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Intelligent Transport Systems (ITS); Access layer specification in the 5 GHz frequency band; Multi-Channel Operation (MCO) for Cooperative ITS (C-ITS); Release 2

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Foreword

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

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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

ETSI EN 302 663 [i.1] specifies the access layer for ITS-G5 for Release 1 and ETSI EN 303 613 [i.2] specifies the access layer for LTE-V2X for Release 1.

The present document provides Release 2 C-ITS access layer updates and extensions specific to Multi-Channel Operation (MCO).

Where possible the specifications are access layer agnostic.

1 Scope

The present document specifies Release 2 C-ITS access layer MCO extensions based on Release 1 backward compatibility.

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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Not applicable.

2.2 Informative references

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NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

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 302 663: "Intelligent Transport Systems (ITS); ITS-G5 Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band".
- [i.2] ETSI EN 303 613: "Intelligent Transport Systems (ITS); LTE-V2X Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band".
- [i.3] ETSI TS 103 697: "Intelligent Transport Systems (ITS); Architecture; Multi-Channel Operation (MCO) for Cooperative ITS (C-ITS); Release 2".
- [i.4] IEEE 802.11bd™: "IEEE Draft Standard for Information technology--Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 5: Enhancements for Next Generation V2X".

NOTE: Available at <https://standards.ieee.org/ieee/802.11bd/7451/>.

- [i.5] IEEE 802.11™-2020: "IEEE Standard for Information technology-Telecommunications and information exchange between systems Local and metropolitan area networks-Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

access layer instance: fully parametrized (service channel, technology, TX power, ...) transceiver entity in the access layer

access layer instance ID: Unique Identifier for an access layer instance

access layer instance group: set of access layer instances using the same service channel and access layer technology

access layer instance Group ID: Unique Identifier for an access layer instance group

access layer technology: consistent set of protocols covering the physical layer and link layer functionalities of the ISO/OSI model defined in an independent specification or set of specifications

AliID generation: process of extracting the AliID from a received frame

AliID processing: operation of receiving an AliID from higher layers and configuring the transceiver correspondingly

instance: fully parametrized entity

instantiation: process of parametrizing an entity

channel load ratio: channel load value per ALI group evaluated at the receiving C-ITS-S

cooperative-Intelligent Transport System: ITS system that realize applications bringing awareness of road user behaviour by sharing static and dynamic information of its behaviour and recognized behaviour of others based on a wireless communication system

ITS-G5 with 11bd capabilities: ITS-G5 based access layer supporting the functionality provided by the IEEE 802.11bd [i.4] and IEEE 802.11p [i.5] access layer specification

entity: singular, identifiable, and separate object realizing a function or set of functions

function: self-contained module that accomplishes a specific task

Intelligent Transport Systems (ITS): systems which aim to provide innovative services relating to different modes of transport and traffic management and enable users to be better informed and make safer, more coordinated, and "smarter" use of transport networks

plane: in a networking context, logical grouping of functions over different layers

subchannel: technology dependent group of contiguous Physical Resource Blocks (PRBs) representing the minimum granularity for the allocation of a packet in the frequency domain

3.2 Symbols

Void.

3.3 Abbreviations

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

ALI	Access Layer Instance
AliGroupID	Access layer instance Group IDentifier

NOTE: The abbreviation AliGroupID is compliant with an ASN.1 representation of an identifier.

AliID Access layer instance IDentifier

NOTE: The abbreviation AliID is compliant with an ASN.1 representation of an identifier.

ALN	Access Layer Notification
BPSK	Binary Phase Shift Keying
CC	Convolutional Coder
C-ITS	Cooperative Intelligent Transport System
C-ITS-S	Cooperative Intelligent Transport System Station
CLR	Channel Load Ratio
DCM	Dual Carrier Modulation
ID	Identifier
ITS	Intelligent Transport Systems
LDPC	Low Density Parity Check codes
LTE-V2X	Long Term Evolution based Vehicle-to-Everything
MCO	Multi-Channel Operation
MCS	Modulation and Coding Scheme
NR-V2X	New Radio (5 th generation) Vehicle to Everything
PPDU	Physical Protocol Data Unit
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RID	Reliability Indicator
RX	Receiver
SCH	Service Channel
TC	Turbo-Code
TRX	Transceiver
TX	Transmitter
V2X	Vehicle to Everything

NOTE: All transport equipment used or implemented in or by, vehicle, truck, PTW, bike, pedestrian, train, ship, and other transport equipment.

4 Background

An access layer implementation of a C-ITS-S capable of handling more than a single channel simultaneously requires specific multi-channel functionalities. These functionalities are needed to allow the higher layers to take efficiently advantage of the available resources to transmit and receive packets over the air. An access layer supporting multiple channels will have to implement more than one transceiver including all required building blocks like channel coding, multiplexing, potential input queues, channel load estimation entity and power amplifier. Each of these transceivers may be switched or configured to different operational channels and may be parametrized to deploy different combinations of the available access layer resources.

For proper multichannel operation of a C-ITS-S the different possible configurations of the transceivers need to be accessible to the higher layer entities for the control of the channel load and the related transmission properties.

5 Access layer MCO operation

5.1 Introduction

The access layer of an MCO capable C-ITS-S implements and operates more than a single transceiver active simultaneously. This set of transceivers may be capable of implementing different access layer technologies (e.g. ITS-G5, LTE-V2X, etc.). Each of which may be parametrized to be adapted to the requirements of the applications and the related message dissemination. A single transceiver may be instantiated using a set of different access layer parameters. These parameters are:

- Access layer technology (ITS-G5, LTE-V2X, NR-V2X, etc.)
- Used physical channel (SCH0, ..., SCH6)

- Modulation and coding scheme (MCS) or reliability indicator:
 - Channel coder (CC, TC, LDPC, etc.)
 - Channel Coding rate
 - Modulation scheme
- TX power

A parametrized transceiver called "Access Layer Instance" (ALI) represents a specific access layer instantiation of a transceiver. The ALI implements the access layer technology (ITS-G5, LTE-V2X, NR-V2X), the used channels, the channel coding, the modulation and the transmit power. The ALI may be changed from message-to-message dissemination.

A specific set of parameters is identifiable by a unique Access layer instance Identifier, AliID.

The combination of the access layer technology and the used physical channel is called "Access Layer Instance Group" (ALI group). Each ALI group is identified by a unique access layer instance group identifier, AliGroupID.

The data flow and management flow of the MCO capable access layer are depicted in Figure 1, Figure 2 and Figure 3 and are described in the following clauses.

5.2 Access layer data flow

The access layer data plane as depicted in Figure 1 provides all functionalities required to transmit a PPDU over the physical channel defined as part of the AliID. In the presented figure it is assumed that the set of transceivers may be flexibly parametrized to provide different access layer technology functionalities, thus may be instantiated as technology agnostic transceivers based on the actual AliID.

Another representation of an MCO technology agnostic C-ITS-S is depicted in Figure 2, where the different access layer technologies are limited to a technology specific set of transceivers. Here, an access layer instance may only run on a transceiver that may implement the access layer technology associated to that ALI.

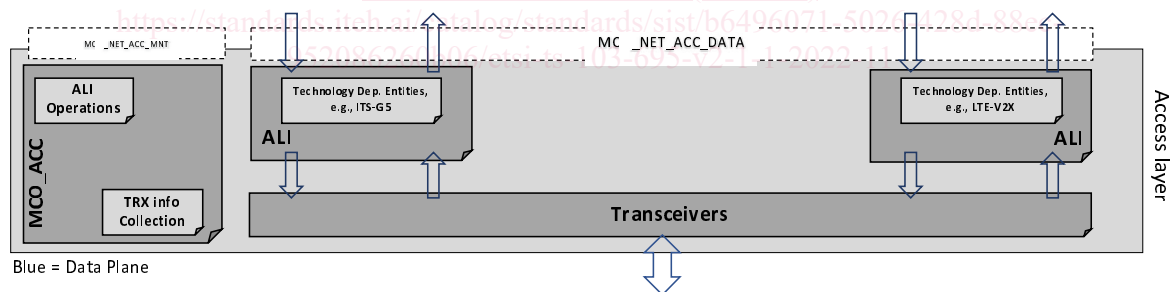


Figure 1: MCO Access layer, Data flow with full flexible transceiver design

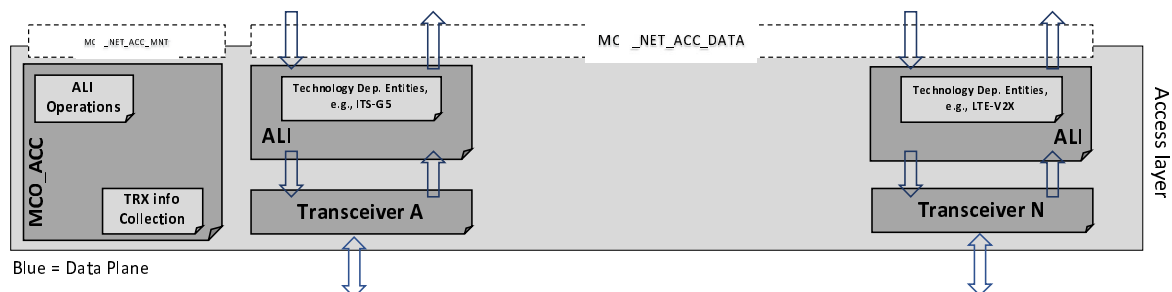


Figure 2: MCO Access layer, Data flow with separate set of transceiver design

5.3 Access layer management flow

As identified in the ETSI TS 103 697 [i.3] at the management plane there are two Access layer entities as part of MCO_ACC depicted in Figure 3.

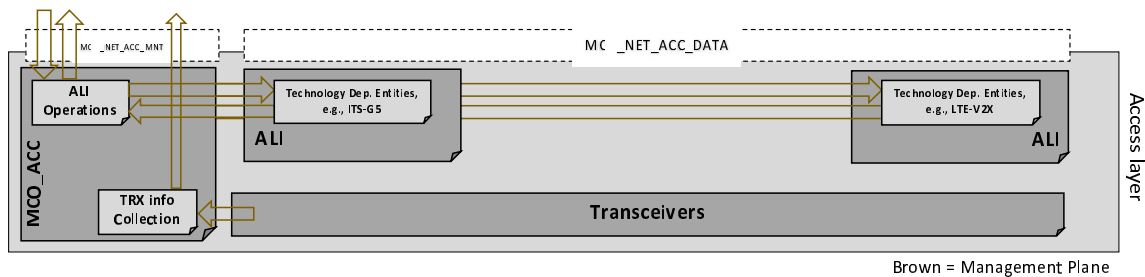


Figure 3: MCO Access layer Management Plane, combined and separate TRXs

ALI Operations: In case higher layers provide an AliID to the ALI Operations, this entity shall configure the corresponding transceivers. The used channel and the access layer technology (ALI group) are semi dynamic characteristics whereas the other parameters (MCS, TX power) may change on a message-by-message basis. Semi dynamic means that these parameters need a longer configuration time. The actual required configuration time for the semi dynamic characteristics is implementation dependent. The ALI operation entity shall provide the actual state of all transceivers to the higher layer.

TRX Info Collection: Transceiver information collection entity; this entity collects all status and measurement information from the available transceivers and provide this information to higher layer. This information are the Access Layer Notifications per transceiver (ALN) and the Channel Load Ratio per transceiver (CLR).

As part of the TRX Info Collection, an **Access Layer Notifications (ALN) function** collects the communication conditions flags and provide them to higher layers. The ALN provides information about the following events at the access layer related to the delivery of the data frames:

- Queue overflow
- Drop of packets
- Time out of packets

The generated notifications shall be specific for a data frame. The ALN shall be provided to the Networking & Transport layer.

As part of the TRX Info Collection, a **received AliID generation function** shall generate an AliID for each received data frame based on the access layer information contained in the physical layer control of the frame. The generated AliID shall be provided to the higher layers. The format of the received AliID shall be as defined in clause 6.2.

As part of the TRX Info Collection, the **Channel Load Ratio (CLR)** measurement function estimates the actual channel load ratio for a specific ALI group for a given technology. This function is not MCO specific and thus will not be further specified in the present document. This technology specific ratio is as such provided to higher layers.

The AliID for the frames to be transmitted and the AliID of the received frames may be transferred between the layers as part of the data packets. This would simplify the required synchronization between the configuration information contained in the AliID and the related data frame.

6 MCO Access layer extension

6.1 Introduction

An MCO enabled access layer needs to support certain functionalities to permit the distribution of the C-ITS traffic onto the available physical channels with a specific set of parameters as defined by the AliID. These extensions shall be fully backward compatible with the Release 1 devices.

6.2 Access layer instance IDentifier (AliID)

The Access layer instance IDentifier (AliID) shall represent a unique identifier for the access layer instance. Based on the AliID it shall be possible to set all relevant parameters of a transceiver. A specific transceiver might not be capable of supporting all possible parameter combinations.

The AliID may consist of eight positions (1 letter and 8 decimal digit numerical positions):

- AliID contains a letter to identify the access layer technology, first position of the AliID:
 - A: ITS-G5;
 - B: ITS-G5 with 11bd capabilities;
 - C: LTE-V2X;
 - D: NR-V2X.
- The first and second figure specify the used physical channel, 2 and 3 position:
 - 00: SCH0;
 - 01: SCH1;
 - ...
 - 06: SCH6;
 - 07:

NOTE 1: Two figures are required to cover future extension like 60 GHz, 2 570 MHz to 2 620 MHz, channel bounding.

- Third and fourth figure specify Reliability Indicator (RID):
 - In the case of ITS-G5, the RID figure indicates directly the MCS, following Annex A, Table A.1;
 - In the case of ITS-G5 with 11bd capabilities, the RID figure indicates directly the MCS, following Annex A, Table A.2;
 - In the case of LTE-V2X, see clause A.3;
 - In the case of NR-V2X, see clause A.4.
- The fifth figure specifies the number of access layer repetitions: 0 to 9.
- The sixth and seventh figure specify the TX power:
 - 00: 0 dBm
 - 01: 3 dBm
 - 02: 6 dBm
 - ...
 - 07: 21 dBm
 - 08: 24 dBm
 - ...
 - 99: not known

NOTE 2: In the AliID corresponding to a received message, the power level is set to 99 (not known).