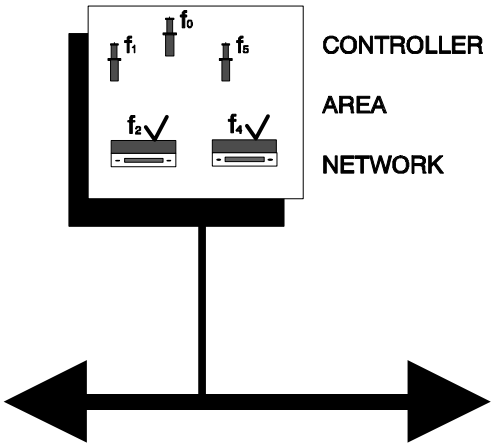
CAN in Automation (CiA)
International Users and Manufacturers Group e.V.



CAN Application Layer for Industrial Applications
CiA/DS205-1
February 1996

LMT Service Specification

1. SCOPE

This document contains the Layer Management Service Specification. This document is part of a set of documents that standardize the CAN Application Layer for Industrial Applications.

2. REFERENCES

/1/: CiA/DS201, CAN in the OSI Reference Model

/2/: CiA/DS205-2, LMT Protocol Specification

/3/: CiA/DS207, Application Layer Naming Conventions

/4/: CiA/DS102, Version 2.0, CAN Physical Layer for Industrial Applications

3. GENERAL DESCRIPTION

3.1 LMT Perspective

LMT is one of the application layer entities in the CAN Reference Model (see /1/). LMT offers the possibility to inquire and change the settings of certain parameters of the local layers on a CAN module with LMT Slave capabilities by a CAN module with LMT Master capabilities via the CAN Network.
The following parameters can be inquired and/or changed by the use of LMT:

- NMT-address of the NMT Service Element
- bit timing parameters of the physical layer
- LMT address

By using LMT a LMT Slave can be configured for a CAN network without using any devices like DIP-switches for setting the parameters. There are several solutions available for LMT Slaves with and without a unique LMT-address or non-volatile storage.

3.2 LMT Objects and Attributes

LMT functionality is modelled using two objects (see figure 1). The LMT Master object exists exactly once in a CAN network supporting LMT. The LMT Master configures layer parameters of connected CAN modules by the use of LMT Slave objects residing on the individual modules.
Communication between LMT Master and LMT Slaves is accomplished by the LMT protocol.

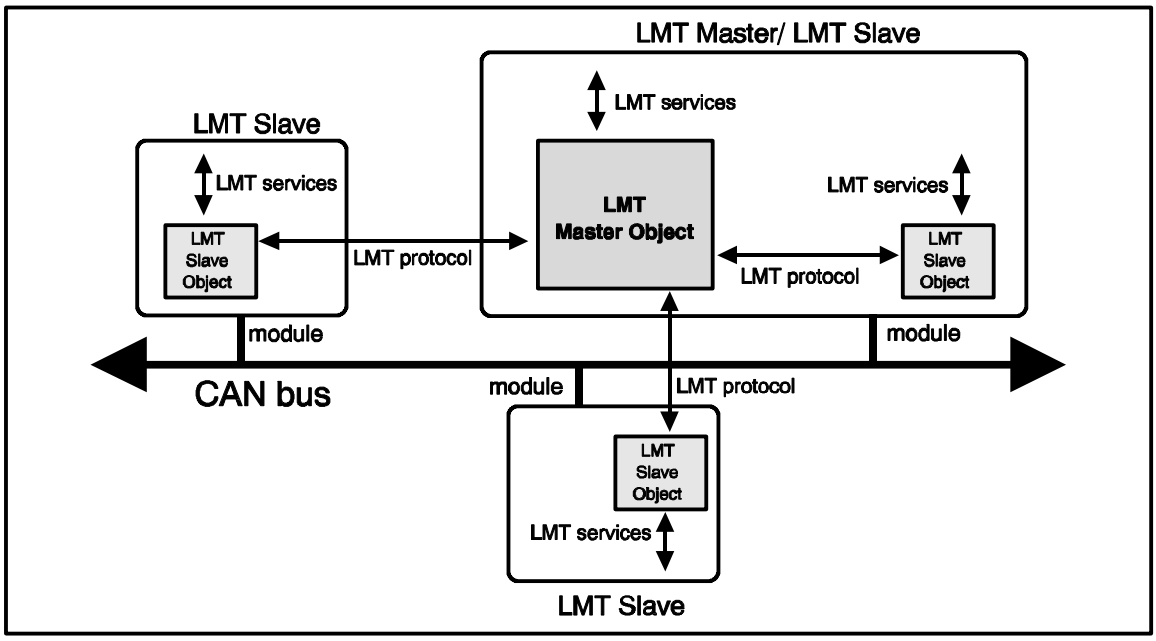


Fig. 1: The LMT Model

3.2.1 LMT Master Object

The module that configures other modules via a CAN network is called the LMT Master. There may be only one LMT Master in a network.
The LMT Master has no attributes.

3.2.2 LMT Slave Object

The module that is configured by the LMT Master via a CAN Network is called the LMT Slave. The number of LMT Slaves in a network is not limited.
The LMT Slave has the following attributes:

- **LMT Address**
  The LMT address uniquely identifies a LMT Slave. The format of the LMT address is specified in the 'Application Layer Naming Conventions' (see /3/). The LMT address of a LMT Slave can be inquired. It is valid only for LMT Slaves of class 2.

- **LMT Class**
  Each LMT class indicates the LMT capabilities that are available on a LMT-Slave.

  Class 0: No LMT Services are implemented.
  Class 1: All LMT Services with exception of Switch Mode Selective and Inquire LMT Address, Identify Remote Slaves, Identify Slaves are implemented.
  Class 2: All mandatory LMT Services are implemented.

- **LMT Mode**
  The LMT mode distinguishes between the LMT configuration phase and the operation phase of the module. In configuration mode all LMT services, in operation mode only the switch mode services are available. Any module not explicitly put into configuration mode is in operation mode.

3.3 LMT Modes and Services

LMT services can be functionally grouped in three areas:

- The switch mode services provide a way to logically connect the LMT Master and LMT Slave(s) for configuration purposes. They change the LMT mode attribute of the LMT Slave (see figure 2).

- The configuration services perform the actual task of configuring the layer parameters of an LMT Slave. The configuration services are only available in configuration mode.

- The inquiry services provide a way for the LMT Master to determine layer parameters. The inquiry services are available only in configuration mode.

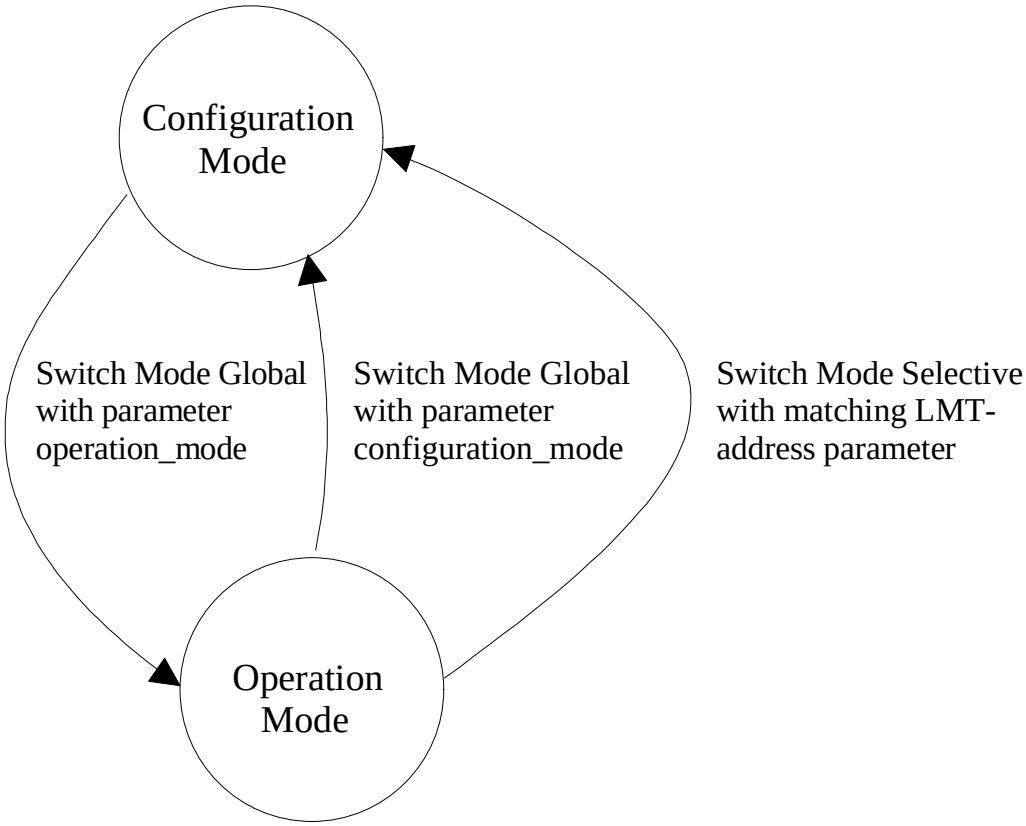


Fig. 2: LMT modes and switching procedure

3.4 LMT Service Descriptions

The LMT services are described in a tabular form that contains the parameters of each service primitive (see /1/).

4. SWITCH MODE SERVICES

The Switch Mode Services control the mode attribute of a LMT Slave. LMT provides two ways to put a LMT Slave into configuration mode, Switch Mode Global and Switch Mode Selective. Switch Mode Selective switches exactly one LMT-Slave into configuration mode. Switch Mode Global switches all LMT Slaves into configuration mode.
Some LMT configuration and inquiry services require that only one LMT Slave is in configuration mode. To execute these services for a class 1 LMT Slave requires that only one LMT Slave is in the network.

Besides the LMT Switch Mode Services there may be other (local and module specific) means to change the mode of an LMT Slave, that are not within the scope of the CiA Standard on the CAN Application Layer for Industrial Applications.

4.1 Switch Mode Global

This service is used to switch all LMT Slaves in the network between operation mode and configuration mode.

Parameter	*Request/Indication*
Argument mode configuration_mode operation_mode	**Mandatory** mandatory selection selection

This service is unconfirmed and mandatory for LMT class 1 and class 2 slaves.

4.2 Switch Mode Selective

This service is used to switch the class 2 LMT Slave, whose LMT address attribute equals LMT_address, into configuration mode.

Parameter	*Request/Indication*
Argument LMT_address	**Mandatory** mandatory

This service is unconfirmed and mandatory for LMT class 2 slaves.

5. CONFIGURATION SERVICES

The configuration services are available only in configuration mode. Some of the services require that exactly one LMT Slave is in configuration mode.

5.1 Configure NMT Address

Through this service the LMT Master configures the NMT-address parameter of a LMT Slave.

Parameter	*Request/Indication*	*Response/Confirmation*
Argument	**Mandatory**	
NMT-addressNMT	mandatory	
module_name	selection	
module_ID	selection	
Remote Result		**Mandatory**
success		selection
failure		selection
reason		optional

This service allows only one LMT Slave in configuration mode. This service is confirmed and mandatory for LMT class 1 and class 2 slaves. The remote result parameter confirms the success or failure of the service. In case of a failure optionally the reason is confirmed.

5.2 Configure Bit Timing Parameters

Through the Configure Bit Timing Parameters service the LMT Master sets the new bit timing on a LMT Slave.

Parameter	*Request/Indication*	*Response/Confirmation*
Argument	**Mandatory**	
table_selector	mandatory	
table_index	mandatory	
Remote Result		
success		**Mandatory**
failure		selection
reason		selection
		optional

By means of the table_selector the bit timing parameter table to be used is specified. In the bit timing parameter table the bit timing parameters for different baud rates are specified. With table_selector value ´0´ the standard CiA bit timing parameter table is referenced (see /4/). The table_index selects the entry (baud rate) in the selected table.

This service allows only one LMT Slave in configuration mode. The service has to be followed by an Activate Bit Timing Parameters service to activate the configured parameters. After execution of the Configure Bit Timing Parameters service the node may not execute any remote CAL services except the services Configure Bit Timing Parameters, Activate Bit Timing Parameters and Switch Mode.

This service is confirmed and mandatory for LMT class 1 and class 2 slaves. The remote result parameter confirms the success or failure of the service. In case of a failure optionally the reason is confirmed.

5.3 Activate Bit Timing Parameters

Through the Activate Bit Timing Parameters service the LMT Master activates the bit timing as defined by the Configure Bit Timing Parameters service.

Parameter	*Request/Indication*
Argument switch_delay	**Mandatory** mandatory

The switch_delay parameter specifies the length of two delay periods of equal length, which are necessary to avoid operating the bus with differing bit timing parameters. Each node performs the actual switch of the bit timing parameters ´switch_delay´ milliseconds after the reception of the command. After performing the switch, a node does not transmit any messages before the second time ´switch_delay´ has passed.

This service is unconfirmed and mandatory for LMT class 1 and class 2 slaves.

Note

Nodes may have different processing times for performing the Activate Bit Timing Parameters command and messages that are transmitted before this command may still be in the receive queue of a node. This means that a node may still transmit CAN messages with the old bit timing during the duration of the processing delay. Therefore switch_delay has to be longer than the longest processing time of any node in the network to avoid that a node already switches while another node still transmits using the old bit timing parameters. After the time specified by switch_delay has passed the first time, every node must perform the switch during

the second duration of switch_delay. Therefore after switch_delay has passed the second time, all nodes are guaranteed to be listening with the new bit timing parameters. The diagram in figure 3 shows the location of the two switch_delay periods.

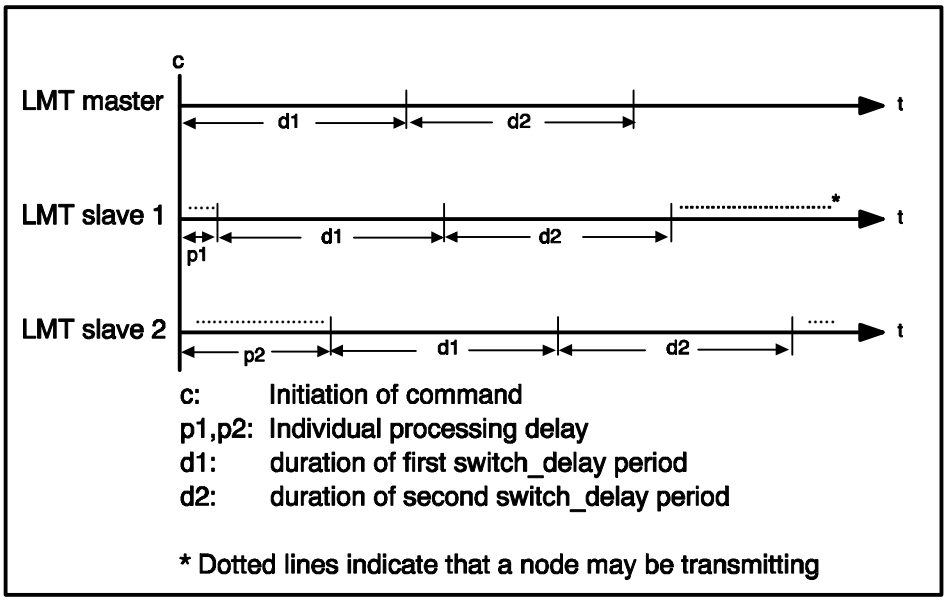


Fig. 3: Definition of the two switch_delay periods

5.4 Store Configured Parameters

The Store Configured Parameters service is used to actuially store the configured parameters into non-volatile storage.

Parameter	*Request/Indication*	*Response/Confirmation*
Argument	**Mandatory**	
Remote Result success failure reason		**Mandatory** selection selection optional

This service is confirmed and mandatory for LMT class 1 and class 2 slaves. The remote result parameter confirms the success or failure of the service. In case of a failure optionally the reason is confirmed.

6. INQUIRY SERVICES

The inquiry services are available only in configuration mode.

6.1 Inquire LMT Address

This service allows to determine the LMT-address parameters of a LMT Slave in configuration mode.

Parameter	*Request/Indication*	*Response/Confirmation*
Argument	**Mandatory**	
Remote Result LMT_address manufacturer name product name serial number failure reason		**Mandatory** selection mandatory mandatory mandatory selection optional

Exactly one LMT slave may be in configuration mode when this service is executed. This service is confirmed and mandatory for LMT class 2 slaves. The remote result parameter confirms the LMT address of the LMT Slave in configuration mode or the failure of the service. In case of a failure optionally the reason is confirmed.

7. Identification Services

7.1 LMT Identify Remote Slaves

Through this service, the LMT Master requests all LMT slaves, whose LMT address meets the LMT_Address_selection to identify themselves through the 'LMT Identify Slave' service. LMT_Address_sel consists of a fixed manufacturer and product name and a span of serial numbers. This service is unconfirmed and mandatory for LMT Nodes with Class 2.

Parameter	*Request/Indication*
Argument LMT_Address_sel	Mandatory mandatory

7.2 LMT Identify Slave

Through this service, an LMT Slave indicates, that it is a Slave with an LMT address within the LMT_Address_sel of an 'LMT Identify Remote Slave' service executed prior to this service. The service is unconfirmed and mandatory for LMT Nodes with Class 2.

Parameter	*Request/Indication*
Argument	**Mandatory**