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Intelligent transport systems — Mobility integration — 'Controlled zone' management for urban vehicle access restrictions (UVARs) using C-ITS

Systèmes de transport intelligents — ITS urbains — Gestion de "zones contrôlées" pour les UVAR à l'aide de C-ITS

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Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is part of a set of standards from ISO/TC 204 related to ITS Mobility Integration/Urban ITS (U-ITS). It provides an internationalized, version of CEN/TS 17380 for management of vehicles in a "Controlled Zone" (CZ). It is primarily designed for urban vehicle access restrictions (although it is also appropriate for similar restriction control in any road system context). Its technical provisions are interoperable with CEN/TS 17380. This document aims to complement CEN/TS 16157-11.

A CZ is a geographically contained physical area for which access restriction conditions are applicable for all or some categories of vehicle or user, at all or specified times.

Management of traffic in a CZ is important for the following reasons, amongst others.

— As cities and urban complexes expand, and the significant trend of movement from rural areas to cities continues around the world, pollution and congestion in these urban areas is becoming an increasingly significant problem. Traffic, i.e. vehicle movements within the urban complex, is a source of pollution.

NOTE Other causes of pollution include air conditioning, central heating systems, coal and wood burning heating, factories, etc.

— Jurisdictions can wish to control certain issues, such as movement of vehicles in cities producing traffic congestion and overcrowding on public transport at peak periods, as this can enable better management of traffic flow.

A CZ, also referred to as an "Urban Vehicle Access Restriction" (UVAR) zone, is a zone of enactment of one or more traffic restrictions to adhere to a permanent or temporary regulation applicable in a defined geographical area. These restrictions are frequently referred to as "Urban Vehicle Access Regulations".

It is recognized that different jurisdictions will design and introduce their own CZ paradigms of different method and construct. However, regardless of the goal to be achieved or the political objective, the basic technical requirements for managing road traffic in a CZ are similar, and the basic methodologies are the same.

The methodology specified in this document is often referred to as "geofencing", i.e. the creation of a virtual geographic boundary.

Management of CZs can be achieved using data frames from the data dictionary (CZDD) specified in this document, and data frames contained in the in-vehicle information (IVI) data dictionary specified in ISO/TS 19321. Data frames specified in this document and in ISO/TS 19321 constitute Application Data Units.

While the CZDD is dedicated to CZs, the IVI data dictionary is of a general nature. There is no strict one-to-one mapping between the CZDD data frames and the data frames from the IVI data dictionary related to CZ.

This document identifies two possible methods for transmitting CZ data frames:

1) a method based on the general CZ message being part of the general TMS message set (see the concept of ITS messages and ITS message sets specified in ISO 17419, which does not require a specific communications technology);

2) the IVI message method, which is specified in ETSI TS 103 301.

Intelligent transport systems — Mobility integration — 'Controlled zone' management for urban vehicle access restrictions (UVARs) using C-ITS

1 Scope

This document provides information and specifications on the management of road traffic in controlled zones (CZ) through the application of geofencing. Specifically, this document specifies a "Controlled Zone Data Dictionary" (CZDD) for management of controlled zones, and provides an extendible toolkit that regulators can use, for example, to inform potential CZ users (e.g. vehicles) about:

— the CZ area, i.e. the geographical boundaries of the CZ;

— CZ access conditions including exemptions;

— time windows indicating when these CZ access conditions are applicable.

This allows potential CZ users to select an appropriate routing, either by pre-trip planning or ad hoc re-routing.

This document also provides illustrations and guidelines on how to use this toolkit.

The toolkit is designed in accordance with the general ITS station and communications architecture specified in ISO 21217, and with optionally applicable C-ITS protocols and procedures, e.g. ISO 22418 on "Service Announcement", ISO 18750 on the "Local Dynamic Map", and ISO 17419 on globally unique identifiers. Cybersecurity provision can be provided through conformance to ISO 21177.

Enforcement is out of scope of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 17419, *Intelligent transport systems — Cooperative systems — Globally unique identification*

ISO 18750, *Intelligent transport systems — Co-operative ITS — Local dynamic map*

ISO/TS 19321, *Intelligent transport systems — Cooperative ITS — Dictionary of in-vehicle information (IVI) data structures*

ISO 21177, *Intelligent transport systems — ITS station security services for secure session establishment and authentication between trusted devices*

ETSI TS 103 301, *Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services*

ETSI TS 103 097 V2.1.1, *(2021-10), Intelligent Transport Systems (ITS); Security; Security header and certificate formats; Release 2*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
controlled zone
CZ
area for which access conditions are applicable

3.2
CZ area
controlled zone area
geographical location of a *controlled zone (CZ)* (3.1) in terms of precisely defined boundaries

Note 1 to entry: In the context of this document, a CZ area is not necessarily a two-dimensional area, but may be a location identified with any kind of location referencing method (linear, two-dimensional, three-dimensional).

3.3
CZ user
controlled zone user
physical entity, typically a vehicle, that intends operating in a *CZ* (3.1) or is already operated in a CZ

3.4
geofencing
creation of a virtual geographic boundary by applying information and communication technologies such as those specified for intelligent transport systems (ITS)

3.5
in-vehicle system
IVS
ITS-station unit or a navigation device or mobile phone application used in a vehicle which is capable of handling the control zone system transactions

4 Symbols and abbreviations

C-ITS	cooperative ITS
CZM	controlled zone manager
ITS	intelligent transport systems
ITS-SU	ITS station unit
IVI	in-vehicle information
U-ITS	ITS mobility integration / urban ITS
UVAR	urban vehicle access restrictions

5 Management of controlled zones

5.1 General

Central management of traffic flows in a “Controlled Zone” (CZ) is complex, and to date has proven difficult. Technically, it may involve downloading data to an “In-Vehicle System” (IVS), for example, an ITS station unit (ITS-SU; as specified in ISO 21217) or a navigation device. Alternatively, it may be undertaken by control of traffic signals (for example in a ferry: boarding and customs-controlled zone). It may also be a combination

of these. Real world implementation widely uses traffic control devices such as road traffic signs and road markings to identify controlled zones.

Controlling access to urban zones, i.e. applying respective access restrictions, is also referred to as “Urban Vehicle Access Restriction” (UVAR).

5.2 CZ manager

In order to identify a CZ and to achieve control of it, an authority, i.e. an entity or body or person, has to manage the CZ. Within this document, that role is called the “Controlled Zone Manager”. In administrative terms, there are many ways this can be instantiated. This is a matter of local policy, and not determined in this document.

Every CZ created by a CZ manager shall be globally uniquely identified by a CZ identifier. This document specifies the CZ identifier as a universal object identifier (OID). The IVI data dictionary specified in ISO/TS 19321 uses a Service Provider ID for this purpose; this Service Provider ID is specified in ISO 14816.

NOTE 1 A service provider identified by a Service Provider ID can also have an OID.

NOTE 2 Organizations acting as a CZ manager identified by an OID are responsible for creating subsequent branches of the organization themselves (for example, branches which are used for CZ purposes). This enables the creation of globally unique CZ identifiers without the need for creating a respective registration authority.

The CZ manager is in charge of disseminating information on the existence of its CZs and the related CZ access conditions, such that potential road users are informed in due time about restrictions to access CZ areas.

5.3 Controlled zone

A CZ is defined as a physical location which has restricted access defined by CZ access conditions (see 5.4) and optional CZ exemptions (see 5.5), including information on timely validity. The location of a CZ, i.e. the CZ area, may be defined quite differently, for example:

— as a linear location, e.g. a street identified by the street name;

— as a contiguous two-dimensional area, optionally with “holes”;

— as a contiguous three-dimensional space, optionally with “holes”;

— as a set of non-overlapping contiguous locations / areas / spaces with or without “holes”;

— as one or several identified streets or segments thereof;

— as a complete city;

— as any other reasonable definition.

However, once the definition of a CZ area changes, the previously valid CZ identifier shall become invalid, and a new CZ identifier shall be assigned.

The boundary of a CZ shall be designed such that it is outside of the CZ area.

If the boundary is given by a closed polygon, the inner area of the polygon, i.e. the area of the CZ, shall be defined by the vertices of the polygon in ascending order such that the inner area is to the right of the edges of the polygon.

NOTE 1 A closed polygon is a plane figure that is described by a finite number *N* of straight-line segments connected to form a closed polygonal chain. The segments of a polygonal circuit are called its edges. The points where two edges meet are the polygon's vertices. The vertice given by the start point of the first segment is identical with the vertice given by the end point of the last (*N*-th) segment. A closed polygon defines two areas, i.e. an inner area and an outer area.

NOTE 2 The examples used in this document are provided as examples of how CZs can be applied and do not represent accurate representations of current regulations in place at the time of the publication of this document.

EXAMPLE The centre of the city of Ulm in Germany is surrounded by streets and segments of streets, see Figure 1. The boundary of the CZ "centre of the city of Ulm" is given by (1) Bahnhofsplatz, (2) segment of Olgastrasse between Bahnhofsplatz and Salzstadelgasse, (3) segment of Salzstadelgasse between Olgastrasse and car park "Salzstadel", (4) segment of Olgastrasse between Salzstadelgasse and Frauenstrasse, (5) segment of Frauenstrasse between Olgastrasse and Neue Strasse, (6) segment of Neue Strasse between Frauenstrasse and Friedrich-EbertStrasse, (7) segment of Friedrich-Ebert-Strasse between Neue Strasse and Bahnhofsplatz. CZ users, regardless of the given CZ access conditions, are allowed to use these streets that define the CZ boundary. This enables access to the car parks located at the boundary of this CZ, e.g. from "Olgastraße" following "Salzstadelgasse" up to "Museum der Brotkultur", below which the car park "Salzstadel" is located.

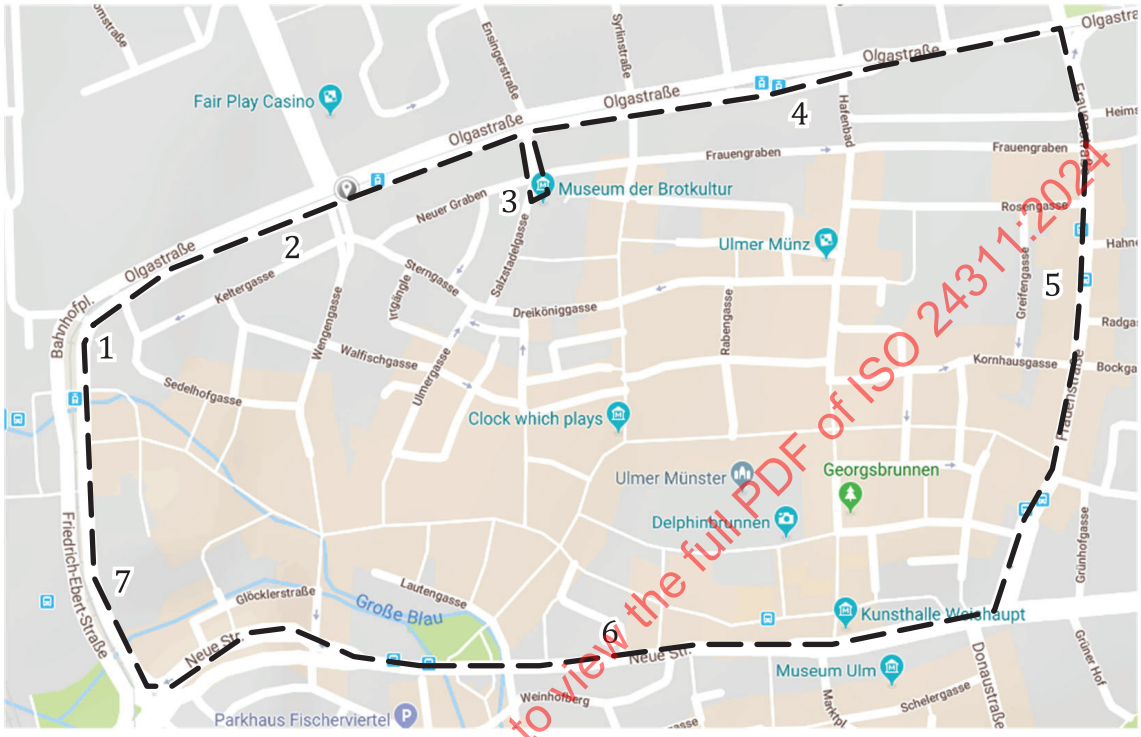


Figure 1 — Example of CZ "centre of the city of Ulm"

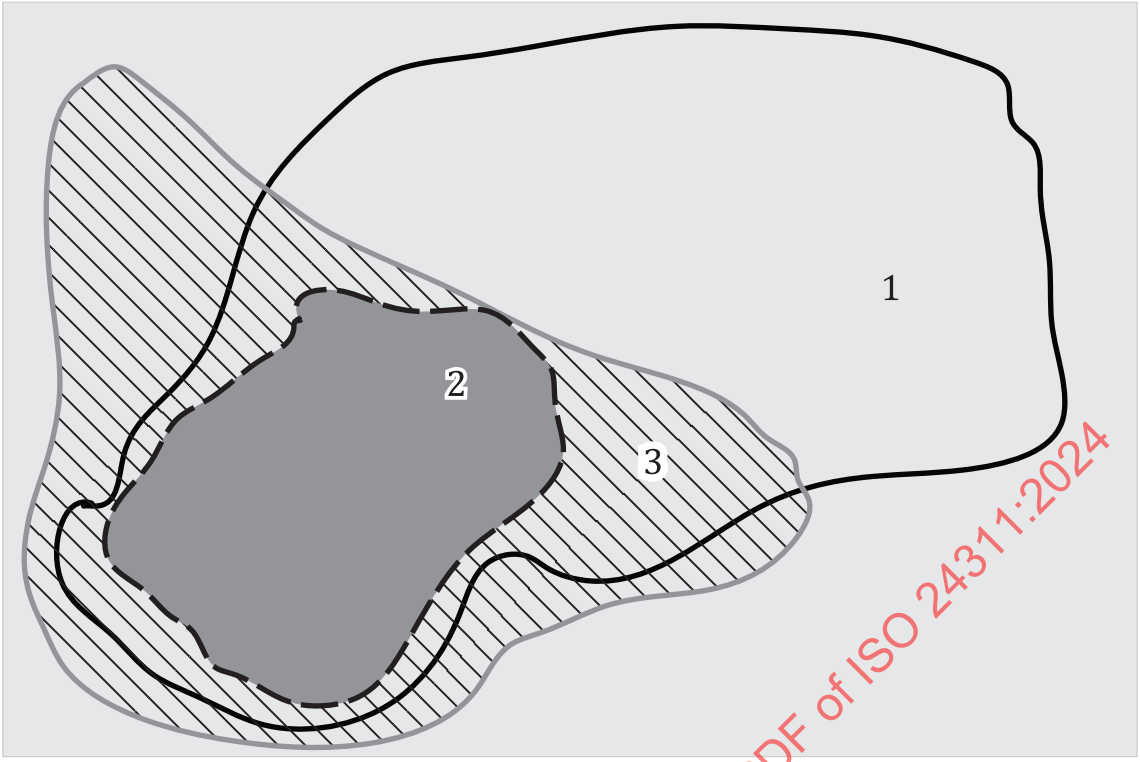
CZs may be:

— located adjacent to each other;

— overlapping with other CZs for other control purposes; thus, multiple CZs can exist in the same physical geographical location.

Exemptions can be applicable for explicitly identified CZ users or CZ user groups, i.e. for preferred CZ users (see 5.5).

Figure 2 provides an example of three different and overlapping CZs in a city.



Key

1 diesel engine control zone

2 zero emissions zone

3 3,5 metre height / 7,5 tonne weight limit zone

Figure 2 — Co-located control zones

Figure 2 shows a geographical area with three CZs.

— The first, and largest, in this example, is a "diesel engine control zone", where there is a ban on the use of diesels prior to Euro Class 5, and time-of-day limitations on the use of any diesel.

— The second CZ is a "vehicle size-controlled zone" that covers an area both inside and outside of the "diesel engine control zone" (but not all of the "diesel engine control zone") and prohibits both tall and heavy or wide vehicle traffic because of narrow roads and low bridges.

— The third CZ is a "zero tailpipe emission zone" in the historic city centre and its main shopping street. It is located entirely within the two other CZs and controls on the single parameter of zero tailpipe emissions.

In this example, the "diesel engine control zone" covers multiple factors in respect of diesel vehicles. The "vehicle size-controlled zone" covers height, weight, and width restriction in a common zone that is partly within and partly outside the "diesel engine control zone" (overlapping CZs). In case of overlapping CZs, within an overlap area the access restrictions of all overlapping CZs shall apply.

The CZ user thus has to evaluate up to three sets of CZ access conditions (see 5.3) for up to three CZs. The result will be the granted access conditions.

This document does not impose any design requirements on CZ managers. Thus, CZ managers have the free choice on how to define CZs and the related CZ access conditions, e.g. whether they define a new CZ per CZ access condition, or whether they define several CZ access conditions per CZ, if applicable. With reference to the example in Figure 2, instead of defining three overlapping CZs, the CZ manager can also specify four CZs:

1) diesel engine CZ access condition (black-only);

2) height and weight CZ access condition (blue-only);

3) diesel engine and height and weight CZ access conditions (only black and blue);

4) diesel engine and height and weight and zero emissions CZ access conditions (black, blue and red).

NOTE 3 It is assumed that calculating the presence in a CZ is more time-consuming than evaluating several CZ access conditions.

5.4 CZ access conditions

Identification of CZ access conditions is, at its simplest core, a binary option of “allowed” or “prohibited”. However, a more complex approach is favourable, indicating one or several reasons why access to a CZ is restricted. This approach enables conditional access to a CZ, dependent on the CZ access conditions and the properties of a CZ user. CZ access conditions include the following.

— “allowed”: this indicates that there are currently no access conditions applicable for the given CZ.

— “prohibited”: this indicates that currently the access to the CZ is prohibited in general without mentioning a specific reason.

— “prohibited for CZ users (vehicles) with given properties”: this shall be used to indicate one or several conditions under which operation in a CZ is prohibited. The CZ user may only operate inside the CZ if all presented conditions result in a final “access is allowed,” or if appropriate exemptions are given.

— “unknown”: this is not an operational CZ access condition to be presented by the CZ manager to CZ users. It complements the operational access conditions and can be useful in software for different purposes.

EXAMPLE 1 The CZ access condition “prohibited for CZ users (vehicles) with given properties” can contain a restriction related to emissions of a vehicle and a restriction for vehicles with a total weight exceeding a defined limit. Operation in the CZ is thus only allowed if neither the emissions of the CZ user are above the given limit, nor the total weight of the CZ user exceeds the given limit.

EXAMPLE 2 Powertrain management is a special case of air quality management. In the case of hybrid vehicles, the CZ manager or the CZ regulation can set up a CZ access condition that hybrid vehicles can enter and operate within the CZ, but only in a tail-pipe emission free mode (i.e. electric).

EXAMPLE 3 A CZ can be generally closed due to an event.

NOTE 1 It is possible that further access conditions will be defined in a revision of this document.

If CZ access conditions indicate access restrictions for a specific CZ user or CZ user group, access to the CZ may be granted on the basis of explicit CZ exemptions (see 5.5). Every CZ access condition presented by a CZ manager shall thus also contain information on whether CZ exemptions are applicable for a specific CZ access condition.

EXAMPLE 4 A CZ defined for a public festivity can be closed for all kinds of CZ users with the exemption of public transport, suppliers' registered vehicles, ambulances, fire brigade and police vehicles.

CZ access conditions shall be made available to potential CZ users (e.g. vehicles or their operators) by CZ managers, thereby providing the CZ users with a respective routing decision (see 5.6). This involves communication (e.g. either for pre-trip planning using the Internet, or for real-time routing using wireless communications between central stations or roadside furniture and mobile stations such as ITS-SUs or navigation devices) or observation of message signs by vehicle operators.

A change of CZ access conditions shall not invalidate the respective CZ identifier. However, the time of an update of access conditions shall be reported (see 7.2), such that a receiver of this information can distinguish between a previous reception of information on this CZ and a subsequent update of this information.

A certain complexity can lie in the evaluation of CZ access conditions presented by CZ managers to the potential CZ users and the decision process that determines the finally applicable granted access conditions (“allowed” / “prohibited”) for a specific geographic location, which can also include real-time measurements of parameters of a vehicle, e.g. parameters related to the emissions of a vehicle's engine. This process may

require evaluation of several sets of CZ access conditions received from one or several CZ managers for different CZs.

NOTE 2 How such an evaluation and decision process is to be implemented is out of scope of this document.

5.5 CZ exemptions

The term “exemption” is used in this document for two slightly different circumstances, both resulting in the fact that a CZ user may operate in a CZ although basically applicable access restrictions are defined by means of the CZ access conditions. These two circumstances are described as follows.

a) The properties of a CZ user do not violate the CZ access conditions, i.e. no access restrictions apply. This is an “implicit exemption”.

b) The properties of a CZ user indicate a conflict with the CZ access conditions, but an exemption is granted by the CZ manager for a given CZ access condition. This is an “explicit exemption”. Such CZ users are referred to as “preferred CZ users”.

Explicit exemptions may be applicable for any CZ user, or may be granted to individual CZ users or CZ user groups. Examples of possible explicit exemptions are:

— “allowed to leave the CZ”;

— “allowance is subject to a fee”;

— “allowed to be in the CZ for a maximum time starting from the time when entering the CZ”;

Possible explicit exemptions applicable for specific CZ user groups are:

— “allowed for vehicles of special type or with special characteristics”, e.g.

  — police,

  — ambulance,

  — fire brigade,

  — military,

  — vehicles with even licence plate number.

Possible explicit exemptions applicable for specific CZ users are:

— “allowed for users (vehicles) with a registered exemption”, e.g.

  — resident of a CZ,

  — disabled driver.

Explicit exemptions may be stored in an IVS in a secure way, or certified by means of a written document.

Preferred CZ users shall be allowed on any route within the CZ regardless of any CZ access condition other than those limiting the physical capabilities of a route, e.g. weight, height, width or exceptional conditions (that are not specified in this document).

An online database containing registered exemptions allows for different types of enforcement. A CZ user should be prepared to prove that its operation in the CZ is allowed.

Some of these explicit exemptions, in order to be enforceable by an enforcement system authorized by the CZ manager, can require, for example:

— proof of initial conditions of the CZ user, e.g. its start location;

— contracts, e.g. for payment of fees;

— CZ user (vehicle) registration;

— proof of start time of trip and time of leaving the CZ.

Enforcement options are the subject of requirements of regulations. These are usually enacted locally on nationally determined criteria. Such enforcement options can be based on standards. However, enforcement options are out of scope of this document and may be provided in other standards deliverables.

5.6 Resultant behaviour

The action to be taken by a CZ user upon becoming aware of a specific CZ and its related CZ access conditions and exemptions is to either:

— continue with its originally intended routing, or

— re-plan and change its routing in order not to violate regulatory access restrictions.

Basic routing paradigms are identified in 5.7. However, how that re-routing is achieved is beyond the scope of this document.

5.7 Routing paradigms

There are three principal paradigms of vehicle routing to follow predetermined or dynamically advised regulatory information on CZs:

a) MANUAL: manual routing by the CZ user, e.g. the driver of a vehicle, using devices that are not connected to the vehicle, such as smart phones;

b) AUTOMATIC: routing based on final decisions performed by an “In-Vehicle System” (IVS), i.e. an electronic device installed in the vehicle;

c) CZM: routing performed by the operator of a vehicle as requested by the CZ manager, i.e. accepting the routing requirement presented by the CZ manager (CZM).

NOTE 1 The term “vehicle routing” basically includes all types of vehicles that can be operated on roads.

For all three paradigms, the basic information on routing is provided by the CZ manager.

Paradigm a) (MANUAL) allows a human to come to the final routing decision, which easily enables violation of access restrictions.

Paradigm b) (AUTOMATIC) uses the IVS to come to a final routing decision. Respective routing software:

— shall correctly implement CZ access conditions such that no violation of access restrictions occurs;

— may follow a routing proposal optionally presented by the CZ manager.

In Paradigm c) (CZM), which is a variant of paradigms a) and b), the operator of the vehicle accepts an optional specific routing proposal provided by the CZ manager.

NOTE 2 “Operator of a vehicle” can be a human or an electronic device in an automated or autonomous vehicle.

For all three routing paradigms, the routing decision may depend on measurements. Measurements can be applicable e.g. to CZs for air quality management.

5.8 Controlled zone messages and data dictionary

5.8.1 Messages

This document identifies suitable message concepts applicable for CZ management in Clause 8.

5.8.2 Data dictionary

This document specifies a "Controlled Zone Data Dictionary" (CZDD) as a toolkit of standardized data sequences, also referred to as data frames, that can be selected, complemented, and used by a jurisdiction to enable that jurisdiction to develop and implement its control objectives (rather than to provide a single use-case dependent solution). Complementary and associated standards deliverables may extend this general toolkit to provide specific data sequences for particular aspects of CZ management.

The ASN.1 specification of the CZDD is provided in Annex A. Additional explanations and specifications are provided in Clause 7.

6 Use cases

6.1 General

Clause 6 illustrates in a non-comprehensive way several use cases of road traffic management for CZs. For some use cases, appropriate data and messages are specified in this document.

6.2 Pre-trip planning

Many ways of pre-trip planning exist, and thus different approaches for communicating CZ access conditions from CZ managers to CZ users can apply such as:

a) human investigations, for example, using street maps printed on paper and Internet access to a server providing CZ access conditions;

b) routing software, such as Internet map services for routing, that uses CZ access conditions provided by a server;

c) routing devices, whether portable or installed in vehicles, using digital maps that have overlays containing the knowledge on CZs and will get CZ access conditions from a server.

It is assumed that the result of pre-trip planning will be the choice of a permitted route. All three routing paradigms introduced in 5.7 apply for pre-trip planning.

6.3 Approaching a CZ boundary

Regardless of whether a CZ user performed pre-trip planning or not, the CZ user may receive CZ access conditions when approaching a CZ boundary; the given distance of a CZ user from a CZ boundary at time of receiving CZ access conditions is irrelevant. This information provisioning can be by:

— (variable) message signs installed at the roadside or on gantries;

— applying a CZ Message as specified in Clause 8, such as an IVI message (such as that specified in ISO/TS 19321 and ETSI TS 103 301 to display a CZ traffic sign;

— localized communications from a roadside ITS-SU to the IVS of the CZ user, i.e. typically a vehicle ITS-SU or a navigation device; information provisioning may be initiated by "Service Announcement" as specified in ISO 22418. In case the Fast Networking and Transport Protocol (FNTP) specified in ISO 29281-1 is used for localized communications of information related to CZs, the port number for this purpose shall be as specified in Annex B;

— networked communications (cloud-based) between a central ITS-SU, e.g. the server of a CZ manager, and the IVS of the CZ user which may be triggered either:

  1) by a service provider based on knowledge of its customers actual location, or

  2) by the CZ user based on prior knowledge of the location of the CZ, e.g. previously stored in a "Local Dynamic Map" (LDM) as specified in EN ISO 18750; see Annex C.

Reception of CZ access conditions may result in a re-routing procedure.

6.4 Starting in a CZ

The case where a journey starts within a CZ is a special use case. Whether that means that the vehicle is requested to shut down and not be used, or requested to leave the zone by the most direct route, or another option, is a local policy decision of the jurisdiction managing the controlled zone.

In this case, the CZ user does not necessarily initially know to be in a CZ, as the CZ user can have previously reached the start location at a time when no access restrictions applied at this location.

EXAMPLE Parking close to a railway station for park-and-ride; upon return from the train trip, the parking location is within a CZ with applicable access restrictions.

Thus, starting in a CZ involves four use-cases. The CZ user, prior to start of operation, identifies whether its start location is within a CZ with applicable access restrictions or not, and whether an applicable exemption applies.

In case of applicable access restrictions, the CZ user:

a) can optionally leave the CZ on the basis of an exemption although basic access restrictions apply;

b) can optionally be in operation for a limited time on the basis of an exemption although basic access restrictions apply, see 6.5;

c) can optionally be in operation on the basis of an EFC payment exemption although basic access restrictions apply, see 6.6;

d) can optionally be generally in operation on the basis of an individual exemption although basic access restrictions apply;

Alternatively, if no access restrictions apply, the CZ user can operate without considering any one of the four use-cases listed above.

6.5 Operation in a CZ for a limited time

This use-case deals with a specific exemption. It may be used, for example:

a) to manage the use-case b) presented in 6.4, i.e. allowing to leave a CZ within a given maximum time;

b) to allow a CZ user to enter a CZ although access restrictions basically apply for this specific CZ user, but applying the requirement that operation within the CZ shall not exceed a given maximum time.

The maximum allowed time of operation in a specific CZ may also be linked to a minimum time span within which, after leaving the CZ, re-entrance is prohibited under the condition that the access restrictions still apply.

NOTE A similar use-case is well known for EFC, where the fee of entering a city depends on the time duration the vehicle will stay inside the city after entering the city.

6.6 Operation in a CZ is subject to a fee

This use-case deals with the specific exemption that access is allowed upon payment of a given fee. Details of this use-case are out of scope of this document. Respective specifications are expected to be developed in the context of standardization of electronic fee collection.

6.7 Access to CZ controlled with a barrier

If access to a CZ is controlled by a barrier, mechanisms are needed to either open the barrier for a CZ user that may access the CZ, or reroute the rejected CZ user to an alternative route. The mechanisms may be manual or automatic. Automatic mechanisms can use, for example:

a) identification of the identity of the CZ user, e.g. the vehicle licence plate number, by means of video technologies and cross-checking with a database containing exemptions and properties of the CZ user;

b) identification of properties of the CZ user by means of wireless communications, e.g. applying service announcement specified in ISO 22418 with details specified in Annex B.

7 Elements of the CZ data dictionary

7.1 General

Clause 7 explains selected data sequences of which the ASN.1 specification shall be as specified in Annex A.

7.2 ControlledZone

The concept of the CZ is introduced in 5.3. A CZ is presented with the ASN.1 type `ControlledZone` consisting of three components:

1) `czId`: the globally unique identifier of a CZ of ASN.1 type `OBJECT IDENTIFIER` introduced in 5.2;

2) `czArea`: the area of the CZ within which the access conditions apply, introduced in 5.3;

3) `czAccessConditions`: the set of applicable access conditions introduced in 5.4.

The CZ area may be specified in various ways as introduced in 5.3. The location definitions shall be given by the ASN.1 type `LDMarea` specified in EN ISO 18750, allowing for future extensions.

NOTE At time of writing this document, the only type of `LDMarea` specified in EN ISO 18750 is the "polygon definition".

7.3 CzAccessConditions

The CZ access conditions are identified by the ASN.1 type `CzAccessConditions` consisting of two components:

a) `lastUpdate`: date of last update of a CZ access condition provided with the ASN.1 type `Time48IAT`;

b) `accessConditions`: list of zero or more access conditions of ASN.1 type `CzAccessCondition`.

CZ access conditions are presented with the ASN.1 type `CzAccessCondition` consisting of three components:

1) `czAccessConditionDetail`: details of the access condition (ASN.1 information object class `CLASS CZAC`);

2) `czAccessConditionValidity`: a sequence of validity information of the access condition defined in the first component (ASN.1 information object class `CLASS TIMEINFO`);

3) `czApplicableCzExemptions`: information on whether and which CZ exemptions are applicable for the access condition defined in the first component. (ASN.1 information object class `CLASS CZEXEMPT`); see also Table 2.

The timely validity of a CS access condition presented in the ASN.1 type `CzAccessConditionValidity` may be presented in various ways, including;:

— a timely start event, e.g. "date and time", and a timely end event; both with various ways to present timely events;

— a full day given by a date;

— a full week of a year;

— a full month of a year.

Note See also the ASN.1 type `TimeInformation` specified in EN ISO 18750.

`CzAccessConditionValidity` is a sequence of the ASN.1 type `TimeInformation` specified in EN ISO 18750 allowing for future extensions.

NOTE At time of writing this document, only two types of `TimeInformation` are specified in EN ISO 18750, i.e. a single time value, and a pair of time values indicating start time and stop time.

CZ access conditions for which globally unique reference numbers are specified so far are presented in Table 1; see 5.4 for more examples of CZ access conditions.

Table 1 — CZ access conditions

Reference number (`CzAccessConditionRef`)	**Explanation** (`czAccessConditionFormat`) / **ASN.1 type**
`czacUnknown`: 0	This value points to an unknown CZ access condition. / `CzACunknown`
`czacAllowed`: 1	No access restrictions apply. / `CzACallowed`
`czacProhibited`: 2	Access is prohibited generally without a given reason. / `CzACprohibited`
`czacRequestedUserProperties`: 3	Access is allowed for CZ users, e.g. vehicles, with given properties. / `CzACrequestedUserProperties`

Further access conditions may be defined as specified in A.3.

7.4 CzAccessConditionsExemptions

The CZ exemptions are identified by the ASN.1 type `CzAccessConditionsExemptions` which is a sequence of a single CZ exemption of ASN.1 type `CzExemption`.

A single CZ exemption of ASN.1 type `CzExemption` consists of two components:

1) `czExemptionRef`: globally unique identifier of the CZ exemption defined in the second component;

2) `czExemptionFormat`: details of the CZ exemption identified by the globally unique identifier contained in the first component.

CZ exemptions for which globally unique reference numbers are specified so far are presented in Table 2; see also 5.5.

Table 2 — Exemptions from CZ access conditions

Reference number (`CzExemptRef`)	**Explanation** (`czExemptionFormat`)/ **ASN.1 type**
`czexemptUnknownOrNone`: 0	This indicates that no CZ exemptions are granted, or that exemptions are unknown; used example in the component `czApplicableCzExemptions` of `CzAccessCondition`, see 7.3 / `CzExemptUnknownOrNone`
`czexemptAll`: 1	This indicates that all CZ exemptions are applicable for a given access condition; used in the component `czApplicableCzExemptions` of `CzAccessCondition`, see 7.3 / `CzExemptAll`
`czexemptLeaveZoneOnly`: 5	CZ users may only leave the CZ. This requires a proof that a journey started inside the CZ. / `CzExemptLeaveZoneOnly`
`czexemptFee`: 6	Operation of a CZ user (e.g. a vehicle), in a CZ is subject to a fee. If this CZ access condition is presented together with other CZ access conditions, then the fee shall be applicable only in case these other CZ access conditions result in a prohibition. / `CzExemptFee`
`czexemptMaxTime`: 7	Operation of a CZ user (e.g. a vehicle) in a CZ is allowed for a limited time span. If this CZ access condition is presented together with other CZ access conditions, then the maximum time span shall be applicable only in case these other CZ access conditions result in a prohibition. This CZ access conditions requires a proof of "start of journey". / `CzExemptMaxTime`

8 Messages and related security

8.1 General

CZ messages shall contain information on one or several CZs using the data structure defined in 8.2 or in 8.3. The intended final recipients are the potential CZ users.

The term "CZ message" refers to an application message, i.e. it does not contain elements of the ITS networking and transport layer and the ITS access layer.

Applicable security depends on the encapsulation of a CZ message in a message exchanged between devices and on the type of device involved in message transmission.

— Broadcast of IVI messages carrying CZ information shall be as specified in ETSI TS 103 301 and shall be secured by signing the message as it is specified in ETSI TS 103 097.

— Broadcast of CZ messages not using IVI may use any appropriate method of transmission including the method of security.

— Sessions, see Annex B, between ITS-SUs shall be secured as specified in ISO 21177.

Note For smartphones or navigation devices as IVSs, where the driver is supposed to follow the instructions from the CZ application, security will most likely rely on current intervention techniques and cellular network security, and it is unlikely that GDPR would allow any disclosure of records of phone-application messages.

8.2 Applying the concept of In-Vehicle Information

The application of the concept of IVI for conveying information on CZs shall be as specified in ISO/TS 19321. A description of the respective approach in ISO/TS 19321 is in this subclause and in Table 3.

The IVI CZ message contains the data type `IviStructure` specified in ISO/TS 19321 to convey CZ information of one or more CZs as explained in Table 3:

Table 3 — IviStructure components for CZ

IviStructure component	CZ usage
`IviStructure.mandatory. serviceProviderId`	The identification of the CZ Manager
`IviStructure.mandatory. iviIdentificationNumber`	The CZ identifier
`IviStructure.mandatory.timeStamp`	The timestamp of the generation or last change of CZ information
`IviStructure.Optional.glc.parts. Zone. area`	The boundary of a CZ
`IviStructure.Optional.giv. roadSignCodes. code.iso14823`	The ISO 14823-1 pictogram codes pertinent to CZ, e.g. Code 12 – 415 "Notice that all vehicles are forbidden to pass through the designated section of the road."
`IviStructure.Optional.giv. roadSignCodes. code. iso14823.attributed.dtm`	The recurrent times at which the CZ is operational
`IviStructure.Optional.giv. extraText`	Readable text applicable to the CZ
`IviStructure.Optional.giv. vehicleCharacteristics.tractor. equalTo`	CZ access conditions: single characteristics of the CZ users for which the CZ signage is applicable, i.e. for which the CZ is prohibited
`IviStructure.Optional.giv. vehicleCharacteristics.tractor. ranges`	CZ access conditions: the ranges of characteristics of the CZ users for which the CZ signage is applicable, i.e. for which the CZ is prohibited
`IviStructure.Optional.giv. vehicleCharacteristics.tractor. notEqualTo`	CZ Exemptions: the characteristics of the CZ users for which the CZ signage is not applicable, i.e. for which the CZ is allowed

An example of an IVI - CZ Message containing the `IviStructure` is the Infrastructure to Vehicle Information Message of ASN.1 type `IVIM` specified in ETSI TS 103 301.

8.3 Applying the concept of ITS message sets

One or several data frames from one or several data dictionaries can be combined in an ITS message. ITS messages can be part of an ITS message set identified by a globally unique ITS message set identifier specified in ISO 17419. This approach enables a globally unique identification of messages. Receivers, that do not know all messages of a message set, nevertheless can read and understand at least those messages of which the details in terms of ASN.1 code are known.

Th CZ message specified in this document and using the concept of ITS message sets shall be of ASN.1 type `CZinfoMessage` as specified in Annex A. This CZ message is part of the general urban traffic management message set specified in CEN/TS 17241; see Clause A.4.

There are no requirements on how to encapsulate this CZ message in a general message for transmission to other ITS-SUs, except the general requirement on security specified in 8.1.

Annex A
(normative)

ASN.1 module of the CZ data dictionary

A.1 General

The ASN.1 basic notation is specified in ISO/IEC 8824-1.

Applicable encodings of the types and values specified in Clause A.2 depend on the usage. ASN.1 BASIC-PER, UNALIGNED, as specified in ISO/IEC 8825-2, typically applies for communications over narrowband wireless links. A typical example of using ASN.1 BASIC-PER, UNALIGNED (UPER) encoding is for messages transmitted over narrow-band wireless channels such as IEEE 802.11 OCB at 5,9 GHz, e.g. specified in ISO 21215. XML encoding typically applies for communications between infrastructure devices, or transmitted by CV2X (or similar).

The ASN.1 module

— `CZdd1 {iso(1) standard (0) cz (24311) czdd (1) majorVersion1 (1) minorVersion0 (0)}`

containing the definition of the CZ data dictionary is specified in Clause A.2. These ASN.1 definitions are provided in machine-readable format in the normative electronic attachment to this document

— ISO 24311v1m0.asn

available in the web folder

— https://standards.iso.org/iso/24311/ed-1/en

The SHA-256 cryptographic hash digest for the referenced file iso24311v1m0.asn, offering a means to verify the integrity of the referenced file, is:

— D2A30D77C6528FA651424F57AC54CF3BEFA7DBFEF950A21A7C7CAD2047D776F2

The SHA-256 algorithm is specified in NIST 180-4.

For information purposes only, Clause A.2 presents this ASN.1 module.

In case of differences between the ASN.1 presentation in the electronic attachment and the description in this document, the presentation in the electronic attachment shall prevail.

Clause A.4 specifies how the messages specified in this document become part of a general TMS message set such as that specified in CEN/TS 17241.

The ASN.1 types `LDMarea` and `TimeInformation` shall be as specified in ISO 18750.

NOTE 1 `LDMarea` and `TimeInformation` are ASN.1 open types (information object class). Thus, the set of information objects is extendible. Extensions can also be specified in other standards and will be recorded by ISO/TC 204.

The ASN.1 types `Time48IAT` and `NullType` shall be as specified in ISO 17419.

NOTE 2 The ASN.1 type `NullType` is identical to the built-in type `NULL`. It is defined solely to fix a bug in the TTCN-3 test suite software.

A.2 Module CZdd1

```
--<OSS.PDU>--
-- 2023-06-22

CZdd1  {iso(1) standard(0) cz (24311) czdd (1) majorVersion1 (1) minorVersion0 (0)}
DEFINITIONS AUTOMATIC TAGS::=BEGIN

IMPORTS
-- From EN ISO 18750
LDMarea, TimeInformation FROM CITSldm2 {iso(1) standard(0) cits-ldm (18750) asnm-1(1) version2
(2)}

-- From EN ISO 17419
Time48IAT, NullType FROM CITSdataDictionary1 {iso(1) standard(0) cits-applMgmt (17419)
dataDictionary (1) version1 (1)}

; -- End of IMPORT

-- CZ definitions

ControlledZone::=SEQUENCE{
      czId   OBJECT IDENTIFIER, -- CZ identifier
      czArea LDMarea, -- CZ area definition
      czAccessConditions  CzAccessConditions
      }

-- CZ access conditions

CzAccessConditions::=SEQUENCE{
      lastUpdate   Time48IAT,
      accessConditions   AccessConditions
      }

AccessConditions::=SEQUENCE OF CzAccessCondition

CzAccessCondition::=SEQUENCE{
      czAccessConditionDetail   CzAccessConditionDetail,
      czAccessConditionValidity CzAccessConditionValidity,
      czAccessConditionExemptions     CzAccessConditionExemptions
      }

CzAccessConditionValidity::=SEQUENCE OF TimeInformation -- zero or several time informations

CzAccessConditionExemptions::=SEQUENCE OF CzExemption

-- CLASS for access condition details

CzAccessConditionDetail::=SEQUENCE{
      czAccessConditionRef    CZAC.&czacType( {CzAccessConditionTypes} ),
      czAccessConditionFormat CZAC.&CzacFormat( {CzAccessConditionTypes}
{@czAccessConditionRef} )
      }

CZAC::=CLASS{
      &czacType CzAccessConditionRef UNIQUE,
      &CzacFormat
      }
      WITH SYNTAX {&CzacFormat IDENTIFIED BY &czacType}

CzAccessConditionRef::=INTEGER{
      czacUnknown  (0),
      czacAllowed  (1),
      czacProhibited     (2),
      czacRequestedUserProperties    (3)
      }

CzAccessConditionTypes CZAC::={
      { CzACunknown IDENTIFIED BY czacUnknown }    |
      { CzACallowed IDENTIFIED BY czacAllowed } |
```

```
      { CzACprohibited IDENTIFIED BY czacProhibited } |
      { CzACrequestedUserProperties IDENTIFIED BY czacRequestedUserProperties } ,
      ...
      }

CzACunknown::=NullType -- this is just a flag

CzACallowed::=NullType -- this is just a flag

CzACprohibited::=NullType -- this is just a flag

CzACrequestedUserProperties::=SEQUENCE OF CzRequestedUserProperty

-- CLASS for requested user properties

CzRequestedUserProperty::=SEQUENCE{
      czRequestUserPropRef      CZRUP.&czrupType({CzRequestUserPropertyTypes}),
      czRequestUserPropFormat   CZRUP.&CzrupFormat( {CzRequestUserPropertyTypes} {@
czRequestUserPropRef } )
      }

CZRUP::=CLASS{
      &czrupType CzRequestUserPropRef UNIQUE,
      &CzrupFormat
      }
      WITH SYNTAX {&CzrupFormat IDENTIFIED BY &czrupType}

CzRequestUserPropRef::=INTEGER{
      czrupUnknown (0)
      }

CzRequestUserPropertyTypes CZRUP::={
      { CzRUPunknown IDENTIFIED BY czrupUnknown } ,
      ...
      }

CzRUPunknown::= NullType -- this is just a flag

-- CLASS for exemptions

CzExemption::=SEQUENCE{
      czExemptionRef     CZEXEMPT.&czexemptType( {CzExemptionTypes} ),
      czExemptionFormat  CZEXEMPT.&CzexemptFormat( {CzExemptionTypes} {@
czExemptionRef } )
      }

CZEXEMPT::=CLASS{
      &czexemptType CzExemptRef UNIQUE,
      &CzexemptFormat
      }
      WITH SYNTAX {&CzexemptFormat IDENTIFIED BY &czexemptType}

CzExemptRef::=INTEGER{
      czexemptUnknownOrNone   (0), -- this is only a flag, not an exempt
      czexemptAll (1), -- this is only a flag, not an exempt
      czexemptLeaveZoneOnly   (2),
      czexemptFee (3),
      czexemptMaxTime     (4)
      }

CzExemptionTypes CZEXEMPT::={
      { CzExemptUnknownOrNone IDENTIFIED BY czexemptUnknownOrNone } |
      { CzExemptAll IDENTIFIED BY czexemptAll } |
      { CzExemptLeaveZoneOnly IDENTIFIED BY czexemptLeaveZoneOnly } |
      { CzExemptFee IDENTIFIED BY czexemptFee } |
      { CzExemptMaxTime IDENTIFIED BY czexemptMaxTime } ,
      ...
      }

CzExemptUnknownOrNone::= NullType -- this is just a flag

CzExemptAll::= NullType -- this is just a flag
```

```
CzExemptLeaveZoneOnly::= NullType

CzExemptFee::= NullType
-- Requires subsequent actions to be specified by CEN TC278 WG1, if needed

CzExemptMaxTime::=TimeInformation -- only a single time duration value
-- requires additional specification enabling enforcement


-- Messages
CZinfoMessage::=SEQUENCE OF ControlledZone

-- End of messages

END
```

A.3 Extensions of the ASN.1 module CZdd1

The ASN.1 type definitions presented in Table A.1 and specified in A.2, based on the ASN.1 anytype CLASS, can be extended with new instantiations.

Table A.1 — Extendible ASN.1 type definitions

ASN.1 type	Related ASN.1 CLASS	Related ASN.1 type of reference identifier
CzAccessConditionTypes	CZAC	CzAccessConditionRef
CzRequestUserPropertyTypes	CZRUP	CzRequestUserPropRef
CzExemptionTypes	CZEXEMPT	CzExemptRef

CzAccessConditionTypes:

It is possible that this type will be extended in the future by a CZ access condition "allowed for CZ users (vehicles) with the given properties", which is the complement to the existing CZ access condition "prohibited for CZ users (vehicles) with given properties". At time of publication, no need was identified to implement this complementary type, as all missing operational CZ access conditions can be implemented using extensions of CzRequestUserPropertyTypes.

CzRequestUserPropertyTypes:

Quite complex extensions can be defined to enable further CZ access conditions as needed for deployment projects.

CzExemptionTypes:

Quite complex extensions can be defined to enable further CZ exemptions as needed for deployment projects.

NOTE Specifications of extensions can be done as amendments to this document, or can be specified in other standards. Respective reference identifiers will be assigned by ISO/TC 204 periodically by updates of this document.

A.4 TMS message set

EXAMPLE CEN/TS 17241 specifies the ASN.1 module

— TmsMessageSet {iso(1) identified-organization(3) cen(162) statusFault (17241) tmsMsgSet (1) version0 (0)},

which creates the TMS message set. The following message specified in this document may be part of this TMS message set:

— CZinfoMessage, identified by the reference value 4.