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V5 Protocols

The V5 protocol stack is used to connect an Access Network (AN) to a Local Exchange (LE). It is used for the following access methods:

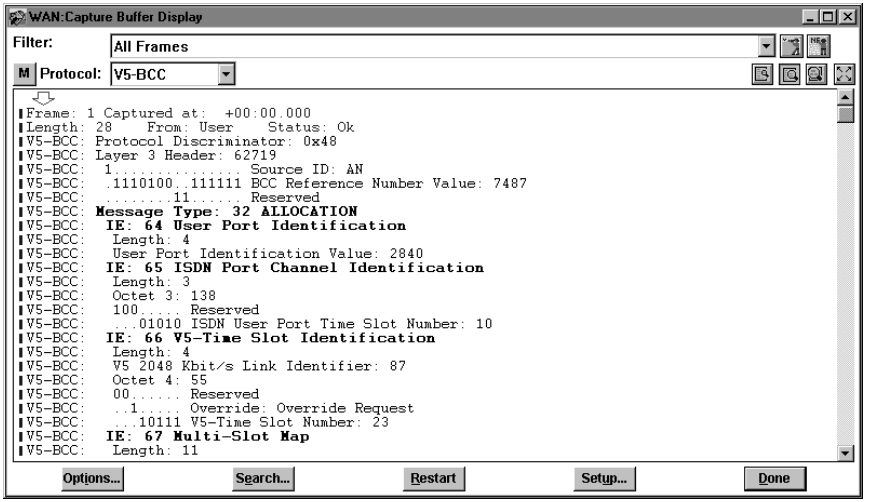
- Analogue telephone access.
- ISDN basic rate access.
- ISDN primary rate access (V5.2).
- Other analog or digital accesses for semi-permanent connections without associated outband signalling information.

V5 uses 2048 kbps links; V5.2 may use up to 16 such interface links. For analog access, on the LE side signalling from the PSTN user port is converted into a functional part of the V5 protocol for signalling to the AN side. For ISDN users a control protocol is defined in the V5 for the exchange of the individual functions and messages required for coordination with the call control procedures in the Local Exchange.

In order to support more traffic and dynamic allocation of links, the V5.2 protocol has several additions:

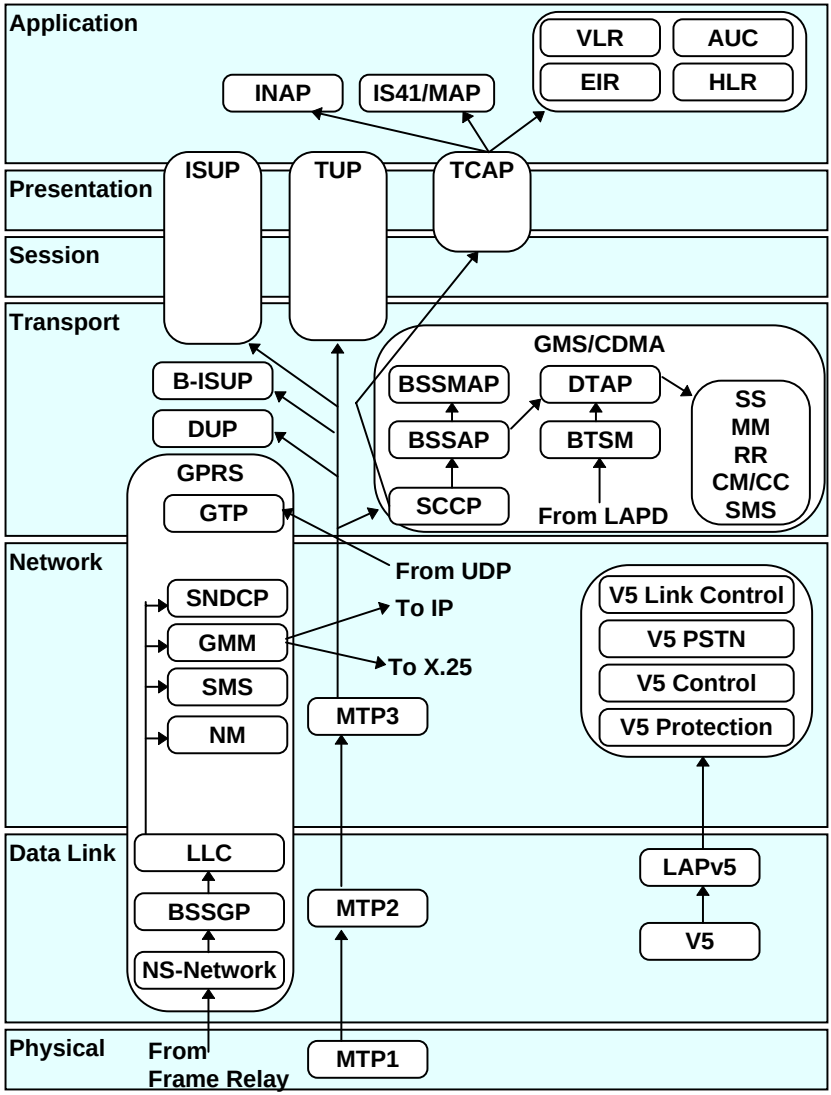
- A bearer channel connection protocol establishes and de-establishes bearer connections required on demand, identified by the signalling information, under the control of the Local Exchange.
- A link control protocol is defined for the multi-link management to control link identification, link blocking and link failure conditions.
- A protection protocol, operated on two separate data links for security reasons, is defined to manage the protection switching of communication channels in case of link failures.

The following protocols are defined for the various protocol layers: LAPV5-EF, LAPV5, V5-Link Control, V5-BCC, V5-PSTN, V5-Control and V5-Protection.



V5-BCC decode

The following diagram illustrates the V5 and other telephony protocols in relation to the OSI model:



Telephony protocol suite in relation to the OSI model

LAPV5-EF

ITU G.964: http://www.itu.int/itudoc/itu-t/rec/g/g800up/g964.html

The V5 Protocol Envelope Function Sublayer exchanges information between the AN and the LE. The format of the frame is as follows:

1		8	Octet
Flag: 0 1 1 1 1 1 1 0			1
EF address	0	EA 0	1
EF address		EA 1	
Information			4 ... n-3
FCS			n-2 n-1
Flag: 0 1 1 1 1 1 1 0			n

V5 envelope function sublayer structure

EF address

13-bit address field. The range from 0 to 8175 is used to identify an ISDN user port within the V5-interface. Values from 8176 to 8191 are reserved and are used to identify a point at which data link layer services are provided by the V5 layer 2 entity to a layer 3.

EA

Address extension bits.

Information

The information field consists of an integral number of octets. The default value for the maximum number of octets is 533 octets. The minimum size is 3 octets.

FCS

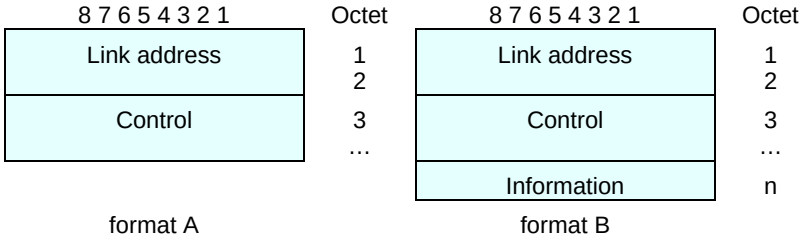
Frame check sequence as defined in section 2.1 of standard G.921.

LAPV5-DL

ITU G.964: http://www.itu.int/itudoc/itu-t/rec/g/g800up/g964.html

The LAPV5 Data Link Sublayer defines peer-to-peer exchanges of information between the AN and the LE .

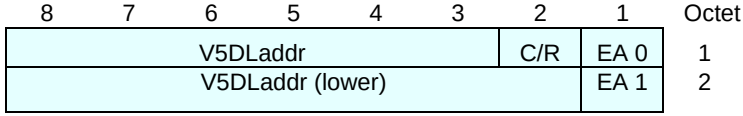
LAPV5-DL frames can be of format A without an information field or format B with an information field. The format of these frames is shown in the following illustration:



V5 data link sublayer structure

Link address

The link address field consists of two octets. The format of the link address is as follows:



V5 Link address structure

V5DLaddr

13-bit address field. Values in the range of 0 to 8175 are used to identify ISDN user ports. Defined values are as follows:

8	7	6	5	4	3	2	1	
1	1	1	1	1	1	C/R	EA	Octet 1
								Octet 2
1	1	1	0	0	0	0	EA	PSTN signalling
1	1	1	0	0	0	1	EA	Control protocol

EA
Address extension bits.

Control
The control field identifies the type of frame which is either a command or response. The control field contains sequence numbers, where applicable.

Information
The information field of a frame, when present, consists of an integer number of octets. The maximum number of octets in the information field is 260.

V5-Link Control

ITU G.965: http://www.itu.int/itudoc/itu-t/rec/g/g800up/g965.html

The V5-Link Control Protocol is sent by the AN or LE to convey information required for the coordination of the link control functions for each individual 2048 kbps link.

The format of the link control protocol header is shown in the following illustration:

8	7	6	5	4	3	2	1	Octet
Protocol discriminator								1
Layer 3 address								2
Layer 3 address (lower)								3
0	Message type							4
Other IEs								etc.

V5 link control structure

Protocol discriminator

Distinguishes between messages corresponding to one of the V5 protocols.

Layer 3 address

Identifies the layer 3 entity, within the V5 interface to which the transmitted or received message applies.

Message type

Identifies the function of the message being sent or received. The message type may be LINK CONTROL or LINK CONTROL ACK.

Other IEs

Information elements. The only IE for the link control protocol is the Link Control Function. Its format is as follows:

8	7	6	5	4	3	2	1	Octet
0 0 1 0 0 0 0 1								1
Length of link control function								2
1	Link control function							4

Link Control Function IE

Link control function

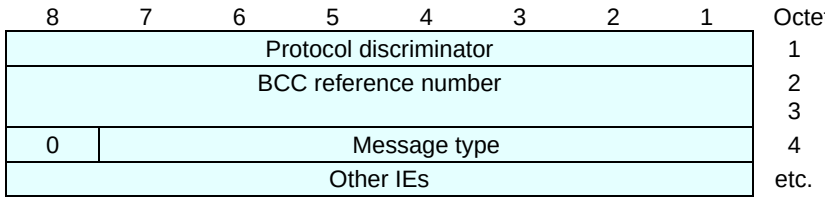
The link control function conveyed by the message.

V5-BCC

ITU G.965: http://www.itu.int/itudoc/itu-t/rec/g/g800up/g965.html

The V5-BCC protocol provides the means for the LE to request the AN to establish and release connections, between specified AN user ports and specified V5-interface time slots. It enables V5 interface bearer channels to be allocated or de-allocated by independent processes (on a per call, preconnected or semi-permanent basis). There may be more than one process active at any one time for a given user port.

The format of the header is shown in the following illustration:



BCC header structure

Protocol discriminator

The Protocol Discriminator distinguishes between messages corresponding to one of the V5 protocols.

BCC reference number

The BCC reference number information element is specific to the BCC protocol and uses the location of the Layer 3 address information element within the general V5 message structure.

The BCC reference number identifies the BCC protocol process, within the V5.2 interface, to which the transmitted or received message applies.

The BCC reference number value is a random value generated by the entity (AN or LE) creating the new BCC protocol process (this random value is implemented as a sequential generation of values). It is essential that values are not repeated in messages for which a different BCC process is required (in the same direction), until the old BCC process has been finished and the number deleted. In the case of any process generating error indications, the BCC reference number should not be re-used until sufficient time has elapsed for delayed arrival of messages containing the same BCC reference

number. The length of the BCC reference number IE is 2 octets. Its format is shown here:

8	7	6	5	4	3	2	1	Octet
Src ID	BCC reference number value							4
0	0	BCC reference number value						

BCC reference number IE structure

Src ID

Source Identification is a field of one bit specifying the entity (LE or AN) that has created the BCC reference number (i.e. the entity that has created the BCC protocol process). The coding of this field is zero for an LE created process and one for an AN created process.

BCC reference number

13-bit field used for providing the binary coding that identifies the BCC process.

Message Type

The Message Type identifies the function of the message being sent or received. Message types may be as follows:

- ALLOCATION.
- ALLOCATION COMPLETE.
- ALLOCATION REJECT.
- DE-ALLOCATION.
- DE-ALLOCATION COMPLETE.
- DE-ALLOCATION REJECT.
- AUDIT.
- AUDIT COMPLETE.
- AN FAULT.
- AN FAULT ACKNOWLEDGE.
- PROTOCOL ERROR.

Other IEs

Various elements concerned with the V5-BCC messages. The following IEs are specific to BCC:

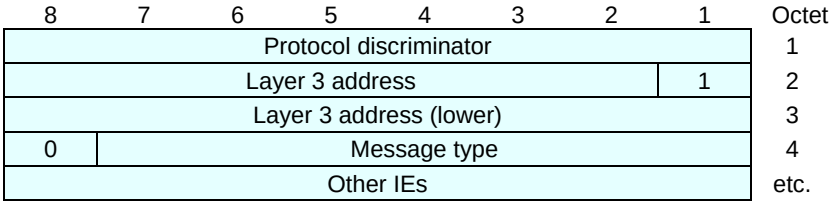
- User port identification.
- ISDN port channel identification.
- V5-time slot identification.
- Multi-slot map.
- Reject cause.
- Protocol error cause.
- Connection incomplete.

V5-PSTN

ITU G.964: http://www.itu.int/itudoc/itu-t/rec/g/g800up/g964.html

The signalling protocol specification and layer multiplexing PSTN protocol on the V5-interface is basically a stimulus protocol in that it does not control the call procedures in the AN, but rather transfers information about the analogue line state over the V5 interface. The V5-PSTN protocol is used in conjunction with the national protocol entity in the LE. The national protocol entity in the LE which is used for customer lines which are connected directly to the LE, is also used to control calls on customer lines which are connected via the V5-interface. For time critical sequences, it is necessary to extract certain signalling sequences (e.g., compelled sequences) from the national protocol entity into an 'AN part' of the national protocol entity. The V5-PSTN protocol has a relatively small functional part which is concerned with path setup, release of the path on the V5 interface, call collision resolution on the V5 interface and handling of new calls in case of overload conditions in the LE. The majority of line signals are not interpreted by the V5-PSTN protocol, but simply transferred transparently between the user port in the AN and national protocol entity in the LE.

The format of the header is shown in the following illustration:



PSTN header structure

Protocol discriminator

Distinguishes between messages corresponding to one of the V5 protocols. The value of the protocol discriminator for PSTN is 01001000.

Layer 3 address

This identifies the layer 3 entity, within the V5 interface to which the transmitted or received message applies.

Message type

Identifies the function of the message being sent or received. Message types for PSTN may be as follows:

- ESTABLISH.
- ESTABLISH ACK.
- SIGNAL.
- SIGNAL ACK.
- STATUS.
- STATUS ENQUIRY.
- DISCONNECT.
- DISCONNECT COMPLETE.
- PROTOCOL PARAMETER.

Other IEs

For PSTN the following information elements may appear:

Single Octet IEs:

- Pulse-notification.
- Line-information.
- State.
- Autonomous-signalling-sequence.
- Sequence-response.

Variable Length IEs:

- Sequence-number.
- Cadenced-ringing.
- Pulsed-signal.
- Steady-signal.
- Digit-signal.
- Recognition-time.
- Enable-autonomous-acknowledge.
- Disable-autonomous-acknowledge.
- Cause.
- Resource-unavailable.

V5-Control

ITU G.964: http://www.itu.int/itudoc/itu-t/rec/g/g800up/g964.html

The V5-Control user port status indication is based on the defined split of responsibilities between AN and LE. The structure of the V5-Control protocol is shown in the following illustration:

8	7	6	5	4	3	2	1	Octet
Protocol discriminator								1
Layer 3 address							0	2
Layer 3 address (lower)							1	3
0	Message type							4
Other IEs								etc.

Control header structure

Protocol discriminator

Distinguishes between messages corresponding to one of the V5 protocols.

Layer 3 Address

Identifies the layer 3 entity, within the V5 interface to which the transmitted or received message applies.

Message type

Identifies the function of the message being sent or received. Message types for the control protocol may be as follows:

- PORT CONTROL.
- PORT CONTROL ACK.
- COMMON CONTROL.
- COMMON CONTROL ACK.

Other IEs

For the control protocol the following information element may appear:

Single Octet IEs:

- Performance grading.
- Rejection cause.

Variable Length IEs:

- Control function element.
- Control function ID.
- Variant Interface ID.

V5-Protection

ITU G.965: http://www.itu.int/itudoc/itu-t/rec/g/g800up/g965.html

A single V5 interface may consist of up to sixteen 2048 kbps links. According to the protocol architecture and multiplexing structure a communication path may carry information associated with several 2048 kbps links (non-associated information transfer). The failure of a communication path could therefore impact the service of a large number of customers in an unacceptable way. This is particularly true for the BCC protocol, the control protocol and the link control protocol, where all user ports are affected in the event of a failure of the relevant communication path. In order to improve the reliability of the V5 interface, protection procedures for the switch-over of communication paths under failure are provided.

The protection mechanisms are used to protect all active C-channels. The protection mechanism also protects the protection protocol C-path (itself) which is used to control the protection switch-over procedures. In addition flags are continuously monitored on all physical C-channels (active and standby C-channels) in order to protect against failures which are not already detected by Layer 1 detection mechanisms. If a failure is detected on a standby C-channel, the system management will be notified and as a result, will not switch a logical C-channel to that non-operational standby C-channel.

The format of the header is shown in the following illustration:

8	7	6	5	4	3	2	1	Octet
Protocol discriminator								1
Layer 3 address							1	2
Layer 3 address (lower)								3
0	Message type							4
Other IEs								etc.

Protection protocol structure

Protocol discriminator

Distinguishes between messages corresponding to one of the V5 protocols.

Layer 3 address

Identifies the layer 3 entity, within the V5 interface to which the transmitted or received message applies.

Message type

Identifies the function of the message being sent or received. Message types for the protection protocol may be as follows:

- SWITCH-OVER REQ.
- SWITCH-OVER COM.
- OS-SWITCH-OVER COM.
- SWITCH-OVER ACK.
- SWITCH-OVER REJECT.
- PROTOCOL ERROR.
- RESET SN COM.
- RESET SN ACK.

Other IEs

For the protection protocol, the following information elements may appear:

Variable Length IEs:

- Sequence number.
- Physical C-channel identification.
- Rejection cause.
- Protocol error cause.