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Intelligent transport systems — Cooperative ITS —

Part 1: Roles and responsibilities in the context of co-operative ITS architecture(s)

Systèmes intelligents de transport — Systèmes intelligents de transport coopératifs —

Partie 1: Rôles et responsabilités dans le contexte des ITS fondés sur l'architecture

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 204, *Intelligent transport*.

This first edition cancels and replaces ISO/TS 17427:2014 which has been technically revised.

A list of all the parts in the ISO 17427 series can be found on the ISO website.

Introduction

Cooperative Intelligent Transport Systems (*C-ITS*) (3.8) are a promising advancement of Intelligent Transport Systems (ITS). Numerous applications, made possible only, or most efficiently, by the cooperation of *actors* (3.2) (other vehicles, the *infrastructure* (3.12), *service* (3.25) providers, even bystanders), are being devised that open up new possibilities to make traffic safer, more efficient and smarter. Technologies are being developed and improved to realize and support those new *services* and *applications* (3.3). But, to finally implement *C-ITS* and to achieve the benefits of greater safety and better mobility, multiple *actors* will have to cooperate with each other in a completely new way. *Actors* that have to date worked in isolation, i.e. in so called "silos", will have to find a way to achieve these possibilities. New *actors* may also be required for the provision of some *services*. This requires a clear definition and assignment of *behaviours* (3.4), *responsibilities* (3.21) and liabilities. Therefore a general, abstract organizational architecture with the description of the single *roles* (3.22), their *behaviour*, and the corresponding *responsibilities*, is an essential prerequisite for the deployment of *C-ITS*.

The organizational relationships with the description of roles and responsibilities, is a crucial part of the whole *C-ITS* architecture. *C-ITS* is not an objective in itself, it is a means to achieve the potential of service provision through the cooperation of *actors* involved in the ITS sector. The architectural viewpoint comprising the organizational architecture has extensive influences on the deployment and implementation of *C-ITS*.

This document describes the high level roles and responsibilities of a *C-ITS* service provider and aligns it with other *C-ITS* standards and specifications.

Intelligent transport systems — Cooperative ITS —

Part 1: Roles and responsibilities in the context of co-operative ITS architecture(s)

1 Scope

This document contains a detailed description of the (actor invariant) *roles* (3.22) and *responsibilities* (3.21) required to deploy and operate *Cooperative-ITS (C-ITS)* (3.8). The organization/organization of actors / roles described in this document are designed to be appropriate for any fully operational system that uses the *C-ITS* concepts and techniques in order to achieve its service provision. This document is presented in terms of an organizational or *enterprise viewpoint* (3.10) as defined in ISO/IEC 10746-1.

This document is for all types of road traffic of all classes, and for any other actors involved in the provision of applications and services which use *C-ITS* techniques to achieve service provision. The description of roles is technology agnostic and, in terms of *C-ITS*, agnostic in respect of communication modes and embraces vehicle-vehicle communications, vehicle-infrastructure communications and infrastructure-infrastructure communications.

This document provides a methodology for the identification of service specific roles and their corresponding responsibilities based on a process oriented approach. Additionally, the methodology is used to identify the roles and responsibilities for *C-ITS* in general. Both the methodology as well as the roles and responsibilities for *C-ITS* are deduced from ISO/IEC 10746-1, ISO/IEC 10746-2, ISO/IEC 10746-3, the reference model of Open Distributed Processing. Open Distributed Processing offers five viewpoints of which the *enterprise viewpoint* corresponds with the organizational architecture and its *roles* and *responsibilities*.

To limit the scope of the document to the core of *C-ITS*, the *roles* are separated into external and internal. Considered to be internal are all roles that are highly relevant for the purpose of achieving service provision by means of *C-ITS*. Considered to be external are all roles involved in *C-ITS*, but not set up only for the purpose of *C-ITS*.

This document provides a description of a high-level architectural viewpoint on *C-ITS*. It is designed to be used as a blueprint when implementing service provision systems that use *C-ITS*, and the corresponding organizational structures. The characteristics of *C-ITS* entail a huge number of data/information exchanges. Therefore the implementation stringently respects privacy and data protection as it is defined in ISO/TR 12859 and in national laws and regulations (where instantiated). Privacy and data protection affects all roles defined in this document due to these characteristics and all actors occupying roles in C-ITS respects the corresponding standards and regulations.

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/TR 12859:2009, *Intelligent transport systems — System architecture — Privacy aspects in ITS standards and systems*

ISO 14817-2, *Intelligent transport systems — ITS central data dictionaries — Part 2: Governance of the Central ITS Data Concept Registry*

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:

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

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

3.1
action
something which happens; the fact or *process* (3.18) of doing something

EXAMPLE Typically to achieve an aim.

[SOURCE: ISO/IEC 10746-2, 8.3]

3.2
actor
person or organizational unit playing a coherent set of *roles* (3.22) when interacting with the system within a particular use case

[SOURCE: ISO 24014-1:2015, 2.2]

3.3
application
app
software based mechanism of delivering some or all parts of a *service* (3.25)

[SOURCE: ISO 14813-1, 3.2]

3.4
behaviour
collection of *actions* (3.1) with a set of constraints on when they may occur

[SOURCE: ISO/IEC 10746-2, 8.7]

3.5
bounded secure managed domain
BSMD
ITS-S (3.15) *application* (3.3) *processes* (3.18) which function within a controlled environment comprised of an *ITS-S* facilities layer, *ITS*-S networking & transport layer, *ITS-S* access layer, *ITS-S* management entity and *ITS-S* security entity, which adhere to a minimum set of security principles and procedures so as to establish a level of trust between itself and other similar *ITS stations* (3.15) with which it communicates

3.6
client
party which instigates/authorizes the provision of an ITS *service* (3.14)

3.7
community
configuration of *objects* (3.17) formed to meet an objective

[SOURCE: ISO 10746-3, 5.1.1]

3.8
Cooperative-ITS
C-ITS
subset of overall ITS that communicates and shares information between *ITS stations* (3.15) to provide, exchange, or receive, data, give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems

Note 1 to entry: As an alternative to a "subset", Cooperative-ITS could be viewed as a "paradigm" in overall ITS.

[SOURCE: ISO/TR 17465-1, 2.1]

3.9
enterprise object
object (3.17) in enterprise *viewpoint* (3.10)

3.10
enterprise viewpoint
viewpoint on an open distributed processing (ODP) system and its environment that focuses on the purpose, scope and policies for that system

[SOURCE: ISO/IEC 10746-3, 4.1.1.1]

3.11
external enterprise object
enterprise object (3.9) involved in C-ITS but not set up for the only purpose of C-ITS

3.12
infrastructure
system of facilities, equipment and *services* (3.25) needed for the operation of an organization

Note 1 to entry: C-ITS specific: static part of C-ITS incorporating sensors, actuators, static *ITS Station(s)* (3.15).

[SOURCE: ISO 9000:2015, 3.5.2]

3.13
internal enterprise object
enterprise object (3.9) within C-ITS set up only as an internal C-ITS mechanism to enable or support the provision of an *ITS service* (3.14) via C-ITS

3.14
ITS service
provides benefits to its *service recipient* (3.28)

3.15
ITS Station
ITS-S
entity in a communication network, comprised of *applications* (3.3), facilities, networking and access layer components that operate using regular wireless communications interface security, or may operate within a *bounded secure management domain* (3.5)

3.16
data lifecycle process
process (3.18) based on data element transformation

3.17
object
model of an entity, characterized by its *behaviour* (3.4) and dually by its state, distinct from any other object, encapsulated, i.e. any change in its state can only occur as a result of an internal *action* (3.1) or as a result of an interaction with its environment

[SOURCE: ISO/IEC 10746-2, 8.1]

3.18
process
sequence of *tasks* (3.32) or set of interrelated tasks which transform inputs into outputs

[SOURCE: ISO 9000:2015, 3.4.1]

3.19
process chain
sequence of processes (3.18) that wait in the background for an event, with some of these processes triggering a separate event that can start other processes in turn

[SOURCE: SAP Help Portal]

3.20
public key infrastructure
PKI
hierarchy of "certification authorities" to allow individuals and organizations to identify each other for the purpose of doing business electronically

3.21
responsible
responsibility
responsibilities
state of being accountable or answerable, as for an entity, function, system, security service or obligation

Note 1 to entry: A responsibility might be a legally backed assignment of *actions* (3.1) to a *role* (3.22).

3.22
role
described by *tasks* (3.32), a *behaviour* (3.4) and *responsibilities* (3.21) and to be associated with an actor

3.23
scenario
general description of activities between (possible) participating *actors* (3.2)

3.24
sequential process
process (3.18) based on sequence of *actions* (3.1) executed

3.25
service
defined functionality to the system which requires a defined set of data as input, processes this data and delivers a defined output

3.26
service in pull mode
ITS service (3.14) actively requesting the data that is required for the service operation

3.27
service in push mode
ITS service (3.14) operating on data delivered without request by an actor or its system

3.28
service recipient
user
actor (3.2) who receives a *service* (3.25)

3.29
stakeholder
individual or organisation having a right, share, claim or interest in a system or in its possession of characteristics that meet their needs and expectations

3.30
sub-role
subordinate *role* (3.22) consisting of a defined fragment of the superior *role* (3.22)

3.31
system
set of interacting or interdependent components forming an integrated whole

Note 1 to entry: Every system is delineated by its organizational and/or spatial and/or temporal boundaries, surrounded and influenced by its environment, described by its structure and purpose and expressed in its functioning.

3.32
task
action that is fulfilled by a role

4 Abbreviated terms

C-ITS	Cooperative ITS
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
ITS	Intelligent Transport Systems
ITS-S	ITS Station
LDM	Local Dynamic Map
PKI	Public Key Infrastructure
ODP	Open Distributed Processing

5 Compliance

It is recommended that any implementation of an organizational architecture for *C-ITS* (3.8) should comply with this document. Compliance with this document is achieved when all *role*s (3.22) and *sub-role*s (3.30) described in Clause 8 are assigned to corresponding *actor*s (3.2) in *C-ITS*.

6 How to use this document

6.1 Roles and responsibilities in the context of Cooperative-ITS

In order for *C-ITS* (3.8) to work cohesively and interoperably, it shall be specified and implemented consistently.

The instantiations of *C-ITS* that will appear over the coming years and decades will vary according to their specific applications and requirements, and will vary in their technology, particularly over time, as the capabilities for these technologies evolve and develop.

While it is not possible today to predetermine future applications in precise detail, it is important that such applications will operate, and most importantly for *C-ITS*, interoperate, within a collaborative environment.

It is therefore necessary, and desirable, to understand the *roles* (3.22) and *responsibilities* (3.21) of *C-ITS* at a general abstracted level, (above that for any particular application) in order to be able to achieve

such consistency of approach, and by so doing, achieve interoperability and indeed, achieve the basic elements required for successful cooperation.

Clauses 7 to 8 provide an explanation of the methodology in this document. This is achieved using an architecture description and analysis technique known as open distributed processing (ODP) (the reasons for which are explained at the beginning of Clause 7).

Annexes A and B provide informative examples of the methodology and its sample application (Annex A), and profiles (Annex B) for different implementation *scenarios* (3.23) for the identified *roles* and *responsibilities*.

This document should be read in concert with ISO/TR 17427-2 to ISO/TR 17427-10, which are a series of complementary Technical Reports which explain and debate the context of many specific aspects of C-ITS such as the "Core System", liability, privacy, risk management etc. These aspects are therefore not defined or explained in detail within this document.

Subclause 6.2 uses the context and roles and responsibilities determined in this document, and provides checklists that are recommended to be used when developing *C-ITS* standards deliverables, or when implementing a *C-ITS* application.

6.2 Guidance for developers and implementers of *C-ITS* application standards

When developing *C-ITS* application standards or implementing *C-ITS* applications and systems, an architecture should be prepared to ensure that all of the relevant *roles* and *responsibilities* involved in *C-ITS*, relevant to the application standards deliverable or the system under development have been considered, and, where appropriate, specified.

Such a process/recommendation does not imply or require any particular form or format to be imposed on a *C-ITS* (3.8) application standard, *C-ITS* application or system, but is designed to ensure that all of the relevant aspects of *roles* (3.22) and *responsibilities* (3.21) have been considered, and where appropriate are clearly identified and specified within that application standard's deliverable or system specification and implementation.

7 Introduction and theoretical framework

7.1 Use of ODP

For the description of an organisational architecture as one of the viewpoints of *C-ITS*, the concept and terminology of ODP according to ISO 10746 (Parts 1 to 3) is applied in this document.

The organisational architecture described corresponds with the *enterprise viewpoint* (3.10) in ODP, defining the purpose, scope and policies governing the activities of the specified system within the organization of which it is part.

Following the concept and terminology of ODP for the description of the *roles* and *responsibilities*, *C-ITS* can be described as a *community* (3.7) composed of *external* and *internal enterprise objects* (3.11/3.13) with the objective of providing *C-ITS* with its benefits regarding safety, efficiency, comfort and sustainability to the *user* (3.28) and minimization of pollution and other adverse ecological effects. *External enterprise objects* are involved in *C-ITS* but are not set up for the sole purpose of *C-ITS*. Therefore this document only includes aspects of *external enterprise objects* and their *roles* and *responsibilities* if they are relevant in respect of *C-ITS*. The *roles* (3.22) within the *internal enterprise objects* are specified in detail in this document.

The ODP reference model provides abstract language for the relevant concepts. It does not prescribe particular notations to be used in the individual viewpoints. The viewpoint languages defined in this reference model of *C-ITS roles* and *responsibilities* are abstract languages in the sense that they define what concepts should be used, not how they should be represented. Precise notations are not specified in this high level overview. The approaches of this deliverable are consciously defined in a notation- and representation-neutral manner, to increase their use and flexibility. However, it is recognized that

further bridging work will be required in the architecture specifications of the individual *services* (3.25) to enable the development of industrial tools for modelling the viewpoint specifications, the formal analysis of the specifications produced, and the possible derivation of implementations for their system specifications.

Within ITS and its projects, and as recommended in ISO 14814, UML (ISO/IEC 19501) is frequently used to describe architecture aspects of ITS for system modelling. However, while UML is proving to be very useful for the specification of specific *systems* (3.31), it proved unnecessarily challenging to present and succinctly analyse the overall *C-ITS roles* and *responsibilities*, and use UML views, for the overarching description of *C-ITS* roles and responsibilities.

For applications and standards which need to map between this ODP overview, and more specific UML application specifications, refer to ISO/IEC 19793.

NOTE ISO/IEC 19793 (usually referred to as UML4 (ODP) defines use of the Unified Modelling Language 2 (UML 2; ISO/IEC 19505-1 and ISO/IEC 19505-2), for expressing the specifications of open distributed systems in terms of the viewpoint specifications defined by the RM-ODP. It defines a set of UML Profiles, one for each viewpoint language and one to express the correspondences between viewpoints, and an approach for structuring them according to the RM-ODP principles. The purpose of UML 4 ODP is to allow ODP modellers to use the UML notation for expressing their ODP specifications in a standard graphical way; to allow UML modellers to use the RM-ODP concepts and mechanisms to structure their large UML system specifications according to a mature and standard proposal; and to allow UML tools to be used to process viewpoint specifications, thus facilitating the software design process and the enterprise architecture specification of large software systems.

7.2 Transferring ODP to roles and responsibilities for C-ITS

C-ITS features the characteristics of a distributed system with its partition of *service* (3.25) delivery via multiple *ITS stations* (3.15), therefore methodologies for the description of distributed systems are consulted when describing the overall architecture of *C-ITS* (3.8) and its different viewpoints. Conveyed to this standard, it is part of the organizational architecture for *C-ITS* and focuses on the description of *C-ITS* specific *roles* (3.22) and *responsibilities* (3.21).

Following the concept and terminology of ODP for the description of the *roles* and *responsibilities*, *C-ITS* can be described as a *community* (3.7) composed of *external* and *internal enterprise objects* (3.11, 3.13) (see Figure 1) with the objective of providing *C-ITS* with its benefits regarding traffic safety, traffic efficiency, comfort and ecological mobility to the user. *External enterprise objects* are involved in *C-ITS* but are not set up for the sole purpose of *C-ITS*. Therefore this document limits itself to the identification of *roles* and *responsibilities* of *external enterprise objects*.

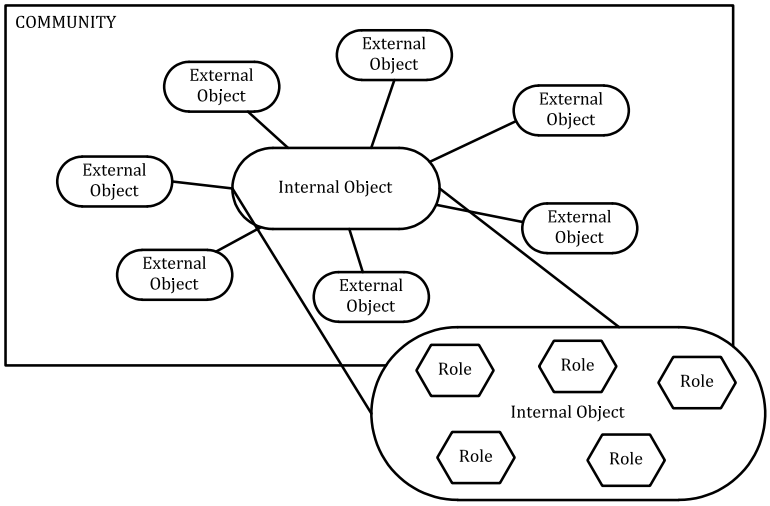

Figure 1 — Relationship between community, internal and external enterprise objects and roles

Internal enterprise object is connected with various *external enterprise objects*. The diagram (Figure 2) illustrates both the *external* enterprise *objects,* and *internal enterprise objects* in a similar representation

as described in Figure 1, and shows the key relationships in the context of *C-ITS* between the *internal enterprise object* and the *external enterprise objects.*

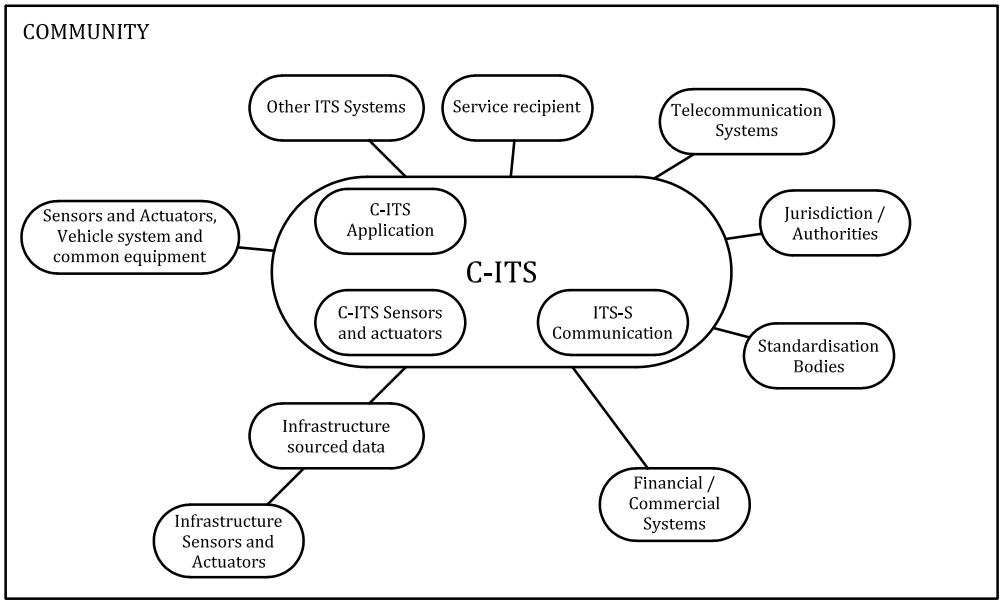

Figure 2 — External and internal enterprise objects in a C-ITS community

C-ITS "enterprise" role and responsibilities

The large oval in the centre of Figure 2 represents the "enterprise" domain of C-ITS (in Figure 1, the "internal object").

C-ITS Sensors and actuators

This term comprises equipment specifically installed to support C-ITS service provision (examples might be lidar, radar, video sensing equipment, etc.).

In the context of ODP, these are "internal objects".

C-ITS applications

These are the specific application services that use C-ITS information to provide their service (examples might be cooperative ice alert, obstacle alert, blind spot warning, ramp access, collision avoidance, etc.).

In the context of ODP, these are "internal objects".

ITS-Station communications (wireless or wired)

This is the means by which one ITS-station interacts with another ITS-station. In the case of communications between vehicles or between vehicles and the infrastructure, this is a wireless communication. In the case of an infrastructure-to-infrastructure C-ITS service provision, this may be wired or wireless.

As these are the essential functions of the "internal object" which enables it to communicate with other objects, in the context of ODP, these communications capabilities are "internal objects".

7.3 External enterprise objects

The following are *external enterprise objects* (3.11) and must meet and pass through the *C-ITS* (3.8) security firewall before their data can be used. In some cases this may be simply the security provisions of the wireless medium, but in some cases will require full BSMD security:

a) **ITS service recipient**

This is the actor who receives the service.

In the context of Figure 1, the service recipient is by definition an external object.

b) **Other ITS systems**

These are other ITS systems, which may well use the vehicle's communications capabilities, but do not provide or use *C-ITS* data or processes (examples might be, service monitoring/reservation, temperature monitoring, fleet management etc.).

In the context of Figure 1, other ITS applications are an external object.

c) **Sensors, actuators, vehicle systems and common equipment**

This ODP object comprises common equipment in the vehicle that may be used for *C-ITS* or non-C-ITS service provision (for example gyroscopes, accelerometers, clock, GNSS etc. are used both for non-C-ITS service provision, such as advanced driver assistance systems, and for *C-ITS* service provision, location based services).

In the context of Figure 1 sensor, actuators, vehicle systems and common equipment are an "external object".

d) **Infrastructure sensors and actuators/infrastructure sourced data**

Many *C-ITS* services may rely on infrastructure sourced information, much of which may come from embedded sensors and actuators (but could also come from the output from other systems, e.g. temperature gauges and received meteorology service information).

In the context of Figure 1, infrastructure sensors and actuators as well as infrastructure sourced data are an external object.

e) **Jurisdictions/authorities**

C-ITS service provision has to take place within the legal framework of a jurisdiction.

In the context of Figure 1, jurisdictions are an external object.

f) **Standardization bodies**

C-ITS can only operate in an interoperable environment. Such interoperability is most commonly achieved by "standards" developed in standardization bodies to which all actors agree to/comply.

In the context of Figure 1, standards bodies are an external object.

g) **Commercial/financial systems**

Many *C-ITS* services will be paid for by service event or subscription (examples might be parking fees, route optimization, etc.).

In the context of Figure 1, commercial / financial systems are an "external object".

It is essential to understand that *C-ITS* is not an end objective in itself, but is a means of achieving application *service* (3.25) delivery.

