CiA® 309

CANopen

Access from other networks

Part 1: General principles and services

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HISTORY

Date	Changes
2004-09-15	*Publication of version 1.0* as draft standard proposal
2006-12-12	*Publication of version 1.1* as draft standard (now publicly available)
2012-04-30	*Publication of version 1.2* as draft standard proposal
2015-07-30	*Publication of version 2.0.0* as draft standard (now publicly available)

- Failure corrections, editorial changes and figure enhancements
- Parameter definitions moved to 3.2.1, definitions added
- Sub-clause 3.2.2 renamed
- Sub-clause 3.2.6 moved to 3.2.5
- Sub-clause 3.2.6 added
- Clause 5 added

NOTE: This document has been converted into "docx format".
The conversion caused minor layout differences to the predecessor document in "doc format". The technical content word-by-word is the very same.

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CONTENTS

1 Scope

This specification defines the services and protocols to interface CANopen networks to other (e.g. TCP/IP-based) networks. This set of specifications is organized as follows:

- Part 1: General principles and services

- Part 2: Modbus/TCP mapping

- Part 3: ASCII mapping

- Part 4: Amendment 7 to Fieldbus Integration into PROFINET IO

Part 1 specifies the network access services provided by a CiA 309 gateway device that give one CiA 309 network device (e.g. PLC or PC application) connected through TCP/IP or other protocols (based on Ethernet, remote access services, or serial links) access to devices attached to CANopen networks. The description of the transport protocol between the CiA 309 gateway device and the CiA 309 network devices using the services specified in this document is not in the scope of this specification part.

2 Normative references

For the purpose of this document, the following normative references (and those given in /CiA301/) apply.

/CiA301/   CiA 301 v. 4.2, CANopen application layer and communication profile

/CiA302-1/   CiA 302-1 v. 4.1, CANopen additional application layer functions – Part 1: General definitions

/CiA302-2/   CiA 302-2 v. 4.1, CANopen additional application layer functions – Part 2: Network management

/CiA302-3/   CiA 302-3 v. 4.1, CANopen additional application layer functions – Part 3: Configuration and program download

/CiA302-5/   CiA 302-5 v. 4.1, CANopen additional application layer functions – Part 5: SDO manager

/CiA302-7/   CiA 302-7 v. 1.0, CANopen additional application layer functions – Part 7: Multi-level networking

/CiA305/   CiA 305 v. 3.0, CANopen layer setting services (LSS)

3 Abbreviations and definitions

3.1 Abbreviations

For the purpose of this document, the following abbreviations (and those given in /CiA301/) apply.

PAS	PDO access services
EMCY	emergency object
PDO	process data object
RTR	remote transmission request
SAS	SDO access services
SDO	service data object
SRD	SDO requesting device (see /CiA302-5/)
TCP/IP	transmission control protocol/internet protocol

3.2 Definitions

3.2.1 Term definitions

For the purpose of this document, the following term definitions and those given in /CiA301/ apply.

3.2.1.1
CiA 301 network device
device that complies with the referenced CiA 301 CANopen application layer and communication profile

3.2.1.2
CiA 309 gateway device
device that translates the CiA 309 series protocols into the CiA 301 protocols

3.2.1.3
CiA 309 network device
device communicating via e.g. TCP/IP network using CiA 309 series protocols

3.2.1.4
COB-ID
parameter that includes CAN-ID and some control bits as defined in /CiA301/

3.2.1.5
data
data read or written from the network device

3.2.1.6
data type
type of data to be read or written

3.2.1.7
data type 1st to 64th
type of data of the objects mapped into a PDO

3.2.1.8
emergency
data received by a CANopen emergency object (EMCY) as defined in /CiA301/. It includes the emergency error code, the error register, and the manufacturer-specific error field as defined in /CiA301/.

3.2.1.9
error msg number
error code indicating the kind of failure

3.2.1.10
error msg text
textual description of the failure

3.2.1.11
failure
information that indicates that the service has been not completed successfully

3.2.1.12
gateway class
information that declares the CiA 309 gateway device's functionality (see 3.2.3)

3.2.1.13
GuardTime
time value as provided in the guard time object as defined in /CiA301/

3.2.1.14
HeartbeatConsumerTime
time value as provided in the consumer heartbeat time object as defined in /CiA301/

3.2.1.15
HeartbeatProducerTime
time value as provided in the producer heartbeat time object as defined in /CiA301/

3.2.1.16
implementation class
information that is transport protocol specific and is defined in the other parts of this specification

3.2.1.17
length
length of data to be read or written

3.2.1.18
LifeTimeFactor
time value as provided in the life time factor object as defined in /CiA301/

3.2.1.19
LSS address
the four entries of object 1018_h: vendor ID, product code, revision number and serial number

3.2.1.20
multiplexer
index and sub-index to access the CANopen object dictionary entry

3.2.1.21
network
number identifying uniquely the CANopen sub-network (see /CiA302-7/). If this parameter is not supported, the service request applies to the unique or default network.

3.2.1.22
nbr_objects
number of objects mapped into a PDO

3.2.1.23
node-ID
number identifying uniquely the device in a CANopen network. If this parameter is not supported, the service request applies to the default node-ID. If this parameter is supported, it shall become the default node-ID for the next service requests.

3.2.1.24
offset
value for direct access to a CANopen object. This parameter is limited to objects of type OCTET_STRING, VISIBLE_STRING, UNICODE_STRING and DOMAIN. The unit shall be UNSIGNED32. If this parameter is not supported, the object shall be read or written from offset 0.

3.2.1.25
product code
unique number identifying the device assigned by the manufacturer as defined in /CiA301/

3.2.1.26
protocol version
number that indicates the CiA 309-1 version the CiA 309 gateway device is based on

3.2.1.27
reason
code-providing information why the service was not successful

3.2.1.28
revision number
unique number identifying the device's version assigned by the manufacturer as defined in /CiA301/

3.2.1.29
SDO time-out
time value for the time-out of all SDO clients

3.2.1.30
serial number
unique number identifying the device within its class assigned by the manufacturer as defined in /CiA301/

3.2.1.31
success
information that indicates that the service has been completed successfully

3.2.1.32
time_out
maximum allowed duration indicated to the CiA 309 gateway device for processing a command, until the command processing is aborted and an error indication is transmitted

3.2.1.33
TxType
transmission type code as defined in /CiA301/

3.2.1.34
vendor-ID
unique identifier as defined in /CiA301/, assigned to a company by CiA

3.2.2   Functional overview

Figure 1 shows the relations between the functional elements referenced in this specification.
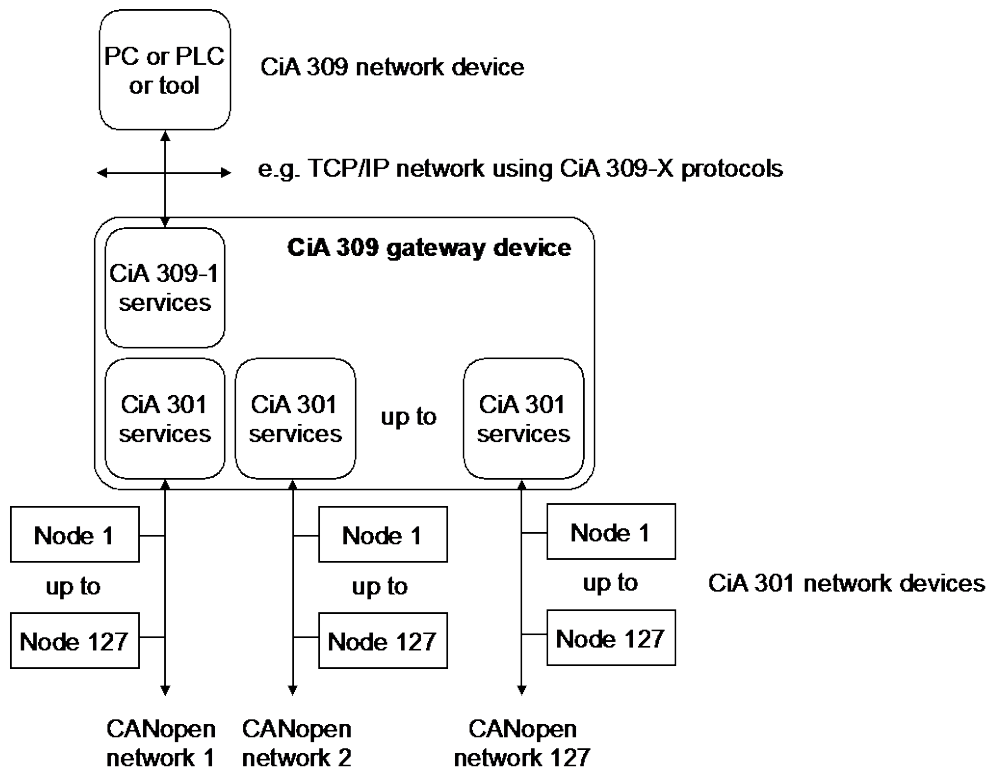
Figure 1 – Overview on functional elements referenced in this specification

3.2.3 Gateway class definitions

A CiA 309 gateway device may support one or more of the following classes:

- Class 1: The gateway is a device, acting as network slave (NMT slave functionality) within the CANopen network. The device shall provide SDO client functionality.

- Class 2: The gateway is a device implementing the functionality of a Class 1 device, which additionally implements SDO requesting device (SRD) functionality.

- Class 3: The gateway is a device acting as the CANopen manager (see /CiA302-1/) within the CANopen network.

3.2.4 Service primitives definitions

Service primitives are the means by which the CiA 309 gateway application and the CiA 309 network device application layer interact. There are four primitives:

- A request is issued by the CiA 309 gateway application to the CiA 309 network device application layer to request a service.

- An indication is issued by the CiA 309 network device application layer to the CiA 309 gateway application to report an internal event detected by the CiA 309 network device application layer or indicate that a service is requested.

- A response is issued by the CiA 309 gateway application to the CiA 309 network device application layer to respond to a previously received indication.

- The CiA 309 network device application layer issues a confirmation to the CiA 309 gateway application to report the result of a previously issued request.

A service type defines the primitives that are exchanged between the CiA 309 network device application layer and the CiA 309 gateway application for a particular service of a service object.

A local service involves only the local service object as shown in Figure 2. The CiA 309 gateway application issues a request to its local service object that executes the requested service without communicating with (a) peer service object(s) via the CiA 309 network.
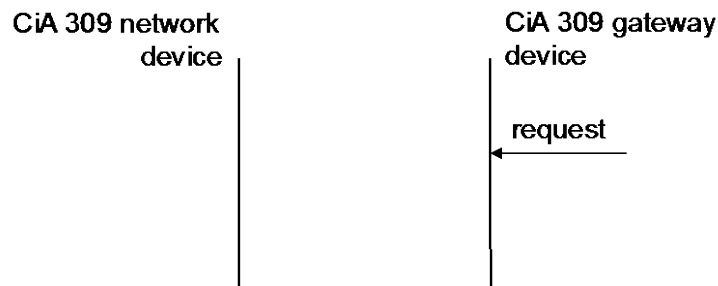
Figure 2 – Local service

An unconfirmed service involves one or more peer service objects as shown in Figure 3. The CiA 309 gateway application or the CiA 309 network device application issues a request to its local service object. This request is transferred to the peer service object(s) that each pass it to its (their) application as an indication.
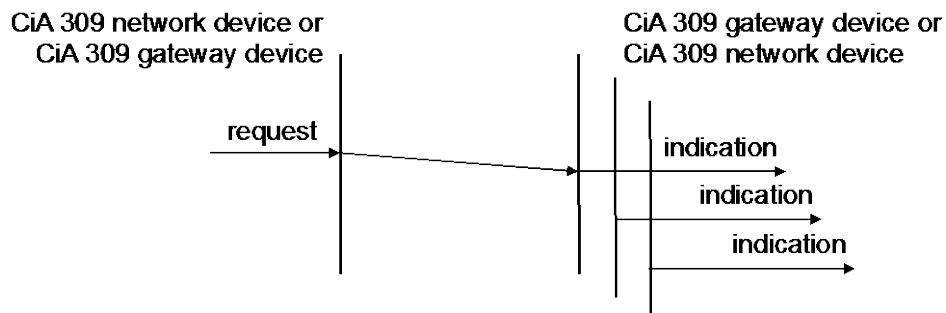
Figure 3 – Unconfirmed service

A confirmed service as shown in Figure 4 involves only to the peer service object. The CiA 309 network device application or the CiA 309 gateway application issues a request to its local service object. This request is transferred to the peer service object that passes it to the CiA 309 network device application respectively to the CiA 309 gateway application as an indication. The CiA 309 network device application or the CiA 309 gateway application issues a response that is transferred to the originating service object that passes it as a confirmation to the requesting service. This event is then indicated to the CiA 309 gateway application respectively to the CiA 309 network device application.
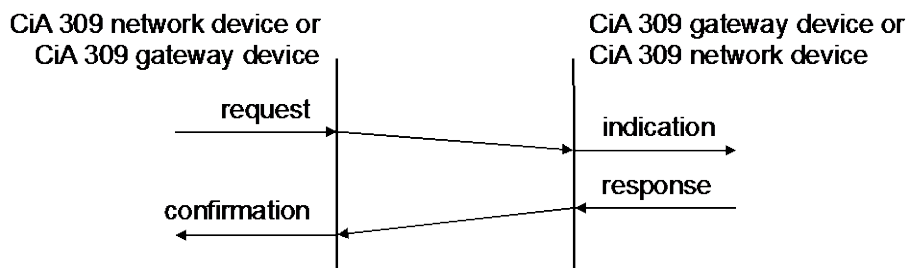
Figure 4 – Confirmed service

A provider-initiated service involves only the local service object as shown in Figure 5. The service object (being the service provider) detects an event not solicited by a requested service. This event is then indicated to the CiA 309 gateway application.
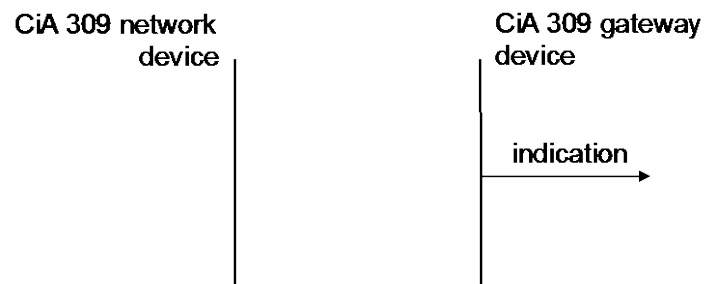
Figure 5 – Provider-initiated service

Unconfirmed and confirmed services are collectively called remote access.

3.2.5 CANopen network, device and object addressing

The CiA 309 gateway device may support more than one CANopen network. If multiple CANopen network interfaces are implemented, the CANopen networks shall be numbered uniquely (e.g. CANopen Net 1, CANopen Net 2, etc.).

The CANopen networks may be of one-level or multi-level type. One-level networks are connected physically to the CiA 309 gateway device. Multi-level networks are connected logically by means of cascaded network architectures. Multi-level networks are reached via the SDO network indication service as defined in /CiA302-7/. A routing table shall be used as defined in /CiA302-7/ in order to map CiA 309 gateway devices in logical networks to the physical port.

In each CANopen network the connected CANopen devices are uniquely addressed by the node-ID (see also /CiA301/). The CiA 309 gateway device itself also provides its own unique node-ID.

In each CANopen device the objects are addressed uniquely by the 16-bit index and the 8-bit sub-index as defined in /CiA301/.

3.2.6 Service parameter category representation

The parameters used for the specified services may be mandatory (shall be implemented), optional (may be implemented) or conditional (shall be implemented if a certain condition is fulfilled). The term selection indicates that exclusively one of the mentioned parameters shall be provided for a certain service.

4 Network access service specification

4.1 SDO access services

4.1.1 General

The services specified in 4.1 are used to initiate and configure SDO services accessing any object in the object dictionary of any device on any of the CANopen networks linked to the CiA 309 gateway device. In case that the CiA 309 gateway device supports multi-level networking as defined in /CiA302-7/, the network service indication shall be handled transparently.

4.1.2 SDO upload

This service shall initiate an SDO upload service. Table 1 defines the parameters for this service.

Table 1 – SDO upload service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Multiplexer	Mandatory	
Data type	Optional	
BOOLEAN	Selection	
UNSIGNED8	Selection	
UNSIGNED16	Selection	
UNSIGNED24	Selection	
UNSIGNED32	Selection	
UNSIGNED40	Selection	
UNSIGNED48	Selection	
UNSIGNED56	Selection	
UNSIGNED64	Selection	
INTEGER8	Selection	
INTEGER16	Selection	
INTEGER24	Selection	
INTEGER32	Selection	
INTEGER40	Selection	
INTEGER48	Selection	
INTEGER56	Selection	
INTEGER64	Selection	
REAL32	Selection	
REAL64	Selection	
TIME_OF_DAY	Selection	
TIME_DIFFERENCE	Selection	
OCTET_STRING	Selection	
VISIBLE_STRING	Selection	
UNICODE_STRING	Selection	
DOMAIN	Selection	
Offset	Optional	
Length	Optional	
Remote result		**Mandatory**
Success		Selection
Data		Mandatory
Length		Optional
Failure		Selection
Reason		Mandatory

4.1.3   Extended SDO upload

This service shall initiate an SDO upload service, without requesting a certain sub-index. All sub-indices of the requested object shall be transferred. Table 2 defines the parameters for this service.

Table 2 – Extended SDO upload service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Object index	Mandatory	
Data type	Optional	

Parameter	Request / indication	Response / confirmation
BOOLEAN	Selection	
UNSIGNED8	Selection	
UNSIGNED16	Selection	
UNSIGNED24	Selection	
UNSIGNED32	Selection	
UNSIGNED40	Selection	
UNSIGNED48	Selection	
UNSIGNED56	Selection	
UNSIGNED64	Selection	
INTEGER8	Selection	
INTEGER16	Selection	
INTEGER24	Selection	
INTEGER32	Selection	
INTEGER40	Selection	
INTEGER48	Selection	
INTEGER56	Selection	
INTEGER64	Selection	
REAL32	Selection	
REAL64	Selection	
TIME_OF_DAY	Selection	
TIME_DIFFERENCE	Selection	
OCTET_STRING	Selection	
VISIBLE_STRING	Selection	
UNICODE_STRING	Selection	
DOMAIN	Selection	
Offset	Optional	
Length	Optional	
Remote result		**Mandatory**
Success		Selection
Data		Mandatory
Length		Optional
Failure		Selection
Reason		Mandatory

4.1.4 SDO download

This service shall initiate an SDO download service. Table 3 defines the parameters for this service.

Table 3 – SDO download service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Multiplexer	Mandatory	
Data type	Optional	
BOOLEAN	Selection	
UNSIGNED8	Selection	
UNSIGNED16	Selection	
UNSIGNED24	Selection	
UNSIGNED32	Selection	
UNSIGNED40	Selection	
UNSIGNED48	Selection	
UNSIGNED56	Selection	
UNSIGNED64	Selection	
INTEGER8	Selection	

Parameter	Request / indication	Response / confirmation
INTEGER16	Selection	
INTEGER24	Selection	
INTEGER32	Selection	
INTEGER40	Selection	
INTEGER48	Selection	
INTEGER56	Selection	
INTEGER64	Selection	
REAL32	Selection	
REAL64	Selection	
TIME_OF_DAY	Selection	
TIME_DIFFERENCE	Selection	
OCTET_STRING	Selection	
VISIBLE_STRING	Selection	
UNICODE_STRING	Selection	
DOMAIN	Selection	
Offset	Optional	
Length	Optional	
Data	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.1.5   Configure SDO time-out

This service shall configure the time-out for all client-SDOs on the CiA 309 gateway device. Table 4 defines the parameters for this service.

Table 4 – Configure SDO time-out service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
SDO time-out	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.2 PDO access services

4.2.1   General

The services specified in 4.2 are used to configure and initiate PDO services in the CiA 309 gateway device. They include:

- Configure a receive PDO

- Configure a transmit PDO

- Request to read a PDO

- Request to write a PDO

- Indicate a received PDO

The two PDO configuration services are intended to create PDOs in the CiA 309 gateway device. If the CiA 309 gateway device implements an object dictionary, the PDO communication and mapping parameters entries shall be set-up accordingly.

The two PDO request services are intended to control the PDOs in accordance to the configured PDO transmission type (see /CiA 301/).

The data types VISIBLE_STRING, OCTET_STRING, and UNICODE_STRING, as well as DOMAIN shall not be used as PAS data type parameter.

NOTE   The PAS services are not intended to configure the PDO communication and mapping entries of the object dictionary of the remote devices. Accessing the CANopen devices individually by means of SAS services may do the PDO configuration.

4.2.2   Configure RPDO

This service shall create an RPDO in the CiA 309 gateway device. Table 5 defines the parameters for this service.

Table 5 – Configure RPDO service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
PDO number	Mandatory	
COB-ID	Mandatory	
TxType	Mandatory	
Nbr_objects	Mandatory	
1st mapped object	Mandatory	
Data type	Selection	
Multiplexer	Selection	
2nd mapped object	Optional	
Data type	Selection	
Multiplexer	Selection	
…	…	
64th mapped object	Optional	
Data type	Selection	
Multiplexer	Selection	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.2.3   Configure TPDO

This service shall create a TPDO in the CiA 309 gateway device. Table 6 defines the parameters for this service.

Table 6 – Configure TPDO service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
PDO number	Mandatory	
COB-ID	Mandatory	
TxType	Mandatory	
Inhibit time	Optional	
Event timer	Optional	
SYNC start value	Optional	

Parameter	Request / indication	Response / confirmation
Nbr_objects	Mandatory	
1st mapped object	Mandatory	
Data type	Selection	
Multiplexer	Selection	
2nd mapped object	Optional	
Data type	Selection	
Multiplexer	Selection	
…	…	
64th mapped object	Optional	
Data type	Selection	
Multiplexer	Selection	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.2.4   Read PDO data

This service shall read the data received by an RPDO. If an RPDO is configured with transmission type 252 or 253 (see /CiA301/), the CiA 309 gateway devices shall trigger it by means of an RTR. The received data shall be transmitted in the remote result. Table 7 defines the parameters for this service.

NOTE   It is recommended not to use RTR.

Table 7 – Read PDO data service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
PDO number	Mandatory	
Remote result		**Mandatory**
Success		Selection
Network		Optional
PDO number		Mandatory
Nbr_objects		Mandatory
Data 1st object		Conditional
…		…
Data 64th object		Conditional
Failure		Selection
Reason		Mandatory

4.2.5   Write PDO data

This service shall trigger the transmission of a PDO. The actual transmission of the PDO shall be triggered according to the configured PDO transmission type (see /CiA301/). Table 8 defines the parameters for this service.

Table 8 – Write PDO data service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
PDO number	Mandatory	
Nbr_objects	Mandatory	
Data 1st object	Conditional	
…	…	
Data 64th object	Conditional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.2.6 RPDO received

This service shall signal that new PDO data has been received and shall provide the received data. Table 9 defines the parameters for this service.

Table 9 – RPDO received service

Parameter	Request / indication
Argument	**Mandatory**
Network	Optional
PDO number	Mandatory
Nbr_objects	Mandatory
1st object value	Conditional
…	…
64th object value	Conditional

4.3 CANopen NMT services

4.3.1 General

The services specified in 4.3 are used to control a CANopen device or a CANopen network and associated error control services.

4.3.2 Start node

This service shall set CANopen devices into NMT state operational. For Class 1 and Class 2 devices this service shall trigger a CANopen request NMT service (see /CiA302-2/). For Class 3 devices this service shall trigger a start remote node service (see /CiA301/). Table 10 defines the parameters for this service.

Table 10 – Start node service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Selection	
All	Selection	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.3   Stop node

This service shall set CANopen devices into NMT state stopped. For Class 1 and Class 2 devices this service shall trigger a CANopen request NMT service (see /CiA302-2/). For Class 3 devices this service shall trigger a stop remote node service (see /CiA301/). Table 11 defines the parameters for this service.

NOTE   The remote result for Class 1 and 2 devices is only the confirmation of the SDO request; for Class 3 devices the remote result is based on the error control services as defined in /CiA301/.

Table 11 – Stop node service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Selection	
All	Selection	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.4   Set node to pre-operational

This service shall set CANopen devices into NMT state pre-operational. For Class 1 and Class 2 devices this service shall trigger a CANopen request NMT service (see /CiA302-2/). For Class 3 devices this service shall trigger an enter pre-operational service (see /CiA301/). Table 12 defines the parameters for this service.

Table 12 – Set node to pre-operational service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Selection	
All	Selection	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.5   Reset node

This service shall set CANopen devices into NMT state reset application. For Class 1 and Class 2 devices this service shall trigger a CANopen request NMT service as specified in /CiA302-2/. For Class 3 devices this service shall trigger a reset node service (see /CiA301/). Table 13 defines the parameters for this service.

Table 13 – Reset node service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Selection	
All	Selection	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.6 Reset communication

This service shall set CANopen devices into NMT state reset communication. For Class 1 and Class 2 devices this service shall trigger a CANopen request NMT service as specified in /CiA302-2/. For Class 3 devices this service shall trigger a reset communication service (see /CiA301/). Table 14 defines the parameters for this service.

Table 14 – Reset communication service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Selection	
All	Selection	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.7 Enable node guarding

This service is only available for Class 3 devices. It shall start node guarding for the device specified by node-ID with the parameters given by GuardTime and LifeTimeFactor. If heartbeat is already activated on the addressed device, the service request shall be rejected. Table 15 defines the parameters for this service.

Table 15 – Enable node guarding service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
GuardTime	Mandatory	
LifeTimeFactor	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.8 Disable node guarding

This service is only available for Class 3 devices. It shall stop node guarding for the device specified by node-ID. Table 16 defines the parameters for this service.

Table 16 – Disable node guarding service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.9 Start heartbeat consumer

This service shall start the consumption of heartbeat messages transmitted by a CANopen device specified by node-ID. Table 17 defines the parameters for this service.

Table 17 – Start heartbeat consumer service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
HeartbeatConsumerTime	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.10 Disable heartbeat consumer

This service shall stop the consumption of heartbeat messages transmitted by a CANopen device specified by node-ID. Table 18 defines the parameters for this service.

Table 18 – Disable heartbeat consumer service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.3.11 Error control event received

This service shall signal the NMT status or error control events received from a CANopen device specified by node-ID. In addition, a "boot-up message received"-event may be signalled by means of this service. Table 19 defines the parameters for this service.

Table 19 – Error control event received service

Parameter	Request / indication
Argument	**Mandatory**
Network	Optional
Node-ID	Mandatory
Status	Optional
Error code	Optional
Boot-up	Optional

4.4 Device failure management services

4.4.1 General

The services specified in 4.4 are used to manage failures within the CiA 309 gateway device or within any other CANopen device.

4.4.2 Read device error

This service shall read emergency object (EMCY) information received from the CANopen device specified by the node-ID parameter. Table 20 defines the parameters for this service.

Table 20 – Read device error service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Remote result		**Mandatory**
Success		Selection
Network		Optional
Node-ID		Mandatory
Error		Selection
Error msg number		Mandatory
Error msg text		Optional
Emergency		Selection
Emergency code		Mandatory
Error register		Optional
Manufacturer error		Optional
Failure		Selection
Reason		Mandatory

4.4.3   Emergency event received

This service shall signal the reception of an EMCY in the CiA 309 gateway device transmitted by a CANopen device specified by the node-ID. Table 21 defines the parameters for this service.

Table 21 – Emergency event received service

Parameter	Request
Argument	**Mandatory**
Network	Optional
Node-ID	Mandatory
Emergency code	Mandatory
Error register	Mandatory
Manufacturer error	Optional

4.5 CANopen interface configuration services

4.5.1   General

The services specified in 4.5 are used to configure and parameterize the CANopen interface of the CiA 309 gateway device.

4.5.2   Initialize gateway

This service shall initiate the CANopen initialization of the CiA 309 gateway device. It shall perform a power-on equivalent reset of the CANopen interface. It is used to initialize the bit-timing parameters. Table 22 defines the parameters for this service.

Table 22 – Initialize gateway service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
CAN bit timing	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.5.3   Store configuration

This service shall command the CiA 309 gateway device to store its CANopen interface configuration. Table 23 defines the parameters for this service.

Table 23 – Store configuration service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Storage specifier	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.5.4   Restore configuration

This service shall command the CiA 309 gateway device to restore its CANopen interface configuration. Table 24 defines the parameters for this service.

Table 24 – Restore configuration service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Storage specifier	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.5.5   Set heartbeat producer

This service shall set the CANopen heartbeat producer time in the CiA 309 gateway device. Table 25 defines the parameters for this service.

Table 25 – Set heartbeat producer service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
HeartbeatProducerTime	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.5.6   Set node-ID

This service shall set the CANopen node-ID in the CiA 309 gateway device for the CANopen network given in the network parameter. Table 26 defines the parameters for this service.

Table 26 – Set node-ID service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.5.7 Start emergency consumer

This service shall start the consumption of emergency objects (EMCYs). The relation between node-ID producing an EMCY and the COB-ID shall be explicitly known. Table 27 defines the parameters for this service.

Table 27 – Start emergency consumer service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
COB-ID	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.5.8 Stop emergency consumer

This service shall stop the consumption of emergency objects (EMCYs). The relation between node-ID producing an EMCY and the COB-ID shall be explicitly known. Table 28 defines the parameters for this service.

Table 28 – Stop emergency consumer service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
COB-ID	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.5.9 Set command time-out

This service shall indicate to the CiA 309 gateway device the maximum allowed duration for processing a command, until the command processing is aborted and an error indication is transmitted. Table 29 defines the parameters for this service.

Table 29 – Command time-out service

Parameter	Request / indication	Response / confirmation
Argument Time_out	**Mandatory** Mandatory	
Remote result Success Failure Reason		**Mandatory** Selection Selection Mandatory

4.5.10   Boot-up forwarding

This service shall allow enabling and disabling the forwarding of "boot-up message received"-events in the CiA 309 gateway device. Table 30 defines the parameters for this service.

Table 30 – Boot-up forwarding service

Parameter	Request / indication	Response / confirmation
Argument Command	**Mandatory** Mandatory	
Remote result Success Failure Reason		**Mandatory** Selection Selection Mandatory

4.6   Gateway management services

4.6.1   General

The services specified in 4.6 are used to manage the CiA 309 gateway device.

4.6.2   Set default network

This service shall set the default network number, which shall be used for all services. Table 31 defines the parameters for this service.

Table 31 – Set default network service

Parameter	Request / indication	Response / confirmation
Argument DefaultNetwork	**Mandatory** Mandatory	
Remote result Success Failure Reason		**Mandatory** Selection Selection Mandatory

4.6.3   Set default node-ID

This service shall set the default node-ID, which shall be used for all services. Table 32 defines the parameters for this service.

Table 32 – Set default node-ID service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Default node-ID	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.6.4 Get version

This service shall get information on the CiA 309 gateway device and its CANopen interface. Table 33 defines the parameters for this service.

Table 33 – Get version service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Remote result		**Mandatory**
Success		Selection
Vendor-ID		Mandatory
Product code		Mandatory
Revision number		Mandatory
Serial number		Mandatory
Gateway class		Mandatory
Protocol version		Mandatory
Implementation class		Mandatory
Failure		Selection
Reason		Mandatory

4.6.5 Set command size

This service sets the maximum size of a command to be accepted by a CiA 309 gateway device. By confirming this service with an OK, the gateway indicates that all commands that are equal to or are less than this size are accepted in principle and are not rejected because of lack of memory resources. In case the gateway does not meet the requested command size, the gateway shall reject the setting of this command size by means of a Failure as the remote result. Table 34 defines the parameters for this service.

Table 34 – Set command size service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Size	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.7 Controller management services

4.7.1 General

The services specified in 4.7 are used to manage a programmable controller implemented within the CiA 309 gateway device or in a remote device on a CANopen sub-network.

Upload and download of the controller program shall be done using SDO upload and SDO download services.

For a programmable controller on a remote device, the object dictionary entries specified in /CiA302-3/ for program control shall be implemented and the CiA 309 gateway shall translate the service into an SDO access to these object dictionary entries.

4.7.2 Reset controller

This service shall reset the controller function. Table 35 defines the parameters for this service.

Table 35 – Reset controller service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.7.3 Start controller

This service shall switch the controller function to "run". Table 36 defines the parameters for this service.

Table 36 – Start controller service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.7.4 Stop controller

This service shall switch the controller function to "stop". Table 37 defines the parameters for this service.

Table 37 – Stop controller service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8   Layer setting services

4.8.1   General

The services specified in 4.8 are used to set node-ID or bit-rate via CANopen network as specified in /CiA305/.

4.8.2   LSS switch state global

This service shall set the LSS state of all devices within the chosen network. Table 38 defines the parameters for this service.

Table 38 – LSS switch state global service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Switch	Mandatory	
Waiting_switch	Selection	
Configuration_switch	Selection	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.3   LSS switch state selective

This service shall switch the LSS state of the selected device within the chosen network. Table 39 defines the parameters for this service.

Table 39 – LSS switch state selective service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
LSS_address	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.4   LSS configure node-ID

This service shall set the new node-ID of the device, which is in configuration state. Table 40 defines the parameters for this service.

Table 40 – LSS configure node-ID service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.5   LSS configure bit-rate

This service shall set the new bit-rate of the device, which is in configuration state. The table_selector and the corresponding bit-rates of the table_index are given in /CiA305/. Table 41 defines the parameters for this service.

Table 41 – LSS configure bit-rate service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Table_selector	Mandatory	
Table_index (bit-rate)	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.6   LSS activate new bit-rate

This service shall switch the selected network to the new bit-rate. The parameter switch_delay is explained in /CiA305/. Table 42 defines the parameters for this service.

Table 42 – LSS activate new bit-rate service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Switch_delay	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.7   LSS store configuration

This service shall store the new node-ID or the new bit-rate to non-volatile memory of the device, which is currently in LSS configuration state. Table 43 defines the parameters for this service.

Table 43 – LSS store configuration service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.8   Inquire LSS address

This service shall request the LSS address of the device, which is currently in LSS configuration state. This is achieved by requesting one LSS number after another. The code for each of the four LSS numbers is defined in /CiA305/. Table 44 defines the parameters for this service.

Table 44 – Inquire LSS address service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Code for LSS number	Mandatory	
Remote result		**Mandatory**
Success		Selection
LSS number		Mandatory
Failure		Selection
Reason		Mandatory

4.8.9 LSS inquire node-ID

This service shall request the node-ID of the device, which is currently in LSS configuration state. Table 45 defines the parameters for this service.

Table 45 – Inquire node-ID service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Remote result		**Mandatory**
Success		Selection
Node-ID		Mandatory
Failure		Selection
Reason		Mandatory

4.8.10 LSS identify remote slave

This service shall request all devices in the network within a range of the LSS address (LSS_address_sel) to identify themselves, if their LSS address is matching. If there is detected at least one device, it is indicated by a success. Table 46 defines the parameters for this service.

Table 46 – LSS identify remote slave service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
LSS_address_sel	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.11 LSS identify non-configured remote slaves

This service shall request all devices to respond, if their node-ID is unconfigured (=FF$_h$). If at least one unconfigured device is detected, it shall be indicated by success of the service. Table 47 defines the parameters for this service.

Table 47 – LSS identify non-configured remote slaves service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.12 LSS Fastscan

This service shall identify the LSS address of unconfigured devices. It is an alternative to the inquire LSS address service. Table 48 defines the parameters for this service.

NOTE   The reception of an LSS identify slave service is indicated as success. Normally, a failure is caused by a time-out.

Table 48 – LSS Fastscan service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
IDNumber	Mandatory	
BitChecked	Mandatory	
LSSSub	Mandatory	
LSSNext	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.13 LSS assign node-ID to LSS address

This service shall search in all networks for a device with a certain LSS address. The desired node-ID shall be assigned to this device. Table 49 defines the parameters for this service.

Table 49 – LSS assign node-ID to LSS address service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
LSS address	Mandatory	
Node-ID	Mandatory	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.8.14 LSS complete node-ID configuration

This service shall search for non-configured devices in all networks and assign a node-ID to them. Table 50 defines the parameters for this service.

NOTE   If this service is used, no other LSS services need to be provided by the CiA 309 gateway device.

Table 50 – LSS complete node-ID configuration service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Remote result		**Mandatory**
Success		Selection
Failure		Selection
Reason		Mandatory

4.9 Manufacturer-specific services

The manufacturer of a CiA 309 gateway device may define additional services. Manufacturer-specific services are not in the scope of this document.

5 CiA 309 operating sequences

5.1 General

Up to now there has always been assumed that the CiA 309 gateway device is transparent, if a communication is ongoing between a CiA 309 network device and a CiA 301 network device. Because of limited processing power or memory resources a transparent gateway becomes visible. Therefore, this clause provides entire protocols, exchanged between a CiA 309 network device and a CiA 301 network device, whereby the communication link is established via a CiA 309 gateway device.

5.2 CiA 309 operating sequences for segmented download of data

5.2.1 General

In order to avoid blocking the CiA 309 network or to consider the memory resources of the CiA 309 gateway device it may be necessary to split the data to several segments and to transfer these segments by means of several concatenated commands.

As illustrated in Figure 6, the segmented download shall be initiated by means of concatenated segmented download commands. On confirmation of the initiation the additional data segments are transferred. Any command shall be confirmed by the response prior to the transmission of the next data segment in the related concatenated segmented download command.
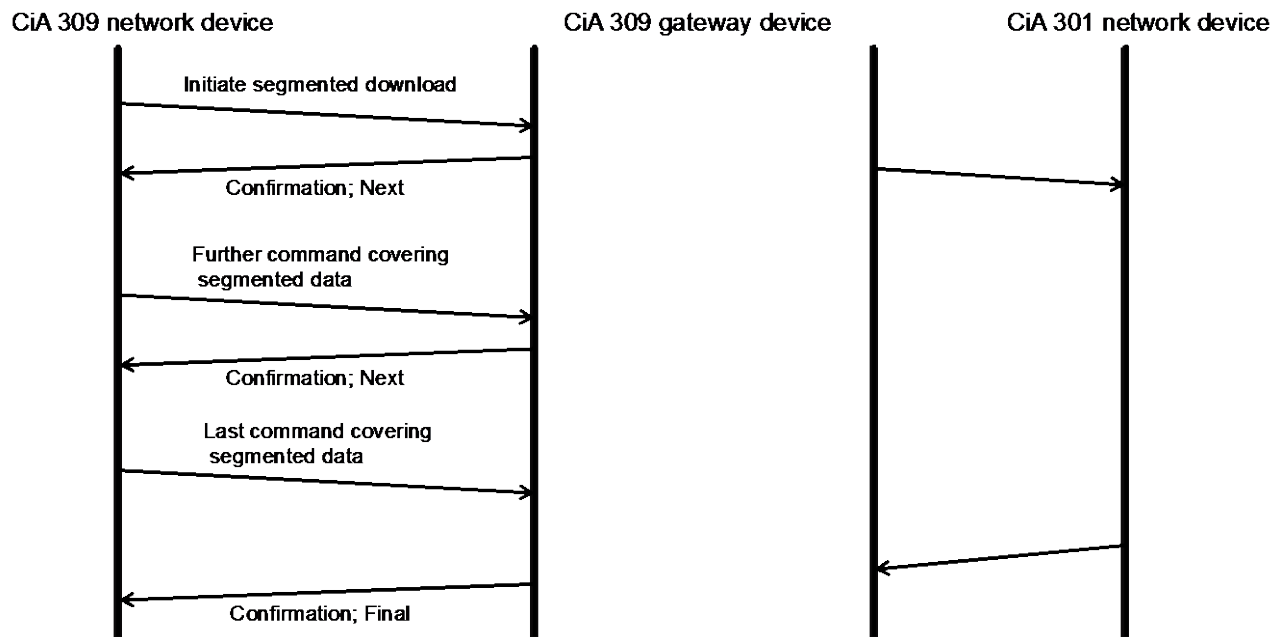
Figure 6 – Concatenated segmented data download protocol

5.2.2 Concatenated segmented download command

This service shall transfer one part of the overall data to be transferred from the CiA 309 network device to the CiA 309 gateway device, as illustrated in Figure 6. Table 51 defines the parameters for this service.

Table 51 – Concatenated segmented download command service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Target OD entry	Mandatory	
Initiation indication	Mandatory	
Last command indication	Mandatory	
Overall size indication availability	Mandatory	
Segment counter	Mandatory	
Data type	Mandatory	
Overall data size	Optional	
Data	Mandatory	
Remote result		**Mandatory**
Success		Selection
Next		Mandatory
Final		Mandatory
Failure		Selection
Reason		Mandatory

5.3 CiA 309 operating sequences for segmented upload of data

5.3.1 General

In order to avoid blocking the CiA 309 network or to consider the memory resources of the CiA 309 gateway device it may be necessary to split the data to several segments and to transfer these segments by means of several concatenated commands.

As illustrated in Figure 7, the segmented upload shall be initiated by means of concatenated segmented upload commands. On confirmation of the initiation the additional data segments are transferred. Any command shall be confirmed by the response prior to the transmission of the next data segment in the related concatenated segmented upload command.
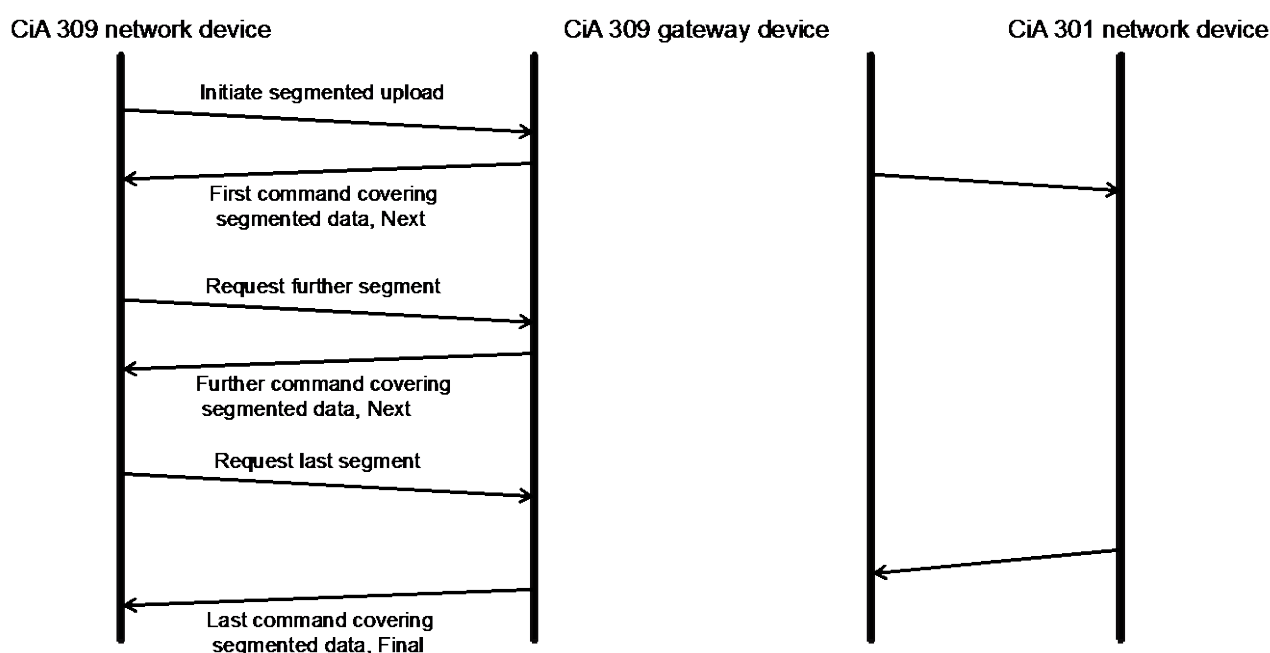

Figure 7 – Concatenated segmented data upload protocol

5.3.2   Concatenated segmented upload commands

This service shall transfer one part of the overall data to be transferred from the CiA 309 gateway device to the CiA 309 network device, as illustrated in Figure 7. Table 52 defines the parameters for this service.

Table 52 – Concatenated segmented upload commands service

Parameter	Request / indication	Response / confirmation
Argument	**Mandatory**	
Network	Optional	
Node-ID	Optional	
Target OD entry	Mandatory in initiation	
Initiation indication	Mandatory	
Demand next indication	Mandatory	
Remote result		**Mandatory**
Success		Selection
First segment indication		Mandatory
Last command indication		Mandatory
Overall size indication availability		Mandatory in initiation
Segment counter		Mandatory
Data type		Mandatory in initiation
Overall data size		Optional in initiation
Data		Mandatory
Failure		Selection
Reason		Mandatory

5.4 Event-triggered progress indication

5.4.1 General

In the context of the transfer of large size of data, the event-triggered progress indication provides the CiA 309 network device an insight into the progress that has been achieved by the CiA 309 gateway device. This way a CiA 309 network device can distinguish between a CiA 309 gateway device that is operating or is erroneously non-operating/sleeping.

5.4.2 CiA 301 progress indication download

This service shall signal the amount of data bytes that have already been transferred between the CiA 309 gateway device and the CiA 301 network device, while a download is in progress from the CiA 309 network device to the CiA 301 network device via a CiA 309 gateway device. Table 53 defines the parameters for this service.

Table 53 – CiA 301 progress indication download service

Parameter	Request
Argument	**Mandatory**
Source/Destination network	Optional
Source/Destination node-ID	Optional
Transferred bytes	Mandatory
Transfer direction	Optional
Transfer sequence number	Optional