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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The aim of the Decentralized Congestion Control (DCC) is to adapt the transmit parameters of the ITS station operating the ITS-G5 technology to the radio channel conditions, in order to maximize the probability of a successful reception at intended receivers.

The DCC aims to provide channel resources among neighbouring ITS-S according to their needs. The Facilities Layer DCC Entity determines priorities between different messages and informs DCC_CROSS about the available resources to control the channel load generated by each application.

In case of a road traffic emergency the ITS-S may still transmit a burst of messages during a short period of time to maintain a safe road traffic environment, even during a high network utilization period, where every ITS-S has very few resources (e.g. CAM period at 1 Hz or 2 Hz). However, this exception occurs rarely and the messages transmitted for this purpose are only those of uttermost importance.

1 Scope

The present document specifies the Facilities Layer DCC Entity of the DCC mechanism for ITS-S using the ITS-G5 technology, taking into account the available channel resources of the ITS-S from the cross-layer DCC entity and the message generation requirements from applications and services. The functional behaviour and the interfaces of the Facilities Layer DCC Entity to the DCC_CROSS component are specified as well. The present document does not address Multi-Channel Operation.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 102 636-4-2: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 2: Media-dependent functionalities for ITS-G5".

[2] ETSI TS 103 175: "Intelligent Transport Systems (ITS); Cross Layer DCC Management Entity for operation in the ITS G5A and ITS G5B medium".

[3] ETSI TS 102 723-1: "Intelligent Transport Systems (ITS); OSI cross-layer topics; Part 1: Architecture and addressing schemes".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 302 665: "Intelligent Transport Systems (ITS); Communications; Architecture".

[i.2] ETSI TS 102 687: "Intelligent Transport Systems (ITS); Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part".

[i.3] ETSI EN 302 663: "Intelligent Transport Systems (ITS); ITS-G5 Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band".

[i.4] ETSI TR 103 562: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Analysis of the Collective Perception Service (CPS); Release 2".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI EN 302 665 [i.1], ETSI TS 103 175 [2] and the following apply:

cross-layer DCC: cooperation mechanisms based on components distributed over several layers of the protocol stack which jointly work together to fulfil the operational requirements of DCC

decentralized congestion control: set of mechanisms for ITS-S to maintain network stability, throughput efficiency and fair resource allocation to ITS-S using ITS-G5 access technology

DCC_ACC: DCC component located at the access layer

DCC_CROSS: DCC cross-layer component located in the management plane

DCC_CROSS_Facilities: function in the DCC_CROSS entity that provides DCC control parameters to the facilities layer and to the applications

DCC_FAC: DCC component located at the facilities layer

DCC_NET: DCC component located in the networking & transport layer

ITS application: component of ITS applications layer

ITS-G5: access technology to be used in frequency bands dedicated for European Intelligent Transport Systems (ITS) as defined in ETSI EN 302 663 [i.3]

3.2 Symbols

For the purposes of the present document, the following symbols apply:

ARD_i	average resource deficit for TC_i
ACR_i	maximum available channel resources for TC_i
ACR_{ij}	maximum available channel resources for application/service j and TC_i
$\overline{CBR_a}$	available percentage of channel resources defined in ETSI TS 103 175 [2]
$\overline{CRE_{ij}}$	estimated channel resource for application/service j and TC_i
CR_a	available percentage of channel resources
CR_i	total estimated channel resources from all applications/services in TC_i
GCR_i	gross channel resource for TC_i
L_{ij}	message length for application/service j and TC_i (in the unit of octets)
$\overline{L_{ij}}$	average message length for application/service j and TC_i (in the unit of octets)
$\overline{L_{ij}^*}$	previously estimated average message length for application/service j and TC_i (in the unit of octets)
NCR_i	net channel resource for TC_i
PNR_i	proportional net channel resource for TC_i
R_{ij}	data rate for application/service j and TC_i
TC_i	traffic class with index i
$T_{off\ ij}$	inter-message interval for application/service j and TC_i (in the unit of seconds)
$\overline{T_{off\ ij}}$	average inter-message interval for application/service j and TC_i (in the unit of seconds)
$T_{off\ \min\ ij}$	proposed minimum inter-message interval for application/service j and TC_i (in the unit of seconds)

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CA	Cooperative Awareness
CAM	Cooperative Awareness Messages
CPM	Collective Perception Message
DCC	Decentralized Congestion Control
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
ITS	Intelligent Transport Systems
ITS-S	ITS Station
MCM	Maneuver Coordination Message
MCS	Modulation and Coding Scheme
MF-SAP	Management Facilities Service Access Point
OFDM	Orthogonal Frequency Division Multiplexing
TC	Traffic Class

4 Decentralized Congestion Control Architecture

4.1 Overview

ETSI EN 302 665 [i.1] provides the ITS reference architecture for an ITS-S and ETSI TS 103 175 [2] provides DCC architecture for ITS-G5 systems as shown in Figure 1. The present document provides details of the DCC_FAC entity residing in the facilities layer for ITS-G5 systems.

The DCC functionality, including interfaces mapped to the ITS-S architecture, is shown in Figure 1. It is distributed between the following entities:

- DCC_FAC located in the facilities layer is optional and specified in the present document;
- DCC_NET located in the networking and transport layer as specified in ETSI TS 102 636-4-2 [1];
- DCC_ACC located in the access layer as specified in ETSI TS 102 687 [i.2];
- DCC_CROSS located in the management plane as specified in ETSI TS 103 175 [2].

The components are connected through the DCC interface 1 to interface 4 as shown in Figure 1. These interfaces are compliant with ETSI TS 102 723-1 [3].

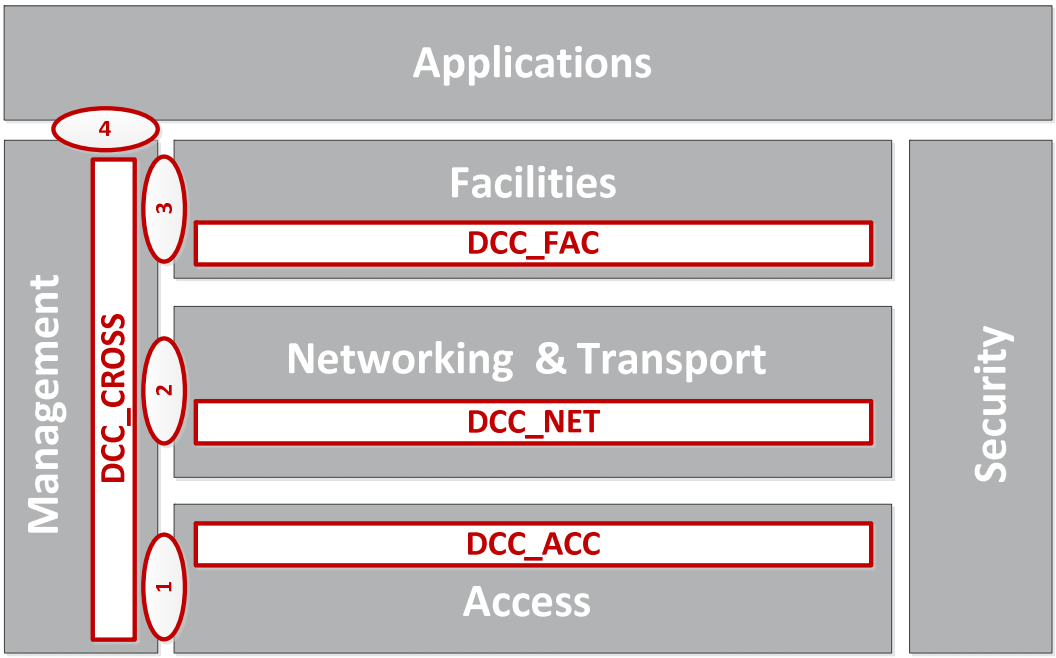

Figure 1: DCC Architecture

5 DCC Facilities Entity (DCC_FAC)

The DCC_FAC is a facilities layer entity that supports the control of the channel load generated by each application/service via DCC_CROSS by considering the available channel resources of the ITS-S from the DCC_CROSS and monitoring the message generation by applications/services. When the DCC_FAC is supported, the functional requirements of DCC_FAC are as follows:

- DCC_FAC shall provide an indication of the upper limit for the channel resource utilization, e.g. minimum of inter-message interval, maximum message size, available data rate according to MCS, etc., for each message generation per application/service.

NOTE 1: Only if the required channel resources are estimated to be higher than the available channel resources, i.e. CBR_a defined in ETSI TS 103 175 [2], will DCC_FAC have an influence on generated messages.

- DCC_FAC shall not cause an ITS-S to underutilize the available channel resources.
- The channel load control for an ITS-S supported by DCC_FAC should slightly overutilize the available channel resources.
- The channel resource utilization indicated by DCC_FAC shall take the message priority based on the traffic class as defined in ETSI TS 102 636-4-2 [1] into account.

If the DCC_FAC entity is supported, the DCC_CROSS shall implement the DCC_CROSS_Facilities function as described in ETSI TS 103 175 [2] (see Figure 2).

NOTE 2: Generated messages cannot be dropped by DCC_FAC by design.

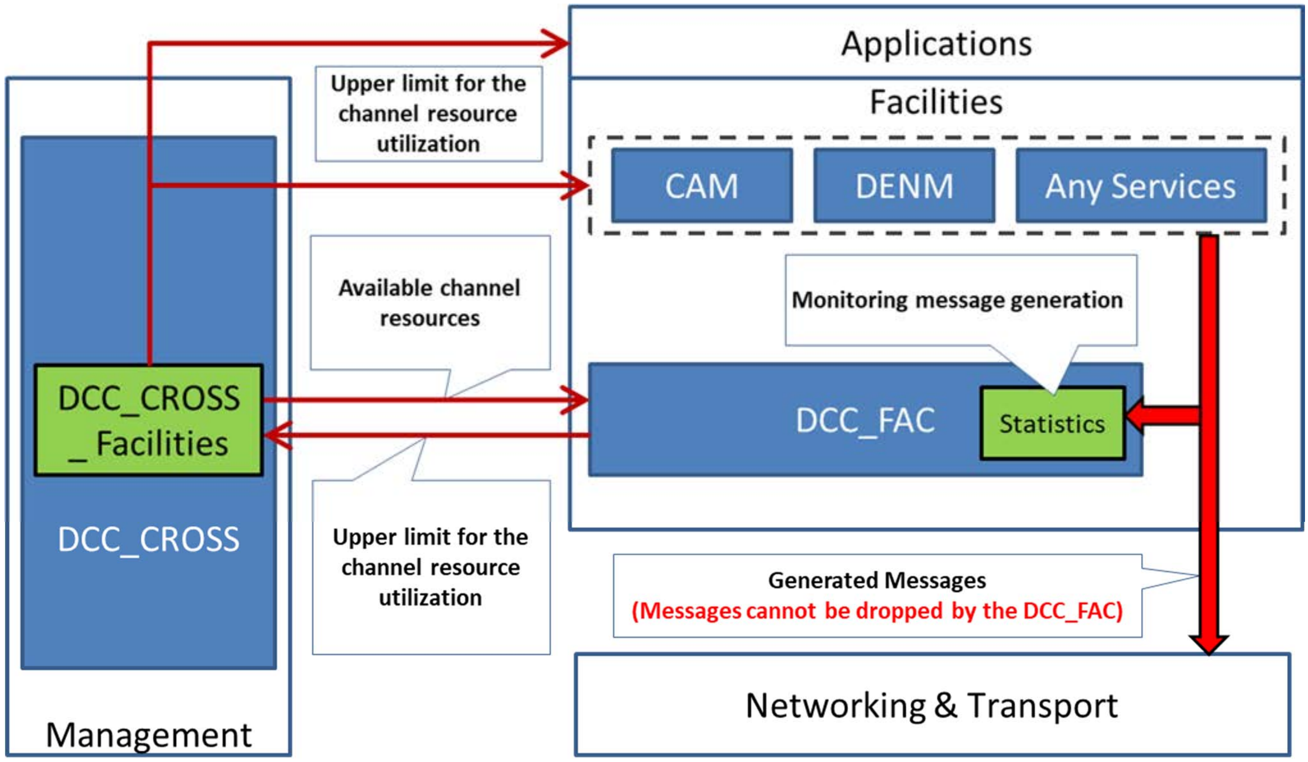

Figure 2: DCC_FAC entity in the Facilities Layer

The detailed mechanism of DCC_FAC entity is implementation specific. Possible mechanisms are described in Annex A and Annex B.

6 Interfaces for DCC_FAC

6.1 Overview

The DCC_FAC entity shall support the interfaces illustrated in Figure 2. The primitive transferred over these interfaces shall be compliant with ETSI TS 102 723-1 [3].

6.2 Interface with DCC_CROSS (MF-SAP)

6.2.1 MF-GET.request

6.2.1.1 Function

This primitive allows retrieving of a parameter in the management entity, as described in clause 5, and Annex A and Annex B.

6.2.1.2 Semantics

The parameters of the management service primitive MF-GET.request shall be as follows:

```
MF-GET.request    (
                  FAC-ID,
                  CommandRef,
                  Sequence of M-Param
                  )
```

Table 1: Parameters of the service primitive MF-GET.request

Name	ASN.1 type	Valid range	Description
MN-ID	INTEGER	Integer number	Unique identifier of the Management Interface
CommandRef	INTEGER	Integer number	Unique cyclic reference number of request
	INTEGER	0 to 255	Number of subsequent M-Param elements
M-Param.No	CHOICE	0 to 255	See Table 5
M-Param.Value		Depends on M-Param.No	

6.2.2 MF-GET.confirm

6.2.2.1 Function

This primitive reports the result of a previous MF-GET.request.

6.2.2.2 Semantics

The parameters of the management service primitive MF-GET.confirm shall be as follows:

MF-GET.confirm (
FAC-ID,
CommandRef,
Sequence of Errors OPTIONAL
)

Table 2: Parameters of the service primitive MF-GET.confirm

Name	ASN.1 type	Valid range	Description
MN-ID	INTEGER	Integer number	Unique identifier of the Management Interface
CommandRef	INTEGER	0 to 255	Unique cyclic reference number of request
	INTEGER	0 to 255	Number of subsequent Errors elements
Errors. M-paramNo	INTEGER	See Table 5	See Table 5
Errors.ErrStatus	ENUMERATED	Specified in ETSI TS 102 723-1 [3].	Indicates error status of request.

6.2.3 MF-SET.request

6.2.3.1 Function

This primitive allows setting of a parameter in the management entity, as described in clause 5, and Annex A and Annex B.

6.2.3.2 Semantics

The parameters of the management service primitive MF-SET.request shall be as follows:

MI-SET.request (
MAC-ID,
CommandRef,
Sequence of M-Param
)