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Road vehicles — Low-speed serial data communication —

Part 3:
Vehicle area network (VAN)

Véhicules routiers — Communication en série de données à basse vitesse —
Partie 3: Réseau local de véhicule (VAN)

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Contents

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Annexes

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11519-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Sub-Committee SC 3, *Electrical and electronic equipment*.

ISO 11519 consists of the following parts, under the general title *Road vehicles — Low-speed serial data communication*:

— *Part 1: General and definitions*

— *Part 2: Low-speed controller area network (CAN)*

— *Part 3: Vehicle area network (VAN)*

— *Part 4: Class B data communication network interface (J1850)*

Annexes A and B form an integral part of this part of ISO 11519.

Road vehicles — Low-speed serial data communication —

Part 3:
Vehicle area network (VAN)

1 Scope

This part of ISO 11519 specifies the data link layer and the physical layer of the Vehicle Area Network (VAN), communications network up to 125 kbit/s, for road vehicle application. The VAN is an access-method-oriented multimaster-multislave which allows optimized request/response management by special method of handling a remote transmission request (retaining access to the medium to allow insertion of a response).

This part of ISO 11519 defines the general architecture of the low-speed communication network up 125 kbits/s and the content of the data link layer, and the physical layer for transmission between different types of electronic modules on board road vehicles.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11519. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11519 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/TR 8509:1987, *Information processing systems — Open Systems Interconnection — Service conventions.*

ISO 8802-2:1989, *Information processing systems — Local area networks — Part 2: Logical link control.*

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this part of ISO 11519, the following definitions apply.

3.1.1 acknowledgement field (ACK): Field used by a module concerned to indicate correct interpretation of the frame by a receiver.

3.1.2 autonomous module: Module which can initiate data sending over the transmission medium.

3.1.3 bitwise arbitration: Arbitration technique which allows a priority message to take precedence on the bus and dominate other messages of lower priority with which it collides. The collision is thus not destructive for the highest-priority message. This bitwise arbitration technique is based on the use of dominant and recessive states on the bus, with the dominant states taking precedence over the recessive bits.

In the event of a collision in the arbitration field (simultaneous sending of recessive and dominant bits), only those modules sending a dominant bit will keep on transmitting, while the others will cease to transmit. This process is repeated for each bit of the arbitration field.

Bus value — The bus can take 2 electrical states:
dominant (D) corresponds to a logic level "0" ,
recessive (R) corresponds to a logic level "1" .

3.1.4 code violation: Any error that converts a bit or other physical symbol into an out-of-code symbol.

3.1.5 collision; interference: Physical phenomenon that occurs when several signals are superimposed on one another, whether they are of internal origin (modules connected to the bus) or external origin (noise).

3.1.6 collision detection: Collision detected by a sending module when interference occurs on the bus and modifies the signal transmitted (more precisely, the signal received is different from the signal sent).

3.1.7 command field (COM): Field containing command information associated with the frame.

3.1.8 contention: Situation that arises when several modules start transmitting simultaneously on the communication bus.

3.1.9 data field (DAT): Part of the frame containing data. The field consists of a whole number of bytes.

3.1.10 data transmission: Process by which encoded data can be sent over a transmission medium sequentially in binary form.

3.1.11 end of data (EOD): Part of the frame indicating the end of data. The EOD is located just after the Frame Check Sequence (FCS).

3.1.12 end of frame (EOF): Part of the frame indicating the end of a frame.

3.1.13 extensibility: Situation where modules can be added to the network without having to change the software or hardware of any module for an existing application, within the limits of the communication layers specified in this document.

3.1.14 MAC frame: Sequence of fields containing either:

a start of frame field;
an identifier field;
a command field;
a data field;
a frame check sequence field;
an end of data field;
an acknowledgement field;
an end of frame field.

or

a start of frame field;
an identifier field;
a command field;
a frame check sequence field;
an end of data field;
an acknowledgement field;
an end of frame field.

Each frame is separated by an interframe spacing field.

3.1.15 frame check sequence (FCS): Part of the frame which checks its integrity. In the present case, this function is performed by means of a Cyclic Redundancy Check (CRC).

3.1.16 identifier field (IDEN): Part of the frame following the SOF, which identifies and specifies the data conveyed in the frame.

3.1.17 interframe spacing (IFS): Minimum time interval locally required between the sending of two consecutive frames, which is controlled by the MAC sublayer.

3.1.18 module: Physical entity connected to the network, capable of receiving and/or sending data via the medium.

3.1.19 remote transmission request: By sending a data request, a module that wishes a data unit can request another module to send it the corresponding data. The data unit can be sent either immediately in the same frame or later in a separate frame identified by the same identifier.

3.1.20 slave module: Module which can

— receive data

— send data when requested, by means of an in-frame response mechanism.

3.1.21 start of frame (SOF): Part of the frame which indicates the start of the frame and synchronizes the receiving modules' clocks.

3.1.22 synchronous access module: Module which can initiate transmission only after a Start of Frame (SOF) character appears on the bus.

3.2 List of abbreviations

ACK	Acknowledge
ADT	Acknowledged Data Transfer
BR	Bit Rate
BT	Bit Time
D	Dominant State
DL	Data Link
EOD	End Of Data
EOF	End Of Frame
FCS	Frame Check Sequence
IFS	Interframe Spacing
LLC	Logical Link Control
LSB	Least Significant Bit
LSDU	Link Service Data Unit

MAC	Medium Access Control
MDI	Medium Dependent Interface
MSB	Most Significant Bit
NADT	Not Acknowledged Data Transfer
OSI	Open Systems Interconnection
PL	Physical Layer
PLS	Physical Signalling
PMA	Physical Medium Attachment
Q/R	Question/Response Frame
RD	Recessive State
RAK	Request Acknowledge
RT	Remote Transmission
RTR	Remote Transmission Request
SOF	Start Of Frame
TS	Time Slot

4 Presentation of architecture

4.1 General

The objectives of the VAN are to interconnect different types of electronic modules on board a vehicle and to transmit messages having different priority levels.

The VAN is an asynchronous data transmission system which allows the transfer of packets of data.

The messages handled can be typically:

— messages of 1 byte, to write or to read from a slave peripheral module;

— messages from 0 to 28 bytes, to exchange parameters and/or events between the different autonomous modules;

— long messages segmented by the user.

The document allows the possibility of interconnecting heterogeneous modules including, among others, very simple slave modules.

The implications for the frame format and layer design are:

— the use of a special Start Of Frame field which can correct the local clocks of the simple modules and establish a common time base;

— the possibility of chaining the response of a module in the same request frame concerning it;

— the possibility of direct in-frame acknowledgement.

4.2 Reference to OSI model

The VAN architecture complies with the ISO reference model for Open Systems Interconnection (OSI) with respect to the breakdown by layers. This breakdown is shown in figure 1.

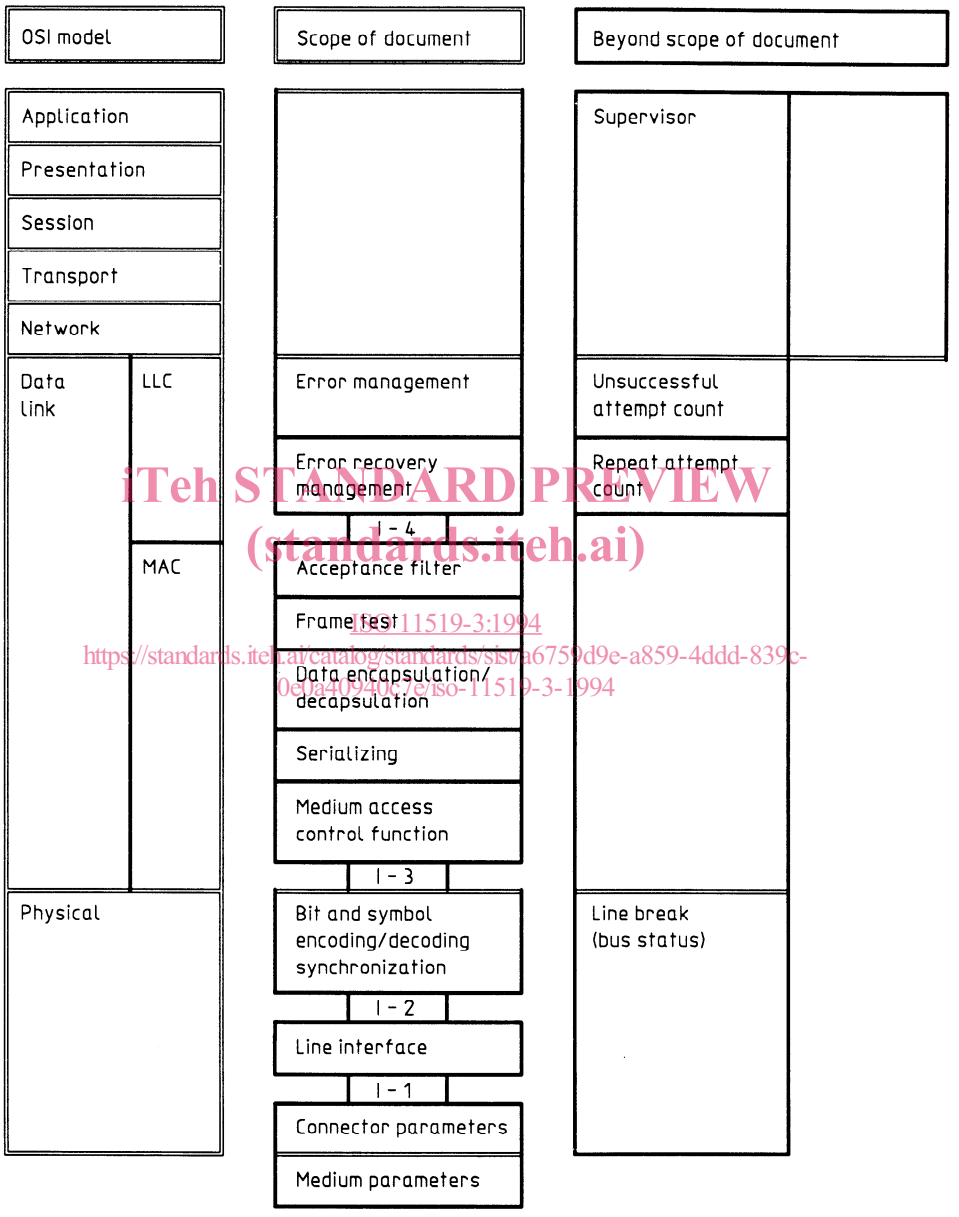

Figure 1 — Breakdown by layers in accordance with OSI model

5 Description of LLC sublayer

The LLC (Logical Link Control) sublayer is the upper part of the data link layer (layer 2 of the ISO reference model — see figure 1).

The objective is to provide a multipoint data transmission service, in connectionless mode.

The architecture of the VAN, described in this part of ISO 11519, allows two types of service which can be provided by the LLC sublayer (in accordance with the International Standard on LAN architecture, ISO 8802-2):

— **The class I LLC service** which offers a data transfer service without acknowledgement: this provides a minimum level of service and requires the implementation of greatly reduced functionalities at the LLC layer protocol level;

— **The class III LLC service** which offers, in addition to class I services (point-to-point, multipoint or broadcast data transfer), check services on the operation of the data link (acknowledgement, flow control, sequencing and error recovery).

Generally speaking, the LLC sublayer provides the functionalities needed for supervision of the data links and should incorporate at its level recovery capabilities in the event of failure of a module.

The description of the services of the LLC sublayer is given in 5.1. The precise definition of LLC procedure elements required for implementation of these services is not yet contained in this part of ISO 11519.

5.1 LLC service specifications

5.1.1 Object

This subclause specifies the services which are provided by the LLC sublayer to the LLC user in the framework of the VAN architectural model defined in this part of ISO 11519 (see figure 1 for the description of the layers).

5.1.2 General presentation of LLC services

The services provided by the LLC sublayer are designed to allow exchange of packets between the local user entity (LLC user) and peer entities (LLC users) which are connected to the communication bus.

In order to provide these services, the LLC sublayer builds its functions on the services provided by the next lower sublayer (MAC services: see 6.1).

There are three types of services provided by the LLC sublayer. All these services are connectionless oriented (i.e. they do not need the establishment and maintenance of a connection, see ISO 8802-2).

5.1.2.1 Unacknowledged data transfer service

The unacknowledged data transfer service provides the means by which a transfer entity can send Link Service Data Units (LSDU) to transfer entities.

This service can be used for point-to-point, multipoint or broadcast exchanges with maximum efficiency.

5.1.2.2 Acknowledged data transfer service

The acknowledged data unit exchange service provides the means by which a transfer entity can exchange Link Service Data Units (LSDU) to another transfer entity with the guarantee that the LSDU has been transmitted correctly.

This service can be based either on an LLC-level acknowledgement mechanism LLC Type 3 when a high level of reliability is required or on the acknowledge capability provided by the MAC sublayer (see 6.3.2.1.1).

This part of ISO 11519 does not specify the functions of the LLC sublayer necessary to provide acknowledged data unit exchanges (LLC type 3).

The acknowledged data transfer service is to be used for point-to-point exchanges only.

5.1.2.3 Remote data transmission service

The remote data transmission service provides the means by which a transfer entity at one module can request (consume) a data unit (LSDU) that is located (produced) at some other remote module.

This service can be used for point-to-point, multipoint or broadcast exchanges, with respect to the transferred data units (LSDU).

This service is divided in two subservices:

— the response preparation service,

— the reply service.

5.1.3 Description of LLC service interactions

5.1.3.1 Service specification method and notation

This subclause describes the service aspects of the LLC sublayer (corresponding to the various functionalities of the LLC sublayer provided for users located in the upper layer).

This is an abstract representation (or model) of an interface between the LLC sublayer and an LLC service user, independent of any specific implementation.

The LLC service definition proposed hereafter complies with the ISO reference model: in particular, it uses the associated service notations in ISO/TR 8509.

The service primitives used are of three types: request, indication, confirm. Their meaning is summarized below:

Request The request primitive is sent by a (N)-user to the (N)-layer or (N)-sublayer to request initiation of a service.

Indication The indication primitive is sent by the (N)-layer or (N)-sublayer to a user of the (N)-service to indicate that an event internal to the (N)-(sub-)layer has occurred and that the event in question is significant for the (N)-user. An indication can be triggered by a service request executed previously or by an internal event in the (N)-(sub-)layer.

Confirm The confirm primitive is sent by (N)-layer to a (N)-user to retrieve the results associated with the previous service request.

The links (logical and temporal) between indication and confirm are diverse, depending basically on the characteristics of each service.

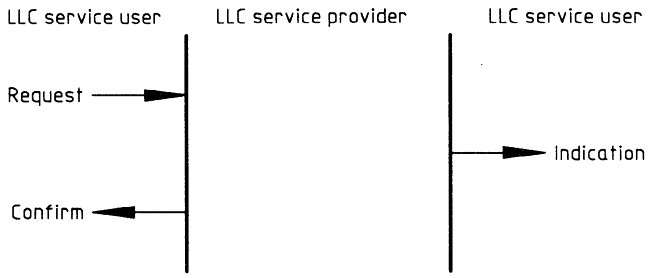

Figure 2 — Schematic diagram of interactions between adjacent layers

5.1.3.2 Description of service interactions

Table 1 gives a list of the service primitives characterizing each of the LLC service elements described in this part of ISO 11519. Subclause 5.1.3.3 gives a detailed description of each of these service primitives.

Table 1 — List of LLC service primitives

Unacknowledged data transfer	
DL-DATA.request	Request for unacknowledged data transfer.
DL-DATA.indication	Indication of unacknowledged data transfer.
DL-DATA.confirm	Confirm of unacknowledged data transfer.
Acknowledged data transfer	
DL-ACK-DATA.request	Request for acknowledged data transfer.
DL-ACK-DATA.indication	Indication of acknowledged data transfer.
DL-ACK-DATA.confirm	Confirm of acknowledged data transfer.
Remote transmission service with acknowledgement	
Reply service	
DL-REPLY.request	Request for remote transmission.
DL-REPLY.indication	Indication of remote transmission.
DL-REPLY.confirm	Confirm of remote transmission.
Response preparation service	
DL-REPLY-UPDATE.request	Request for response preparation.
DL-REPLY-UPDATE.confirm	Confirm of response preparation.
Remote transmission service without acknowledgement	
Reply service	
DL-REPLY.request	Request for remote transmission.
DL-REPLY.indication	Indication of remote transmission.
DL-REPLY.confirm	Confirm of remote transmission.
Response preparation service	
DL-REPLY-UPDATE.request	Request for response preparation.
DL-REPLY-UPDATE.confirm	Confirm of response preparation.

5.1.3.3 Definition of LLC service primitives

This subclause gives the definition of LLC service primitives such as presented in 5.1.3.2 with their associated parameters.

The following parameters are used to formalize the kind of interactions which appear at the transfer/LLC service interface:

— The IDEN parameter is used to identify the data which are exchanged using this interaction (sent, received or requested in a remote transmission);

— The DATA parameter represents the user data transferred (LSDU) using this primitive;

— The SERVICE CLASS specifies whether or not the LLC sublayer uses the acknowledge capability in the medium access control sublayer for the data unit transmission;

— The NREP-DL indicates the maximum number of retransmissions that the data link layer may achieve (using the recovery capabilities of both LLC and MAC sublayers) to provide the complete execution of the corresponding request;

— The NREP-ACK parameter indicates the maximum number of retransmissions that the data link layer may achieve by lack of acknowledgement of the receiving entity;

— The STATUS parameter specifies whether the corresponding request was executed with success or not. In the latter case, it indicates the type of failure.

Table 2 gives the list of parameters associated to the primitives for each LLC service.

Table 2 — Parameters

LLC services	List of parameters	Type of interaction		
		REQ	IND	CONF
Unacknowledged data transfer	IDEN	X	X	X
	DATA	X	X	—
	NREP-DL	X	—	—
	STATUS	—	—	X
Acknowledged data transfer	IDEN	X	X	X
	DATA	X	X	—
	SERVICE-CLASS	X	X	X
	NREP-DL	X	—	—
	NREP-ACK	X	—	—
	STATUS	—	—	X
Reply	IDEN	X	X	X
	DATA	—	—	X
	SERVICE-CLASS	X	X	X
	NREP-DL	X	—	—
	STATUS	—	—	X
Response preparation	IDEN	X	—	X
	DATA	X	—	—
	STATUS	—	—	X

5.2 Error management at LLC level

Transmission errors are indicated by the MAC sublayer to the LLC sublayer.

Error recovery procedures are managed by the LLC sublayer.

Recovery management after loss of arbitration by the LLC sublayer is optional. Repetitions of this type are not accounted for (see 5.3). They can be indicated to the network administration.

5.2.1 Errors in transmit mode

When transmit mode errors are indicated by the MAC sublayer, the LLC sublayer can repeat the transmission request following a time delay.

5.2.2 Errors in receive mode

In receive mode, errors indicated to the LLC sublayer by the MAC sublayer correspond:

— either to an error indicated by the physical layer to the MAC sublayer (code violation, synchronization, etc.);

— or to an invalid frame detected by the MAC sublayer.

If an error is detected in receive mode, the MAC sublayer notifies the LLC sublayer of the type of error (see 6.3.5).

5.3 Error recovery management at LLC level

After a loss of arbitration, an LLC level recovery can occur in the following conditions:

— another frame send attempt is made without further delay, after sending the frame which caused the collision;

— There is no limit to the number of repeat attempts at the LLC sublayer level;

— a specific request by a user of the LLC sublayer can interrupt further send attempts.

A send attempt can only be repeated after sending the EOF character and waiting for the interframe spacing (IFS).

6 Description of the MAC sublayer

This clause describes the functions, main characteristics (and subsequently the protocol) of the MAC (Medium Access Control) sublayer of the VAN.

The MAC sublayer is the lower part of the data link layer of the ISO reference model (see figure 1). It contains the medium access facilities used for sharing a data communication bus between two or more interconnected modules in the vehicle, and the other functionalities required for the implementation of a data link layer (data serializing and deserializing, interface with the physical layer).

This part of ISO 11519 includes an access method specification (general principles) and the corresponding parameter values for implementation on a medium such as that considered in this document (differential pair for bit rates ranging from 10 kbits/s to 125 kbits/s). For the latest technical developments, the limit of the data transfer is 250 kbit/s.

6.1 Specification of MAC service

6.1.1 Object

Subclause 6.1 specifies the services provided by the MAC sublayer to the LLC sublayer within the VAN architecture defined in this document (see figure 1 for the breakdown by layers).

It includes a general description of MAC services (6.1.2) and, for each type of module that is defined, it specifies the list of available services (table 3).

Table 3 — MAC services

Service categories	Role	Types of modules	
		Autonomous	Slave
Unacknowledged data transfer	P(=I)	Yes	No
	C	Yes	Yes
Acknowledged data transfer	P(=I)	Yes	Yes
	C	Yes	Yes
Remote transmission with immediate response	I	Yes	No
	P	Yes	Yes
	C	Yes	Yes
Remote transmission with deferred response	I	Yes	No
	P	Yes	No
	C	Yes	No

Subclause 6.1.3 gives a detailed specification of service primitives: they represent a conceptual description of interactions between the MAC sublayer and a MAC-service user which are necessary for the execution of these services.

6.1.2 General description of MAC service

The services provided by the MAC sublayer are designed to allow data exchange between the local user entity (LLC sublayer) and peer entities (LLC sublayers) connected to the communication bus.

The MAC services proposed in this part of ISO 11519 are of four types:

— **Unacknowledged data transfer service:** This enables the local entity to exchange data over a data link without call connection or acknowledgement of the receiving LLC entities. This simple data transfer is point-to-point, or multipoint, or broadcast-oriented.

— **Acknowledged data transfer service:** This enables the local LLC entity to transfer data to another LLC entity with a request for acknowledgement by the receiving LLC entity. This data transfer mode is point-to-point oriented in connectionless mode.

— **Remote transmission with immediate response service:** This service authorizes the local LLC entity to request the transfer of data produced by another LLC entity at some remote module.

The polled data must be previously prepared and stored at the MAC sublayer level at the producer module: they are sent immediately in the request frame (immediate response: see 6.2.1).