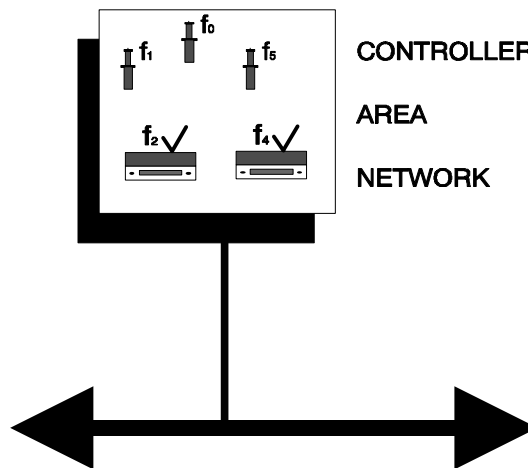# CAN in Automation (CiA)
International Users and Manufacturers Group e.V.

CAN Application Layer for Industrial Applications
CiA/DS204-1
February 1996

DBT Service Specification

DBT Service Specification

1.   SCOPE

This document contains the Distributor 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 Reference Model

/2/: CiA/DS204-2, DBT Protocol Specification

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

/4/: CiA/DS203-1, NMT Service Specification

/5/: CiA/DS202-1, CMS Service Specification

3.   GENERAL DESCRIPTION

3.1   DBT PERSPECTIVE

The essential issue in creating an *open system* where modules from independent suppliers can cooperate via CAN, is how the *identifiers and inhibit-times* are assigned to the COB's that a module uses. Identifiers are used by the CAN Datalink Layer and inhibit-times are defined by the CMS service element of the CAN Application Layer, see /5/. The identifiers and inhibit-times must be distributed in a way that:

- prevents a *conflict* (i.e different functions that use the same identifiers).

- prevents a *mismatch* (i.e different identifiers for the same COB).

- offers the *system integrator* control of the *dynamic behaviour* of the system since the identifier and inhibit-time of a COB determines its priority respectively its maximum access time to the CAN bus.

Three methods can be distinguished to distribute identifiers and inhibit-times to a module (**Note:** it is not required that the same method is used for all modules although this increases the probability of clashes and conflicts):

- If a **standard distribution** is used, the identifiers and inhibit-times are standardized by the module suppliers and system integrators and cannot be changed. A standard distribution requires standardizing all functions and their corresponding identifiers and can only succeed if sufficient identifiers are available and if the application has a limited scope (e.g one system or a specific application type).

- If a **static distribution** is used, the identifiers and inhibit-times are fixed by the module suppliers and may be changed by the system integrator through module specific measures such as setting dip-switches, adapting firmware, etc. A static distribution requires that the system integrator can assign all possible identifiers.

- If a **dynamic distribution** is used, the identifiers and inhibit-times are distributed *via the CAN network* through standard services and a protocol.

The DBT is a service element of the CAN Application Layer (see /1/) that offers dynamic distribution of identifiers and inhibit-times to the COB's that a module uses. The dynamic distribution does not necessarily take place every time the module is 'powered on'. Depending on the facilities of the module, distribution may only be required once e.g when the module is installed in the network.

3.2   DBT Objects and Services

The CMS service element defines for each CMS object the COB's that must be used for the protocols of that object. Each module in the network that acts as a Client or Server of a CMS object must either transmit or receive these COB's and is called a *user* of these COB's. A user is uniquely identified in the network via its *Node-ID*, see /4/.

The DBT uses four objects to model its functionality:

- **the COB Database.** The COB Database contains zero or more COB Definitions. The COB Database may exist on one module only, called the *DBT Master*.

- **a COB Definition.** A COB Definition defines all attributes of a COB. A COB Definition is uniquely identified in the COB Database by its identifier (COB-ID). A COB Definition is created by the DBT Master. For each user a COB Definition contains a User Definition created by that user. A COB definition can optionally contain Predefinitions created by the DBT Master.

- **a User Definition.** A User Definition defines how one module uses that COB. A User Definition is uniquely identified in the COB Database by the *name* of the COB and the Node-ID of that user (**Note:** different users may use different COB names for the same COB). The syntax of COB-names and Node-ID's are defined in /3/.

- **a Predefinition.** A Predefinition defines that all User Definitions with a certain COB-name must use the COB-ID of the COB Definition to which it belongs. A Predefinition is uniquely identified in the COB Database by the name of the COB.

The contents of the COB Database can be manipulated locally by the DBT Master or remotely (possibly via the network) by a *DBT Slave*. A DBT Slave communicates with the DBT Master via the DBT Protocol as depicted in Fig. 1. Note that it is possible that a module is a DBT Master and a DBT Slave at the same time. The DBT Protocol is specified in /2/.
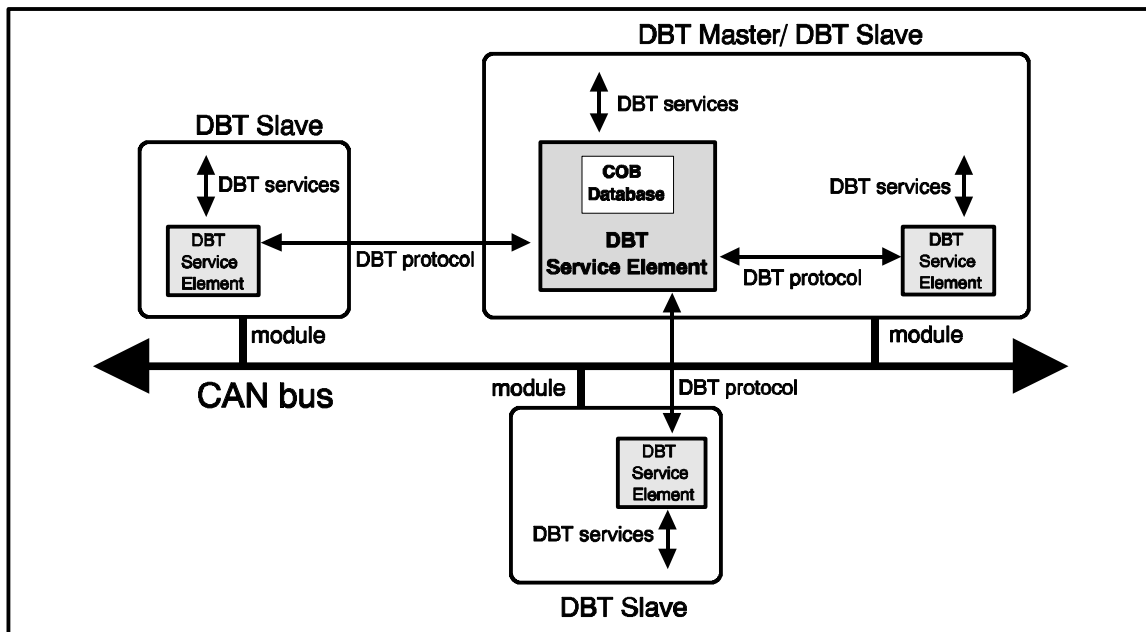

Fig. 1: The DBT Model

The DBT offers the following categories of services:

- **Distribution Control Services:** it is the task of the DBT Master to distribute a COB-ID and inhibit-time for a COB to all its users. The COB-ID and inhibit-time that the DBT Master distributes is determined by the requested values from the DBT Slave and *predefined values* from the DBT Master. The DBT Master can also prevent that a value will be distributed as a COB-ID and enforce a minimum inhibit-time for a certain COB-ID.

- **Consistency Control Services:** through these services, a DBT Slave can detect inconsistencies in the COB Database and inconsistencies between User Definitions created by different users.

3.3   DBT Slave Capabilities

DBT slave capabilities indicate categories of DBT functionality that may or may not be present in the DBT Slave.The following capabilities are defined:

- **Distribution capability**. This capability implements the mandatory distribution control services on a DBT Slave.

- **Consistency capability**. This capability implements the mandatory consistency control services on a DBT Slave.

How to configure DBT slave capabilities on a DBT Slave does not fall within the scope of the CiA Standard on the CAN Application Layer for Industrial Applications.

3.4   DBT Slave Classes

The DBT slave class indicates the capabilities that have been configured on a DBT Slave:

- **Class 0:** no Distribution capability. As a consequence, consistency control, and dynamic distribution of identifiers and inhibit-times is not possible for this module.

- **Class 1:** Distribution capability, no Consistency capability. This is a module for which dynamic distribution of identifiers and inhibit-times is possible, but consistency control is not possible.

- **Class 2:** Distribution capability, Consistency capability. This is a module for which dynamic distribution of identifiers and inhibit-times and consistency control is possible.

3.5   DBT Service Descriptions

The DBT services are described in a tabular form that contains the parameters of each service primitive that is defined for that service. The primitives that are defined for a particular service determine the service type (e.g unconfirmed, confirmed, etc.). How to interpret the tabular form and what service types exist is defined in /1/. In the service descriptions, [a, b] denotes the range of integers from a to b with a and b included. If a > b, the range is empty.

All services assume that no errors occur in the Data Link and Physical Layer. These errors are resolved by the Network Management Service Element, see /1/.

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4. DBT OBJECTS

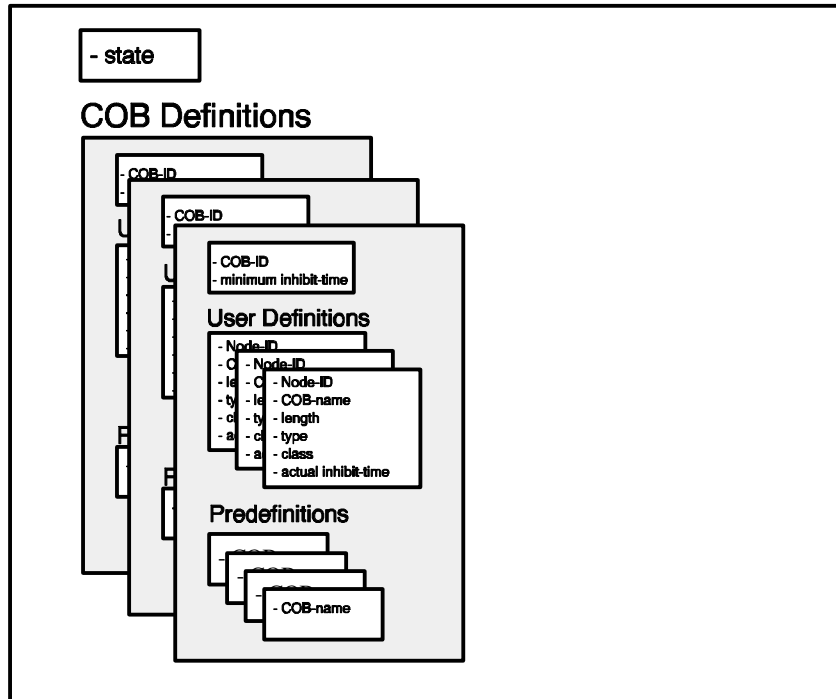All the DBT Objects, their attributes, and their relation are drawn in Fig. 2.

Fig. 2: The COB Database

4.1 COB Database

Attributes:

- **state:** one of the values {ENABLED, DISABLED}. This attribute indicates whether or not the DBT Master is capable of distributing COB-ID's and inhibit-times consistently for the COB's used by the CMS protocol.

- **COB definition set:** The set of all COB Definitions.

4.2 COB Definition

Attributes

- **COB-ID**: a value in the range [1, 1760], indicating the COB-ID of the COB.

- **minimum inhibit-time:** a value in the range [0, 65535] indicating the minimum value in units of 100 μsec for the inhibit-time that must be used by a user of the COB.

- **user definition set:** the set of User Definitons of this COB.

- **predefinition set:** the set of Predefinitons of this COB.

4.3   User Definition

Attributes

- **Node-ID:** see /4/. It identifies the user that created the User Definition.

- **COB-name:** see /3/. The name of the COB as used by the user that created the User Definition.

- **COB-length:** a value in the range [0, 8]. The COB-length indicates the number of data bytes of the COB as used by the user that created the User Definition.

- **COB-type:** one of the values {RECEIVE, TRANSMIT}. The COB-type indicates whether the COB is received (RECEIVE) or transmitted (TRANSMIT) by the user that created the User definition (**Note:** for a Remote-COB, RECEIVE indicates transmitting the request for the COB and receiving the data. TRANSMIT indicates that the request is received and the data transmitted).

- **COB-class:** see /5/. The COB-class relates the number of users that transmit and receive the COB as expected by the user that created the User Definition.

- **actual inhibit-time:** a value in the range [0, 65535]. It indicates the value of the inhibit-time in units of 100 µsec as actually used by the user that created the User Definition.

4.4   Predefinition

Attributes

- **COB-name:** see /3/. All User Definitions for a COB with this COB-name must be created in the user set of the COB Definition to which the Predefinition belongs.

5.   DBT SERVICES

There can be atmost one confirmed DBT service outstanding in the complete network.

5.1   Distribution Control Services

The mandatory distribution control services need to be implemented on the DBT Master. The mandatory distribution control services need to be implemented on a DBT Slave if and only if the Distribution capability has been configured on that DBT Slave.

Create COB Database

Parameter	Request
Argument	**Mandatory**

Through this service, the DBT Master creates a COB Database. No COB Database may exist. After completion of the service the state of the COB Database will be ENABLED and it will contain no COB Definitions. The service is local and mandatory.

Enable Distribution

Parameter	Request
Argument	**Mandatory**

Through this service, the DBT Master sets the state of the COB Database to ENABLED. What conditions can cause this service to be invoked is determined by the DBT Master. The service is local and mandatory.

Disable Distribution

Parameter	Request
Argument	**Mandatory**

Through this service, the DBT Master sets the state of the COB Database to DISABLED. What conditions can cause this service to be invoked is determined by the DBT Master. The service is local and mandatory.

Create COB Definition

Parameter	Request

Argument range
   low COB-ID
   high COB-ID
 min. inhibit-time
	Mandatory mandatory
	   mandatory
	   mandatory
	 mandatory

Through this service, the DBT Master creates all COB Definitions in the COB Database with a COB-ID in the requested range, all with the same minimum inhibit-time. The state of the COB Database must be ENABLED. After completion of the service, the user- and predefinition set of the created COB Definitions will be empty. The service is local and mandatory.

Delete COB Definition

Parmater	Request

Argument range
   low COB-ID
   high COB-ID
	mandatory
	   mandatory
	   mandatory

Through this service, the DBT Master deletes all COB Definitions with a COB-ID in the requested range. The state of the COB Database must be ENABLED. The service is local and mandatory.

Create Predefinition

Through this service, the DBT Master creates a Predefinition with the requested attributes in the predefinition set of the COB Definition identified by COB-ID. No Predefinition and User Definition with the same COB-name may exist in the COB Database. The state of the COB Database must be ENABLED. The service is local and mandatory.

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Parameter	Request
Argument COB-ID COB-name	**Mandatory** mandatory mandatory

Delete Predefinition

Parameter	Request
Argument COB-name	**Mandatory** mandatory

Through this service, the DBT Master deletes the Predefinition identified by COB-name from the COB Database. A Predefinition with the requested COB-name must exist in the predefinition set of a COB Definition in the COB Database. The state of the COB Database must be ENABLED. The service is local and mandatory.

Create User Definition

Parameter	Request/Indication	Response/Confirm
Argument COB-name COB-length COB-class COB-type Node_ID priority inhibit-time	**Mandatory** mandatory mandatory mandatory mandatory mandatory mandatory mandatory	

Remote Result
 success
   COB-ID
   min. inhibit-time
 failure
   reason
		Mandatory
		 selection
		   mandatory
		   mandatory
		 selection
		   optional

Through this service, a DBT Slave creates a new User Definition with the requested attributes in the user set of one of the COB Definitions in the COB Database. If there exists an *offending* COB Definition the service will fail. A COB Definition is offending if and only if the following conditions are met:

- its user set contains a User Definition or its predefinition set contains a Predefinition with the same COB-name

- its user set contains User Definitions with a different value for the COB-length and/or COB-class attributes

If there exists no offending COB Definition but there exists a *matching* COB definition, this definition will be selected. A COB Definition is matching if and only if at least one of the following conditions are met:

- its predefinition set contains a Predefinition with the same COB-name

- its user set contains a User Definition with the same COB-name

If there exists no offending and no matching COB Definition, a *free* COB definition will be selected according to the following rules given in order of precedence:

- a COB definition with an empty user set and an empty predefinition set whose COB-ID corresponds to the requested priority, see the table in annex I of this document.

- a COB definition with an empty user set and an empty predefinition set whose COB-ID exceeds the COB-ID's that correspond to the requested priority, see the table in annex I of this document.

If there exists no offending, no matching, and no free COB Definition, the service will fail.

The service is confirmed and mandatory. The state of the COB Database must be ENABLED. The Remote Result parameter will indicate the success or failure of the selection of a COB Definition. In case of success, the COB-ID of the selected COB Definition and its minimum inhibit-time attribute will be confirmed. The DBT Slave must use the maximum of the requested inhibit-time and the minimum inhibit-time attribute of the selected COB Definition. In case of a failure optionally the reason may be confirmed.

Delete User Definition

Through this service a DBT Slave deletes all User Definitions that were created by the user identified by Node_ID or all existing User Definitions from the COB Database. The state of the COB Database must be ENABLED unless all existing User Definitions are to be deleted.

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Parameter	Request/Indication	Response/Confirm

Argument
  scope
    Node_ID
    all
	Mandatory
	  mandatory
	    selection
	    selection	

Remote Result
  success
  failure
    reason
		Mandatory
		  selection
		  selection
		    optional

The service is confirmed and mandatory. The Remote Result parameter will indicate the success or failure of the request. In case of success, the requested User Definitions were deleted. If all User Definitions have been deleted the state of the COB Database will be ENABLED. In case of a failure, optionally the reason may be confirmed.

5.2   Consistency Control Services

The mandatory consistency control services need to be implemented on the DBT Master. The mandatory consistency control services need to be implemented on a DBT Slave if and only if the Consistency capability has been configured on that DBT Slave.

Verify COB Class

Parameter	Request/Indication	Response/Confirm
Argument	**Mandatory**	

Remote Result
  success
  failure
    COB-ID
    reason
		Mandatory
		  selection
		  selection
		    optional
		    optional

Through this service a DBT Slave requests the DBT Master to verify for each COB Definition in the COB Database, if the number of User Definitions in its user set whose type attribute is RECEIVE respectively TRANSMIT, matches the class attribute of that COB Definition. The state of the COB Database must be ENABLED.

The service is confirmed and mandatory. The Remote Result parameter will confirm the success or failure of the verification. In case of a failure, optionally the COB-ID of a COB Definition for which the verification failed and optionally a reason is confirmed.

Get Checksum

Parameter	Request/Indication	Response/Confirm
Argument	**Mandatory**	
scope	mandatory	
Node_ID	selection	
all	selection	
Remote Result		**Mandatory**
success		selection
checksum		mandatory
failure		selection
reason		optional

Through this service, a DBT slave requests the DBT Master to calculate a checksum. The value of the checksum depends on the requested scope and equals either:

- the remainder of the whole division by 8191 of the sum of the COB-ID's of all COB Definitions in the COB Database that have at least one User Definition

- the remainder of the whole division by 8191 of the sum of the COB-ID's of the COB Definitions whose user set contains a User Definition created by the user identified by Node_ID.

The service is confirmed and mandatory. The Remote Result parameter will confirm the success or failure of the verification. In case of failure, optionally the reason is confirmed.

ANNEX I

COB Identifier Table

The COB-ID table in Fig. 3 describes the usage of the COB identifiers by the protocols of the CAN Application Layer for Industrial Automation.

NMT start/stop services	0
CMS objects priority 0	1-220

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CMS objects priority 7	1541-1760
NMT Node Guarding Protocol	1761-2015
reserved for further use by CiA	2016-2019
LMT Services	2020
LMT Services	2021
NMT Identify Node Protocol	2022
DBT services	2023
DBT services	2024
NMT services	2025
NMT services	2026
reserved for module self-test	2027
reserved for further use by CiA	2028-2031

Fig. 3: The COB-ID Table