr>
<tr><td>VPN identifier (1)</td><td>Multicast identifier (1)</td><td colspan="2">Class service stream(2)</td><td colspan="4">Reserved(4)</td><td>2</td></tr>
<tr><td colspan="8">Upper Payload length(8)</td><td>3</td></tr>
<tr><td colspan="8">Lower Payload length(8)</td><td>4</td></tr>
<tr><td colspan="6">TTL(6)</td><td colspan="2">Protection(2)</td><td>5</td></tr>
<tr><td>Extension header identifier (1)</td><td colspan="3">Reserved(3)</td><td colspan="4">Upper VPN number(4)</td><td>6</td></tr>
<tr><td colspan="8">Middle VPN number(8)</td><td>7</td></tr>
<tr><td colspan="8">Lower VPN number(8)</td><td>8</td></tr>
<tr><td colspan="8">Source address</td><td></td></tr>
<tr><td colspan="8">Destination address</td><td></td></tr>
<tr><td colspan="8">Payload</td><td></td></tr>
</table>

Figure 7-2 – Data packet structure

7.2.1.2.1 VPN identifier field

The VPN identifier field indicates the VPN packet. The VPN identifier field length is 1 bit. If the field is set to 1, the data packet is a VPN data packet. If it is set to 0, the data packet is not a VPN data packet.

7.2.1.2.2 Multicast identifier field

The multicast identifier field indicates multicast packet. The length of multicast identifier field is 1 bit. If it is set to 1, the user packet is a multicast packet. If it is set to 0, the user packet is not a multicast packet.

7.2.1.2.3 Class service stream field

The class service stream field is used to distinguish the different class service streams. The length of the field is 2 bits. There are four classes of service stream.

- 00 highest class service (full resource guaranteed)
- 01 second high level class service (partial resource guaranteed)
- 10 third high level class service (partial resource guaranteed)
- 11 "best effort" service (no resource guaranteed)

7.2.1.2.4 Payload length field

The payload length field is used to indicate payload length in octets. The length of the field is 16 bits.

7.2.1.2.5 TTL field

The TTL field indicates the maximum time the user packet is allowed to remain in PTDN. If the value of the field is zero, the user packet must be discarded. The field is decremented by each network node when the packet passes through. The length of the TTL field is 6 bits.

7.2.1.2.6 Protection field

The protection field is used to indicate classes of routes. The length of the protection field is 2 bits. There are four route classes:

- 00 the main route
- 11 the first standby route
- 01 the second standby route
- 10 the dynamic route

7.2.1.2.7 Extension header identifier field

The extension header identifier field indicates whether there is an extension packet header. If the value of the field is set to 0, there is no extension header. If the value of the field is set to 1, it indicates there is an extension header. The length of the extension header identifier field is 1 bit.

7.2.1.2.7.1 Extension packet format

The extension packet format is described in Figure 7-3.

8	7	6	5	4	3	2	1	Octet
Next Ext(1)	Type(7)							1
Length(8)								2
Value								3

Figure 7-3 – Extension packet structure

Next extension identifier (1 bit):

=0 last extension packet;

=1 more extension packet.

Type(7 bits): The extension packet type.

Length(8 bits): The length of the extension packet.

Value: The maximum length is 256 bytes.

7.2.1.2.7.2 Fragment extension packet

The fragment extension packet format is described in Figure 7-4.

8	7	6	5	4	3	2	1	Octet
Ext(1)	Type(7)							1
Length(8)								2
Resv(2)		MF(1)	Fragment offset(5)					3
Fragment offset(8)								4

Figure 7-4 – Fragment extension packet format

When the value of the type is equal to "0000100", it indicates that the extension packet is the fragment extension packet.

Fragment offset (13 bits): A byte count from the start of the packet, the data packet is split only by the edge device. The middle transport device does not process the fragment packet.

7.2.1.2.7.3 OAM extension packet

The OAM extension packet format is described in Figure 7-5.

8	7	6	5	4	3	2	1	Octet
Ext(1)	Type(7)							1
Length(8)								2
OAM messages								....

Figure 7-5 – OAM extension packet format

When the value of the type is equal to "0000101", it indicates that the extension packet is the OAM extension packet.

Length(8 bits): The length of OAM extension packet.

OAM message: There are several types of OAM messages: Event indications, Loopback indication, and Performance indication. See clause 9.

7.2.1.2.8 Reserved field

The field is reserved for future use, now its value is set to 0.

7.2.1.2.9 VPN number field

VPN number field is used to identify a VPN. The VPN number is unique in PTDN. The length of the VPN number field is 20 bits.

7.2.1.3 Control packet

The control packet structure is described in Figure 7-6:

8	7	6	5	4	3	2	1
Version (4 bits)				Packet type (2 bits)		Address length (2 bits)	
Message type (8 bits)							
Message length (16 bits)							
Source address (64, 96 or 128 bits)							
Destination address (64, 96 or 128 bits)							
Message content (variable)							

Figure 7-6 – Control packet structure

A control packet is identified by setting the packet type field to "01".

7.2.1.3.1 Message type field

The message type field is used to distinguish different types of messages that accomplish different control functions.

7.2.1.3.2 Message length field

The message length field is used to describe the length of message content.

7.2.1.3.3 Message content field

The message content field adopts the TLV format.

7.2.1.4 Management packet

The management packet structure is described in Figure 7-7:

8	7	6	5	4	3	2	1
Version (4 bits)				Packet type (2 bits)		Address length (2 bits)	
Message type (8 bits)							
Message length (16 bits)							
Source address (64, 96 or 128 bits)							
Destination address (64, 96 or 128 bits)							
Message content (variable)							

Figure 7-7 – Management packet structure

A management packet is identified by setting the packet type field to "10".

7.2.1.4.1 Message type field

The message type field is used to distinguish different types of messages that accomplish different management functions.

7.2.1.4.2 Message length field

The message length field in the header of management packet is used to describe the length of message content.

7.2.1.4.3 Message content field

The message content field adopts the TLV format.

7.2.2 Connection-oriented mode

7.2.2.1 Data packet

In connection-oriented mode, data packets are transferred through the virtual circuits. See clause 6.3.3.1.

7.2.2.2 Control packet

Control packets in control plane are carried on the specific packet with LC-ID = 0, see clause 6.3.3.1.3.

Control packets adopt TLV format.

7.2.2.3 Management packet

Management packets in management plane are carried on the specific virtual circuit.

Management packets adopt TLV format.

7.3 Control and management

In connection-oriented mode, middle PTDN nodes have only control plane and management plane in network layer. In connectionless mode, there are three planes in the network layer: data plane, control plane and management plane.

The control plane of the network layer provides VPN and multicast control functions, such as establishment and removal. The management plane of the network layer provides device configuration, performance management, security, and so on.

Detailed message definition will be defined by other Recommendations.

8 Access and interworking

8.1 Interworking

The purpose of interworking between PTDN and PDN is to allow one or both of:

a) Transportation of PDN traffic over a PTDN network; and

b) Customers on either type of network to communicate with one another.

The need to transport PDN traffic over a PTDN network arises when network operators use a core PTDN infrastructure to provide multiple services. There is also a need for PTDN and PDN terminals to be able to communicate directly.

Two interworking types between PTDN and PDN networks are defined; service interworking and network interworking. Service interworking applies when a PTDN terminal equipment (TE) interacts with an PDN terminal equipment (TE); the PTDN TE does not perform any PDN functions and the PDN TE does not perform any PTDN functions. All interworking is performed by an interworking function (IWF).

In the case of network interworking, the PTDN will provide the transparent transport service for the other packet data network, as described in Figure 8-1, and the packet data network on the other side should be of the same type.

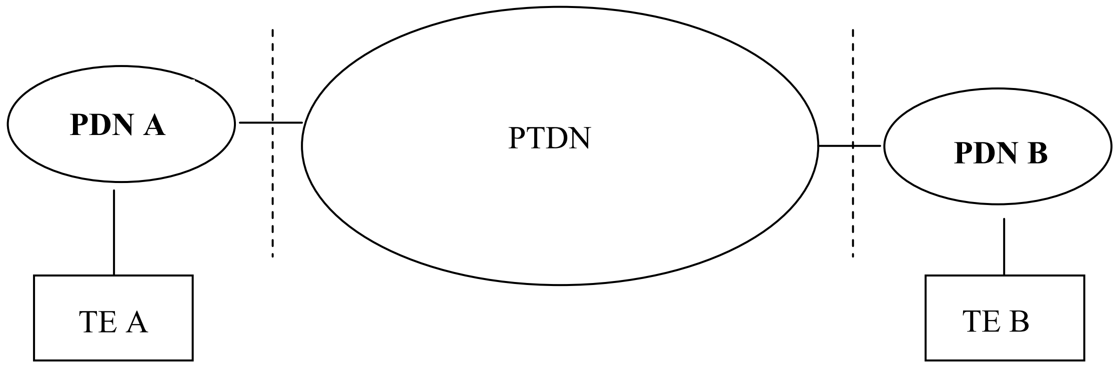


Figure 8-1 – Network interworking

In the case of service interworking, the service provided by PTDN will interwork with the service provided by the other packet data network, as described in Figure 8-2. The establishment and release of interworking connections in the involved networks is carried out by the control plane (C-plane). Once a connection through the interworking function (IWF) has been established, either by the management plane (M-plane) or by the C-plane, the user data is then subject to the interworking rules of the data plane (D-plane).

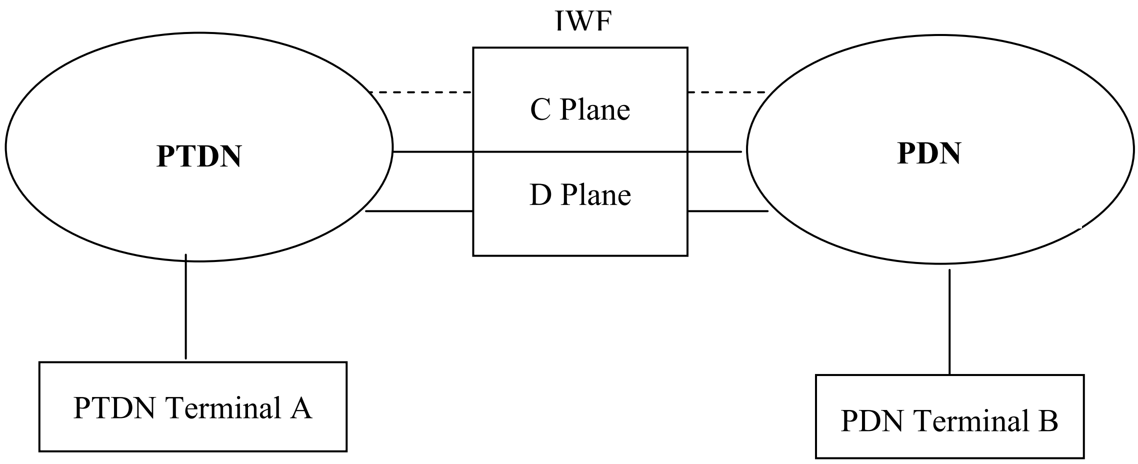


Figure 8-2 – Service interworking

8.2 General functions

In the data plane, the main function is to encapsulate and decapsulate the packets according to the packet formats of the PTDN network or PDN network; then it can appropriately implement the mapping between the PTDN network address and PDN network address with the marking of the characteristic information fields in the packet header. For the network interworking, a nesting PTDN packet header should be encapsulated into the original PDN network packet header as defined in Figure 8-1. For the service interworking, however, the PDN packet headers should be appropriately mapped into the PTDN packet headers as defined in Figure 8-2. It requires that the traffic contracts and QoS commitments between the PDN network and the PTDN network should be taken into consideration in the forwarding process. If the traffic from PDN network to PTDN network exceeds what is required in traffic contracts, the IWF will become congested, and data will be discarded.

The IWF should generate and monitor the OAM message. Any failure in the PTDN network must be detected by the IWF and may be mapped to the forward defect indication (FDI) syntax of the PDN network.

In the control plane, the main function is to correctly generate and maintain the mapping address table between PDN network and PTDN network.

8.3 Components

The IWF should include the control and management components and forwarding components.

8.3.1 Control and management components

Control and management components should correctly generate and maintain the address mapping table, deal with the requests from edge devices locating the boundary between the PDN network and PTDN network at the same administrator domain, and then respond with the matching address mapping item.

There may be two ways to generate the address mapping table. One way is that IWF learns the address mapping item by the active register. The other one is that IWF learns about it from other IWFs.

A refresh mechanism is recommended to validate the item in the address mapping table.

An aggregation mechanism is recommended to reduce the size of the address mapping table on the control entity.

8.3.2 Forwarding components

Forwarding components should appropriately implement the mapping between the PDN network address and PTDN network address according to the address mapping table. Forwarding components can obtain the matching address mapping item by sending the requests to the control components at the same administrator domain.

Caching mechanism is recommended to reduce the latency of searching the matching address mapping item.

9 OAM

The OAM functions in PTDN include event indication, loopback and performance monitoring.

The following clauses introduce different OAM procedures respectively in both the connection-oriented mode and the connectionless mode.

9.1 Connectionless mode

9.1.1 OAM functions

The fixed routing in PTDN ensures OAM messages are delivered through the same path in both communication directions at the network layer. It allows any connection point between the two end-points to check and locate errors in both directions, and get performance parameters.

9.1.1.1 Event indications

When a network node notices that there is congestion or quality drop on a link, it should send an OAM event report to the routing system. After the routing system monitors the indication message, it may take related action according to the configuration, such as to initiate a process of a link switching. An event indication message is composed of an event type and the event occurrence location, etc.

9.1.1.2 Loopback indication

The network layer loopback is achieved by inserting a message that includes loopback information at a point and returned (or loopback) at another point along a fixed path. The loopback message loops at a certain point according to the system commands or the information in the loop message.

The information carried in the loopback message includes flag fields, message fields related to the sender and receiver, the loop indication fields that indicate either loopback message or not, the loop location fields, etc.

9.1.1.3 Performance indication

Within the network layer, the end-to-end continuity check function is provided by sending continuity check packets periodically.

The continuity check packets are not processed but transmitted at the middle network nodes.

The performance monitoring at the end-to-end or at some segment monitors the performance, e.g., packet transmission delay is provided by inserting monitoring packets at the related end points or the end point of this segment.

9.1.2 Carrier modes

The OAM messages are transmitted at the data plane or the control plane in the connectionless mode.

9.1.3 OAM messages

OAM messages adopt the TLV format. There are several types of OAM messages: event indications, loopback indication, and performance indication. A different OAM function has a different OAM message format. The detailed message formats will be defined in future Recommendations.

9.2 Connection-oriented mode

9.2.1 Functions

OAM messages are delivered through the virtual circuit (VC) in both communication directions. They allow any connection point between the two end-points to check and locate errors in both directions, and get performance parameters.

9.2.1.1 Event indications

When a network node notices that a packet transmission interface has failed or is congested, the network node will confirm the source address of the packet according to the failure information table and then send a failure report to the source end or routing system monitor. After the routing system monitor gets the indication message, it may take related action according to the configuration, such as to initiate a process of a link switch. The indication message should contain event type and the event occurrence location (node address and interface number).

9.2.1.2 Loopback indication

The data link layer loopback is achieved by inserting a message that includes loopback information at a point and returned (or loopback) at another point along a virtual circuit. The loopback message loops at a certain point according to the system commands or the information in the loop message.

The information carried in the loopback message includes flag fields, message fields related to the sender and receiver, the loop indication fields that indicate either loopback message or not, the loop location fields, etc.

9.2.1.3 Performance indication

Within the data link layer, the logical channel status check function is provided by sending the status enquiry command periodically. The purpose of the logical channel status check is to indicate the status of existing logical channel at the interface.

The performance monitoring at the logical channel or at some segment monitors the performance, e.g., frame transmission delay is provided by inserting monitoring frames at the related end points or the end point of this segment.

9.2.2 Carrier modes

The OAM message is transmitted through a virtual circuit in the connection-oriented mode; it may be transmitted in a user data channel with a logical channel number (LC-ID) which is the same as that of the user frame; alternatively, it may be transmitted in a control channel.

9.2.3 OAM messages

OAM messages adopt the TLV format. There are several types of OAM messages: event indications, loopback indication, and performance indication. A different OAM function has a different OAM message format. The detailed message formats will be defined in future Recommendations.

Bibliography

The following documents contain information that may be valuable to the reader of this Recommendation. They provide additional information about topics covered within this Recommendation, but are not essential for an understanding of this Recommendation.

[b-ITU-T G.7041] Recommendation ITU-T G.7041/Y.1303 (2008), *Generic framing procedure (GFP)*.

[b-ITU-T G.8010] Recommendation ITU-T G.8010/Y.1306 (2004), *Architecture of Ethernet layer networks*.

[b-ITU-T G.8031] Recommendation ITU-T G.8031/Y.1342 (2009), *Ethernet linear protection switching*.

[b-ITU-T I.322] Recommendation ITU-T I.322 (1999), *Generic protocol reference model for telecommunication networks*.

[b-ITU-T I.326] Recommendation ITU-T I.326 (2003), *Functional architecture of transport networks based on ATM*.

[b-ITU-T I.330] Recommendation ITU-T I.330 (1988), *ISDN numbering and addressing principles*.

[b-ITU-T I.365.1] Recommendation ITU-T I.365.1 (1993), *B-ISDN ATM adaptation layer sublayers: Frame relaying service specific convergence sublayer (FR-SSCS)*.

[b-ITU-T I.365.2] Recommendation ITU-T I.365.2 (1995), *B-ISDN ATM adaptation layer sublayers: Service-specific coordination function to provide the connection-oriented network service*.

[b-ITU-T I.365.3] Recommendation ITU-T I.365.3 (1995), *B-ISDN ATM adaptation layer sublayers: Service-specific coordination function to provide the connection-oriented transport service*.

[b-ITU-T I.365.4] Recommendation ITU-T I.365.4 (1996), *B-ISDN ATM adaptation layer sublayers: Service-specific convergence sublayer for HDLC applications*.

[b-ITU-T I.630] Recommendation ITU-T I.630 (1999), *ATM protection switching*.

[b-ITU-T Q.922] Recommendation ITU-T Q.922 (1992), *ISDN data link layer specification for frame mode bearer services*.

[b-ITU-T Q.931] Recommendation ITU-T Q.931 (1998), *ISDN user-network interface layer 3 specification for basic call control*.

[b-ITU-T Q.933] Recommendation ITU-T Q.933 (2003), *Digital Subscriber Signalling System No. 1 (DSS1) – Signalling specifications for frame mode switched and permanent virtual connection control and status monitoring*.

[b-ITU-T X.25] Recommendation ITU-T 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*.

[b-ITU-T X.36] Recommendation ITU-T X.36 (2003), *Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for public data networks providing frame relay data transmission service by dedicated circuit*.

[b-ITU-T X.37] Recommendation ITU-T X.37 (1995), *Encapsulation in X.25 packets of various protocols including frame relay*.

[b-ITU-T X.45] Recommendation ITU-T X.45 (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, designed for efficiency at higher speeds*.

[b-ITU-T X.121] Recommendation ITU-T X.121 (2000), *International numbering plan for public data networks*.

[b-ITU-T X.124] Recommendation ITU-T X.124 (1999), *Arrangements for the interworking of the E.164 and X.121 numbering plans for frame relay and ATM networks*.

[b-ITU-T X.125] Recommendation ITU-T X.125 (1998), *Procedure for the notification of the assignment of international network identification codes for public frame relay data networks and ATM networks numbered under the E.164 numbering plan*.

[b-ITU-T X.136] Recommendation ITU-T X.136 (1997), *Accuracy and dependability performance values for public data networks when providing international packet-switched services*.

[b-ITU-T X.137] Recommendation ITU-T X.137 (1997), *Availability performance values for public data networks when providing international packet-switched services*.

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

[b-ITU-T X.212] Recommendation ITU-T X.212 (1995) | ISO/IEC 8886:1996, *Information technology – Open Systems Interconnection – Data Link service definition*.

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

[b-ITU-T X.323] Recommendation ITU-T X.323 (1988), *General arrangements for interworking between Packet-Switched Public Data Networks (PSPDNs)*.

[b-ITU-T X.371] Recommendation ITU-T X.371/Y.1402 (2001), *General arrangements for interworking between Public Data Networks and the Internet*.

[b-ITU-T Y.1001] Recommendation ITU-T Y.1001 (2000), *IP framework – A framework for convergence of telecommunications network and IP network technologies*.

[b-ITU-T Y.1231] Recommendation ITU-T Y.1231 (2000), *IP Access Network Architecture*.

[b-ITU-T Y.1251] Recommendation ITU-T Y.1251 (2002), *General architectural model for interworking*.

[b-ITU-T Y.2001] Recommendation ITU-T Y.2001 (2004), *General overview of NGN*.

[b-ITU-T Y.2011] Recommendation ITU-T Y.2011 (2004), *General principles and general reference model for Next Generation Networks*.

[b-ITU-T Y.2012] Recommendation ITU-T Y.2012 (2010), *Functional requirements and architecture of next generation networks*.

[b-ITU-T Y.2611] Recommendation ITU-T Y.2611 (2006), *High-level architecture of future packet-based networks.*

[b-ITU-T Y.2612] Recommendation ITU-T Y.2612 (2009), *Generic requirements and framework of addressing, routing and forwarding in future, packet-based networks.*

[b-ISO/IEC 8802-3] ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*.

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