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BSI Standards Publication

Intelligent transport systems — Cooperative ITS

Part 2: Framework overview

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National foreword

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Intelligent transport systems — Cooperative ITS —

Part 2: **Framework overview**

Systèmes intelligents de transport — Systèmes intelligents de transport coopératifs —

Partie 2: Aperçu général du cadre de travail

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Foreword

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

ISO 17427 consists of the following parts, under the general title *Intelligent transport systems — Cooperative ITS*:

— *Part 2: Framework overview* [Technical Report]

— *Part 3: Concept of operations (ConOps) for 'Core' systems* [Technical Report]

— *Part 4: Minimum system requirements and behaviour for core systems* [Technical Report]

— *Part 6: Core systems risk assessment methodology* [Technical Report]

— *Part 7: Privacy aspects* [Technical Report]

— *Part 8: Liability aspects* [Technical Report]

— *Part 9: Compliance and enforcement aspects* [Technical Report]

— *Part 10: Driver distraction and information display* [Technical Report]

The following parts are under prepartion:

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

— *Part 5: Common approaches to security* [Technical Report]

— *Part 11: Compliance and enforcement aspects* [Technical Report]

— *Part 12: Release processes* [Technical Report]

— *Part 13: Use case test cases* [Technical Report]

— *Part 14: Maintenance requirements and processes* [Technical Report]

This Technical Report provides an informative 'framework overview' of Cooperative Intelligent Transport Systems (C-ITS). It is intended to be used alongside ISO 17427-1, ISO/TR 17465-1 and other parts of ISO 17465, and ISO 21217. Detailed specifications for the application context will be provided by other ISO, CEN and SAE deliverables, and communications specifications will be provided by ISO, IEEE and ETSI.

Introduction

Intelligent transport systems (ITS) are transport systems in which advanced information, communication, sensor and control technologies, including the Internet, are applied to increase safety, sustainability, efficiency, and comfort.

A distinguishing feature of 'ITS' are their communication with outside entities.

Some ITS systems operate autonomously, for example, 'adaptive cruise control' uses radar/lidar and/or video to characterize the behaviour of the vehicle in front and adjust its vehicle speed accordingly. Some ITS systems are informative, for example, 'Variable Message Signs' at the roadside, or transmitted into the vehicle, provide information and advice to the driver. Some ITS systems are semi-autonomous, in that they are largely autonomous, but rely on 'static' or 'broadcast' data, for example, *GNSS* (3.9) based 'SatNav' systems operate autonomously within a vehicle but are dependent on receiving data broadcast from satellites in order to calculate the location of the vehicle.

Cooperative Intelligent Transport Systems (C-ITS) are a group of ITS technologies where service provision is enabled by, or enhanced by, the use of 'live', present situation related, dynamic data/information from other entities of similar functionality [for example, from one vehicle to other vehicle(s)], and/or between different elements of the transport network, including vehicles and infrastructure [for example, from the vehicle to an infrastructure managed system or from an infrastructure managed system to vehicle(s)]. Effectively, these systems allow vehicles to 'talk' to each other and to the infrastructure. These systems have significant potential to improve the transport network.

A distinguishing feature of 'C-ITS', is that data is used across *application* (3.1)/service boundaries.

ISO/TR 17465-1 provides a summary definition of C-ITS as a 'subset paradigm of overall ITS that communicates and shares information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems'.

The benefits of Intelligent Cooperative Systems stem from the increased information that is available from the vehicle and its environment and from other vehicles. The same set of information can be used to extend the functionality of the in-vehicle safety systems, and through vehicle-to-infrastructure communications for more efficient traffic control and management. The benefits include the following:

— improved safety;

— increased road network capacity;

— reduced congestion and pollution;

— shorter and more predictable journey times;

— improved traffic safety for all road users;

— lower vehicle operating costs;

— more efficient logistics;

— improved management and control of the road network (both urban and inter-urban);

— increased efficiency of the public transport systems;

— better and more efficient response to hazards, incidents and accidents.

(source: EC project CVIS)

The difference between any 'ITS system' and a 'C-ITS system' is that C-ITS systems are dependent from the interaction with other vehicles and or the infrastructure, and the exchange of dynamic data, to receive data to enable their function, or conversely to provide data to other vehicles/infrastructure to enable their C-ITS systems to function.

C-ITS as an entity, is therefore the functionality that enables such ‘cooperative’ and collaborative exchange of data, and in some cases, collaborative control, or subservient decision making, in order to provide an *application service* to one or more actors. Descriptions of the roles and responsibilities of those actors can be found in ISO 17427-1.

It is important to understand that C-ITS is not an end in itself, but a combination of techniques, protocols, systems and sub-systems to enable ‘cooperative’/collaborative service provision.

This Technical Report describes and specifies the framework which enables such collaborative and cooperative systems to operate. It is agnostic in respect of technology, and operates with whatever communications and hardware technologies can support its functionalities. Other deliverables in this family of C-ITS standards will define specific aspects of technology and behaviour, and the roles and responsibilities within the context of C-ITS.

This Technical Report may therefore be seen as an ‘overview’ of the features and physical and functional architecture elements that comprise C-ITS.

This Technical Report is a ‘living document’ and as our experience with C-ITS develops, it is intended that it will be updated from time to time, as and when we see opportunities to improve this Technical Report.

Further technical reports in this series are expected to follow.

Please note that these TRs are expected to be updated from time to time as the C-ITS evolves.

Intelligent transport systems — Cooperative ITS —

Part 2: **Framework overview**

1 Scope

This Technical Report characterizes and provides an overview of the framework which enables collaborative and cooperative ITS to operate and defines the characteristics and components of a Cooperative-ITS (C-ITS), its context and relevance for *ITS service* provision, and provides references to International Standards deliverables where specific aspects of C-ITS are defined. The objective of this Technical Report is to raise awareness of and consideration of such issues and to give pointers, where appropriate, to International Standards deliverables existing that provide for all or some of these aspects. This Technical Report does not provide specifications for solutions of these issues.

This Technical Report is agnostic in respect of technology and operates with whatever communications and hardware technologies can support its functionalities.

NOTE Other deliverables in this family of C-ITS standards will define specific aspects of technology and behaviour and the roles and responsibilities within the context of C-ITS.

2 Terms and definitions

2.1
application
app
software application

2.2
application programming interface
API
set of routines, protocols, and tools for building software applications

[SOURCE: ISO 17627:2009, 2.4, modified]

Note 1 to entry: An API expresses a software component in terms of its operations, inputs, outputs, and underlying types; it defines functionalities that are independent of their respective implementations, which allows definitions and implementations to vary without compromising the interface. An API can also assist otherwise distinct applications with sharing data, which can help to integrate and enhance the functionalities of the applications.

Note 2 to entry: APIs often come in the form of a library that includes specifications for routines, data structures, object classes, and variables. In addition to accessing databases or computer hardware, such as hard disk drives or video cards, an API can be used to ease the work of programming graphical user interface components.

2.3
application service
service provided by a service provider accessing data from the *IVS* (2.11) in a vehicle in the case of C-ITS, via a wireless communications network, or provided on-board the vehicle as the result of software (and potentially also hardware and firmware) installed by a service provider or to a service provider's instruction

2.4
bounded secure managed domain
BSMD
secure peer-to-peer communications between entities (*ITS-stations* (2.17)) that are themselves capable of being secured and remotely managed; the bounded nature is derived from the requirement for *ITS-stations* to be able to communicate amongst themselves, i.e. peer-to-peer, as well as with devices that are not secured (referred to as 'other *ITS-stations*'), and realizing that to achieve this in a secure manner often requires distribution and storage of security-related material that must be protected within the boundaries of the *ITS-stations*, leads to the secured nature of the entity, as there is great flexibility to achieve desired communication goals, there is a requirement that this flexibility be managed

Note 1 to entry: Within C-ITS and ISO 21217, such *ITS-stations* are defined as operating within bounded secured managed domains (BSMD), or outside of the BSMD.

2.5
Cooperative ITS
C-ITS
use of ITS technologies where service provision is enabled, or enhanced by, the use of 'live', present situation related, data/information from other entities (for example, from one vehicle to other vehicle(s)), and/or between different elements of the transport network, including vehicles and infrastructure (for example, from the vehicle to an infrastructure managed *central system* (2.6) or from a central infrastructure managed system to vehicle(s))

2.6
central system
service centre system that provides/supports *application service(s)* (2.3) managed through a central facility

2.7
Controller Area Networking bus
CAN bus
network designed for use in automotives, which:

a) uses a single terminated twisted pair cable;

b) is multi master;

c) uses a maximum signal frequency used is 1 Mbit/sec;

d) has a typical length of 40 M at 1 Mbit/sec up to 10 KM at 5 Kbits/sec;

e) has high reliability with extensive error checking;

f) has a typical maximum achieveable data rate of 40 KBytes/sec;

g) has a maximum latency of high priority message <120 µsec at 1 Mbit/sec

Note 1 to entry: CAN is unusual in that the entities on the network, called nodes, are not given specific addresses. Instead, it is the messages themselves that have an identifier which also determines the messages' priority. For this reason, there is no theoretical limit to the number of nodes, although in practice it is ~64.

2.8
'Core' system
combination of enabling technologies and services that will provide the foundation for the support of a distributed, diverse set of *applications* (2.1)/*application* transactions, which work in conjunction with 'External Support Systems' such as 'Certificate Authorities'; the system boundary for the *core system* is not defined in terms of devices or agencies or vendors, but by the open, standardized interface specifications that govern the behaviour of all interactions between core system users

2.9
global navigation satellite system
GNSS
comprises several networks of satellites that transmit radio signals containing time and distance data that can be picked up by a receiver, allowing the user to identify the location of its receiver anywhere around the globe

2.10
host management centre
HMC
service gateway that supervises the secure provision of software and services for C-ITS service provision

2.11
in-vehicle system
hardware, firmware and software on board a vehicle that provides a platform to support C-ITS service provision, including that of the *ITS-station* (2.17) (ISO 21217), the facilities layer, data pantry and on-board *'apps'* (2.1)

2.12
intelligent transport systems
ITS
transport systems in which advanced information, communication, sensor and control technologies, including the Internet, are applied to increase safety, sustainability, efficiency, and comfort

2.13
ITS application
functionality that either completely provides what is required by an *ITS service* (2.16) or works in conjunction with other ITS *applications* (2.1) to provide one or more *ITS services*

2.14
ITS border router
ITS-s router with additional functionality that provides connectivity to other ITS communication nodes over external networks

2.15
ITS mobile router
ITS-s border router (2.14) with additional functionality that allows a change of point of attachment to an external network while maintaining session continuity

2.16
ITS service
functionality provided to surface transport users

2.17
ITS-station
entity in a communication network (comprised of *application* (2.1), facilities, networking and access layer components) that is capable of executing ITS-s application processes (sometimes within a bounded, secured, managed domain), comprised of an ITS-s facilities layer, ITS-s networking and transport layer, ITS-s access layer, ITS-s management entity and ITS-s security entity, which adheres to a minimum set of security principles and procedures so as to establish a level of trust between itself and other similar ITS stations with which it communicates

2.18
wireline
traditional permanent 'wired' connection (although may in reality include microwave and other wireless connections)

3 Abbreviated terms

2G second-generation cellular phone technology e.g. GSM

3G third-generation mobile phone technology e.g. UMTS

API application programming interface (2.2)

BSMD bounded secure managed domain

C-ITS cooperative intelligent transport systems, cooperative ITS

CALM Communications Access for Land Mobiles

CAM Cooperative Awareness Message

CVIS Cooperative Vehicle Infrastructure Systems

GNSS global navigation satellite systems (2.9)

GSM Global System for Mobile Communication (2G mobile communications)

HMC host management centre (2.10)

IPv6 Internet Protocol version 6

ITS intelligent transport systems (2.12)

IVS in-vehicle system (2.11)

NEMO Network Mobility (NEMO) Basic Support Protocol (IETF) RFC 3963

4 Overview of components of a C-ITS enabled system

4.1 Specific service features characterizing C-ITS

ISO 14813-1 describes the ITS service (2.16) groups and services that are generally considered to comprise the realm of ITS. From ISO 14813-1, we can establish that *ITS services* can operate in different paradigms, and some *application services* operate autonomously (see examples given in the introduction).

Some ITS systems are semi-autonomous, in that they are largely autonomous, but rely on ‘static’ or ‘broadcast’ data (see examples given in the introduction).

Cooperative Intelligent Transport Systems (C-ITS) are a group of ITS technologies where service provision is enabled by, or enhanced by, the use of ‘live’, dynamic, present situation related, data/information from other entities (for example, from one vehicle to other vehicle(s)), and/or between different elements of the transport network, including vehicles and infrastructure [for example, from the vehicle to an infrastructure-managed system or from an infrastructure-managed system to vehicle(s)]. Effectively, these systems allow vehicles to ‘talk’ to each other and to the infrastructure. These systems have significant potential to improve the transport network. See also ISO/TR 17465-1 and ISO 17427-1.

For specifications regarding C-ITS terms, definitions and guidance for standards documents, see ISO/TR 17465-1.

For specifications regarding the structure of specific C-ITS Standards deliverables, and general C-ITS definitions, see ISO/TR 17465-2.

For specifications regarding 'Release' procedures for consistent groups of C-ITS Standards, see ISO/TR 17465-3.

The difference between any 'ITS system' and a 'C-ITS system' is that C-ITS systems are dependent on the interaction with other vehicles and or the infrastructure to receive data/sometimes make decisions, to enable their function, or conversely to provide data to other vehicles/infrastructure to enable their C-ITS systems to function.

'Cooperative', in the context of C-ITS, implies cooperation within the following contexts:

a) Direct communication and exchange of relevant information between entities,

b) Dynamic interaction between road users, or between road users and the transport infrastructure for the benefit of road users, and may also mean

c) Use of data provided for one purpose to be (anonymously) collated and managed to bring benefits to other users (example: probe data).

C-ITS as an entity, is therefore the functionality that enables such 'cooperative' and collaborative exchange of data, and in some cases, collaborative control, or subservient decision making, in order to provide an *application service* to one or more actors.

It is important to understand that C-ITS is not an end in itself, but a combination of techniques, protocols, systems and functions to enable 'cooperative'/collaborative service provision. What separates C-ITS from any other ITS communication is the sharing and exchange of data to provide information, and in some cases control, cooperatively between actors in the road network.

However, C-ITS cannot in itself be described as a single mode of operation. C-ITS itself can operate in at least five modes:

a) direct vehicle-to-vehicle;

b) ITS-station (2.17) to any other *ITS-station*;

c) vehicle to *application service* provider/*application service*;

d) via a 'core' backbone, back office;

e) between 'core' systems or 'applications' (2.1).

a) and b) in communication terms are identical; however, for time critical safety applications (2.1) such as car-to-car 'collision avoidance', there are some special 'time critical' requirements that do not apply, for example, in exchanges with *ITS-stations* such as 'personal' phone-based *applications*, or exchanges with *application service* providers. These two use cases, though similar, are therefore considered in this deliverable as separate sub-classes.

b) and c) are again identical in communications terms, but functionally, sub-class c) includes many services that may be provided in a C-ITS context, sharing data with other sources in order to provide the service; however, similar services may also be provided in an ITS context that do not include the 'cooperative'/'collaborative' aspects that characterize C-ITS (albeit with inferior levels of quality of service).

Sub-class d) is an important and separate class, even though the communication is likely to be between two or more peer *ITS-stations,* as with sub classes a), b) and c) (and therefore identical in nature in respect of communications). However, where certification or the involvement or approval of the Jurisdiction is involved, or some form of permissions or payments are involved, there needs to be the presence and involvement of a 'back office', in the context of C-ITS most commonly referred to as a 'Central system' (2.6). ISO/TR 17427-3 will define the concept of operations for "core" systems, and ISO/TR 17427-4 will describe the minimum operating requirements and behaviour of such systems, and ISO/TR 17427-1 explains the roles and responsibilities for such systems. ISO/TR 17427-5 will describe and provide references to standards deliverables to assure C-ITS common approaches to security, while ISO/TR 17427-6 will provide a basis for C-ITS risk assessment.

Further, while some C-ITS services can be provided in a vehicle-to-vehicle context (for example, 'Ice Alerts', 'Obstacle Alerts', and other road condition alerts), they may be provided more efficiently if the detecting vehicle passes the data to a 'core' system, which is then in a more selective and better position to alert other vehicles, as it is a constant within the area (as opposed to a vehicle whose presence in any location is transient). Some other services, such as safe dynamically controlled ramp access (ingress to and egress from highways), and railway (so called 'grade') crossings, which, in the C-ITS context will be part managed by a central road management system, and in part by dynamic collision avoidance data from vehicles in the zone, may be more efficient when provided under the control of a central 'core' system.

Within most administrations currently considering the introduction of support for C-ITS assisted applications (2.1), the 'core' system is seen to be an important component, and a component that can accelerate the business case for C-ITS implementation, by spreading many of its benefits beyond just C-ITS equipped vehicles, at an early stage.

Finally, there are C-ITS services, whose data may originate from road users, but process and provide their application (2.1) between road managers, administrations and jurisdictions via mainstream so called 'wireline' (2.18) communications networks, or the Internet, that do not require the use of ITS-station communications.

4.2 Actors involved in C-ITS service provision

Figure 1 shows a high level view of actors and objects in an ITS service provision use case. In this scenario, ITS-stations lie at the core of most, but not all, ITS service provision. The *ITS-station* may be connected over a variety of wireless media, and through them, or directly, via the Internet.

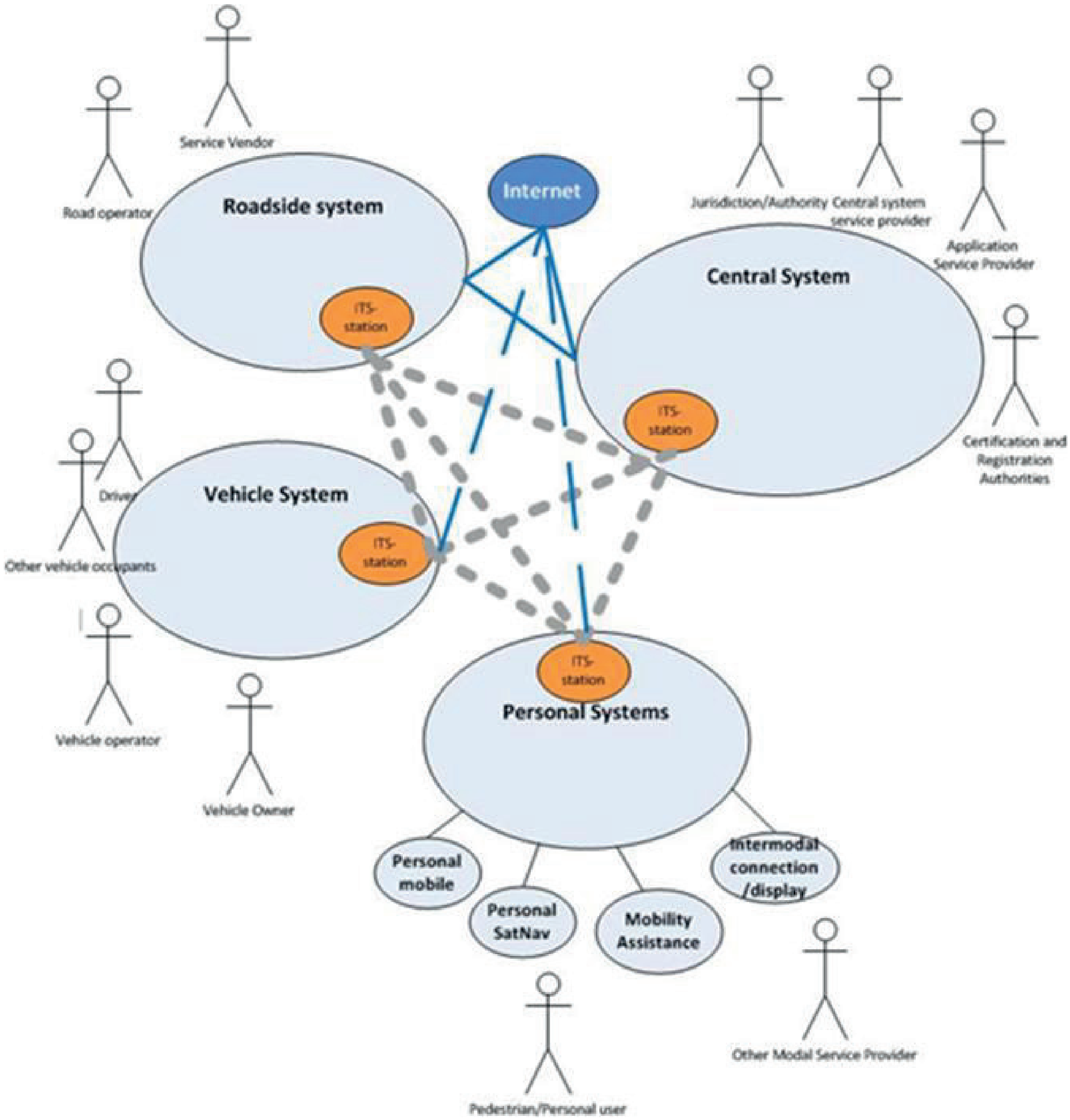

Figure 1 — Functions and actors in an ITS service provision use case

However, while appropriate in the context of 'ITS', Figure 1 is an over simplification in the context of C-ITS, as any *ITS-station* can talk to any other ITS station, and will exchange and share data, and in some circumstances control, based on that shared information. There will certainly be multiple, indeed many, 'vehicle systems', in a world where all or part of the vehicle park is C-ITS capable, there will be as many *ITS-stations* as there are C-ITS capable vehicles. In the C-ITS world, vehicles can exchange data, even control mechanisms, with other vehicles. There will be multiple roadside stations (either permanent or temporary), and many personal ITS stations. There will often also be multiple 'core systems' (2.8), all of which can connect and interact with each other. Figure 2 therefore represents the C-ITS world more realistically, though all of the possible interactions are not shown, in order not to overload comprehension of the figure.

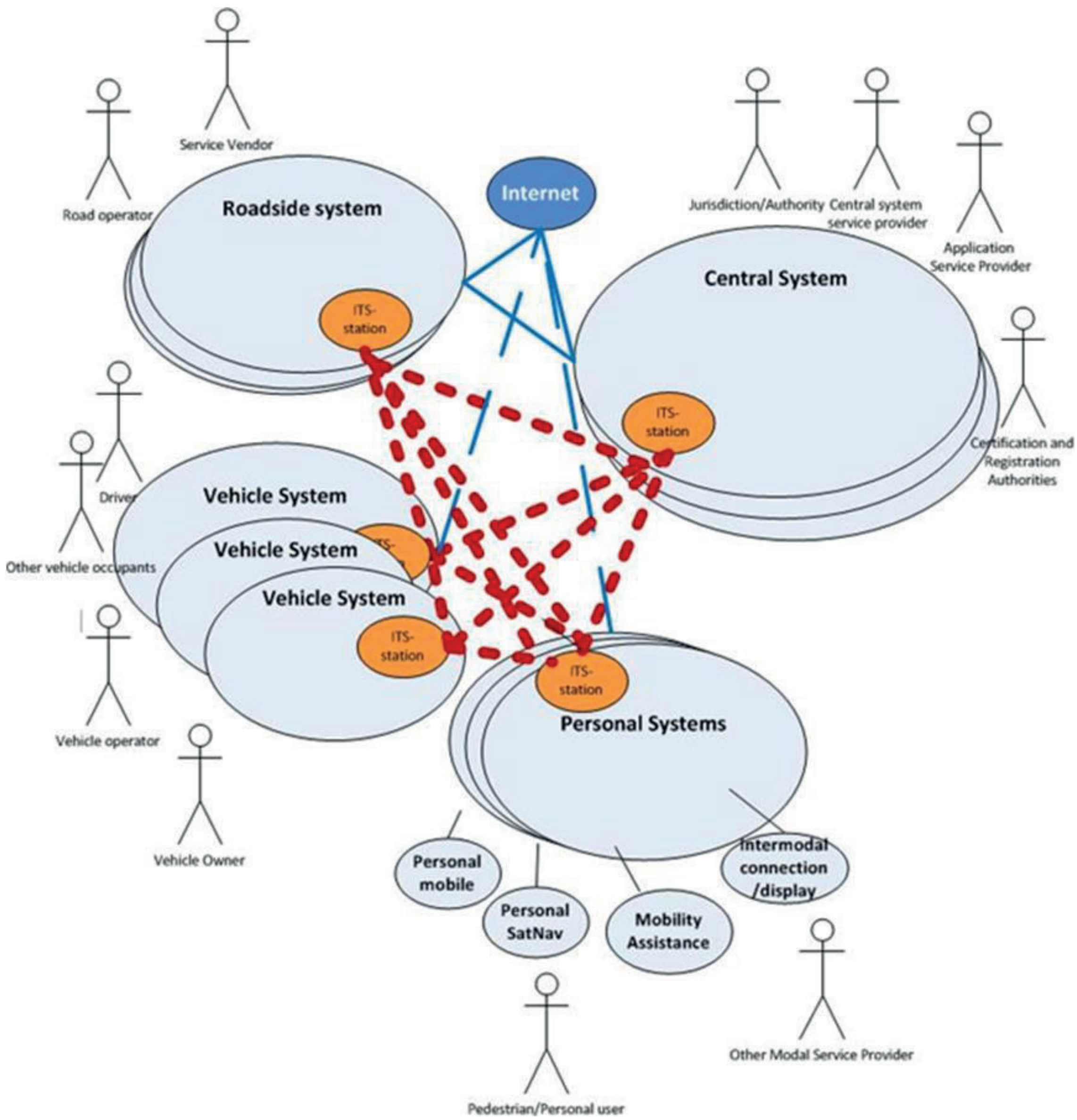

Figure 2 — Functions and actors in a C-ITS multiple instantiation service provision use case

Now both Figure 1 and Figure 2 could arguably just reflect ordinary ITS data exchanges; however, we have established above what it is that differentiates C-ITS from other ITS, is that service provision is enabled, or enhanced, by obtaining or providing relevant dynamic ITS application (2.13) service data/decision making to/from/with other *ITS-stations,* or other *ITS applications*.

We could, more pictorially visualize the C-ITS paradigm as shown in Figure 3, which is an update and enhancement of a figure used in the CVIS project, and the authors acknowledge that work in the development of this Technical Report, and the same figure is used in ISO 21217.

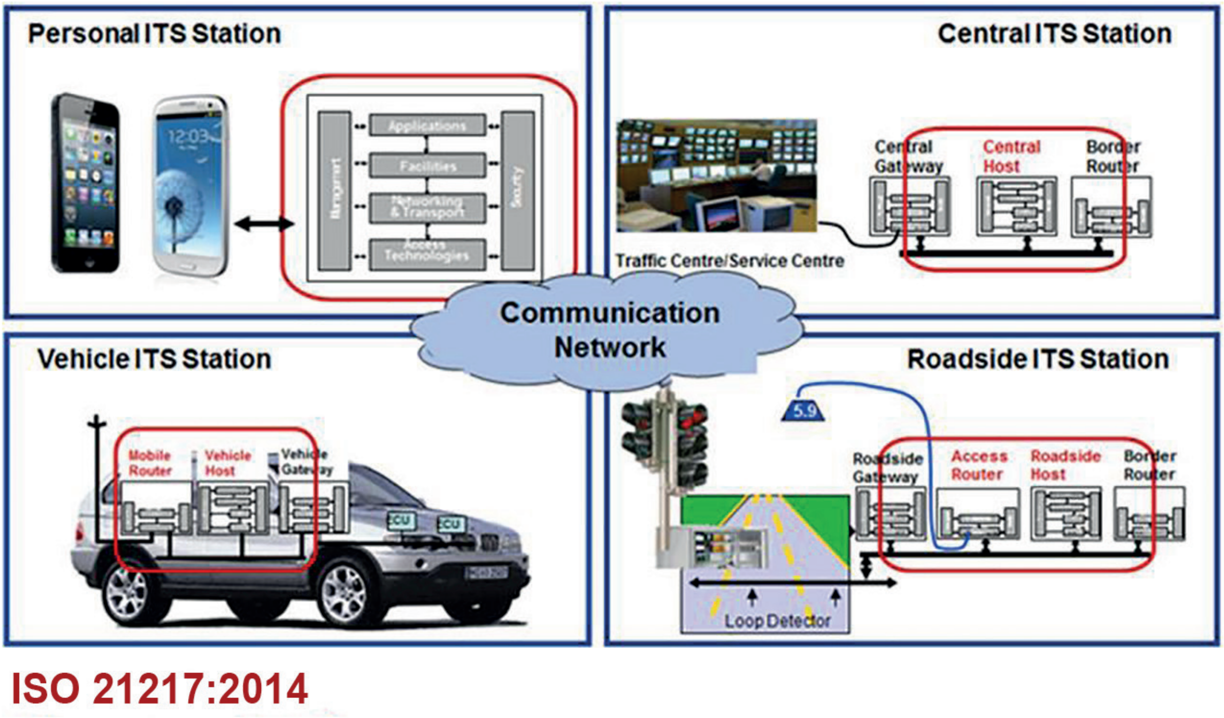

Figure 3 — High level C-ITS connectivity paradigm

In order to achieve C-ITS service provision, a combination of applications (2.1), services and systems are therefore necessary to provide safety, mobility and environmental benefits through the exchange of data between mobile and fixed transportation users. The principal system components are therefore the following:

— **Applications** — that provide functionality to realize safety, mobility and environmental benefits;

— **Equipped vehicles** — vehicles equipped with the communications and data collection and processing capacity to perform in the C-ITS context;

— **Equipped persons** — persons with mobile phones, tablets or similar communications and data collection and processing capacity to perform in the C-ITS context;

— **Communications** — that facilitate data exchange, including roadside *ITS-stations* where appropriate;

— **Core Systems** — which provide the functionality needed to enable data exchange between and among mobile and fixed transportation users;

— **Support Systems** — including security credentials certificate and registration authorities that allow devices and systems to establish trust relationships.

5 Framework overview for C-ITS enabled systems

5.1 Communications

For a high level overview of how *ITS-stations* communicate within the context of C-ITS service provision, see ISO/TR 17465-1, and in particular consider ISO/TR 17465-1, 5.3.5.

Communication requirements to enable and support C-ITS can be as simple as a one-way broadcast of basic status information that can be received and interpreted by other system users, or as complex as a number of two-way dialogues and shared Internet connection amongst an ever-changing ad hoc network of vehicles within a specific area or zone of operation.

To enable maximum flexibility for C-ITS providers and users to configure relationships between actors in the service chain, at the communications level, networks supporting C-ITS will be peer-to-peer where no particular operational, business or legal hierarchy is built-in: any entity can communicate with any other entity, and a vehicle can at one moment be a service provider for a data centre, and the next moment be the client for a traffic information service. Since all system entities are equal in respect of communications, the same platform can be used for all types of *ITS-station*. (However, at the application (2.1) level, a Jurisdiction may require certain behaviour or communication). An ideal ITS application service, particularly in the C-ITS context, needs a communication sub system that

— is available wherever and whenever a vehicle is present in a traffic situation,

— can communicate vehicle-vehicle and vehicle-roadside in a transparent way,

— relieves the applications (2.1) from the need to know about communications setup and management, and

— uses modern Internet techniques and standards for global usability (IPv6); provides a range of different possibilities related to data speeds, communication distance, cost, and many other parameters.

In the ITS-station communications environment, communications between ITS-stations are peer-to-peer relationships. In the context of the communications protocols, the functionality that an ITS-station is performing (vehicle, personal, roadside, core system) is not directly relevant.

However, in terms of security, all systems are not equal. Some ITS systems can utilize security from the communications network over which their wireless communication is made, which provides adequate security for the provision of their service, and others can control their data so it is only provided to a legitimate source, indeed some data may not be sensitive to misuse. But most data in the C-ITS context has some sensitivity, and therefore will have to be effected within layers of security, and some C-ITS communications will have to be effected within the high levels of security that ISO 21217 calls a "Bounded Secure Management Domain" (2.4) (see ISO 21217).

While the functionality of an ITS-station is communications medium agnostic (i.e. it provides both direct and networked connectivity using the most appropriate medium available in a given situation), it will have to support one or more appropriate communications media. Some are specific to ITS, some are public networks suitable for supporting some or all types of C-ITS application services. C-ITS as implemented through the ITS-station architecture, separates applications from underlying communications technologies using the Communications Access for Land Mobiles (CALM) concept. CALM comprises a number of standards for vehicle communication management.

See ISO 21217, ISO 21210, ISO 29281-1, ISO 29281-2, ISO 21212, ISO 21213, ISO 21214,ISO 21215, ISO 21216, ISO 21218, ISO 24102, ISO 24103, ISO 25111, ISO 25112, ISO 25113, ISO 29282, ISO 29283, and ISO 17515.

Other communications standards will be developed according to need.

The standard networking protocol for most C-ITS systems will be IPv6 (Internet protocol version 6), although provision for rapid safety critical communications are provided in ISO 29281-1 and ISO 29281-2.

5.2 Vehicle systems

5.2.1 General

For a vehicle to be able to support C-ITS functionality, it requires more than just an ITS-station. It requires a processing capability (which may or may not be a separate physical device) to support the following:

— platform core functions;

— middleware;

— applications facilities;

— applications;

— native/realtime *application* support.

The “In-Vehicle System” (IVS) (2.11) has to be able to prove that it is able to perform the program of operations required in order to fulfil regulated service provision. This normally implies the combination of the following:

— a processor;

— volatile memory (RAM/DRAM/SRAM etc.);

— recognized operating system (e.g. LINUX®).

Functionality tests for such systems are widely available and easily devised.

Testing of the central processing unit should be completely independent of any envisaged *application service*.

5.2.1.1 Platform core functions

Comprise the physical (ITS-station communications medium, or media), network and transport layers used by the vehicle system and core functionality of the In-vehicle system (IVS) (for example, a Java virtual machine).

5.2.1.2 ITS-station

Comprises communications and processing facilities for one or more media, compliant with ISO 21217.

5.2.1.3 ITS mobile router

Comprises an ITS-s border router (2.14) with additional functionality that allows a change of point of attachment to an external network while maintaining session continuity, containing the appropriate communications implementation and IPv6, NEMO (IETF network mobility support protocol) and non IP networking support.

5.2.1.4 Middleware

Provides the runtime environment for *applications* which can be added or removed in controlled circumstances.

5.2.1.5 Applications facilities

Comprises *application programming interfaces* (API) to features of the platform.

5.2.1.6 Applications

Comprises *applications* running within the *IVS* .

5.2.1.7 Native/realtime application support

Comprises specific *application* support software and provisioning for *applications* that are tied to native hardware (for example, ‘tolling’ and other payment systems).

5.2.2 Vehicle gateway

The vehicle gateway provides

— translation between vehicle-proprietary format and open ‘standard’ format,

— firewall to protect both sides from unauthorised data access, and

— access to the CAN bus (2.7) and other OEM sensor data,

via an ITS-s node in the *IVS* used to interconnect two different OSI protocol stacks at layers 5 through to 7.

5.2.3 In-vehicle control

This provides the means of physical access to data and to any 'control' features that are driven by C-ITS inputs and associated on board 'apps'.

5.2.4 Sensors and data collectors

Comprises sensing equipment (additional to that within the CAN bus) on board and its connection and integration into C-ITS service provision.

5.2.5 Data storage and access

The *IVS* has a means of non-volatile data storage that can retain the stored information even when not powered (such as hard disc, flash memory, etc.).

The *IVS* has a means to receive inputs both from auxiliary equipment and from its communications capability (in order to receive and process instructions from the service provider).

The *IVS* may have multiple interfaces to connect with auxiliary equipment using standard physical interfaces, and in the case of OEM installation, access to the *CAN* bus.

The *IVS* supports a 'facilities' layer [called Regime for Open Application Management (ROAM) in the ISO 15638 series for *applications* for commercial vehicles, and 'FOAM' in Project CVIS]. The facilities layer is now Standardised in ISO 21217 which provides the framework and operational environment for developing and deploying platforms for C-*ITS applications*.

This 'facilities' layer (see ISO 21217) provides an open end-to-end *application* framework, connecting in-vehicle systems, roadside infrastructure and back-end infrastructure for C-ITS.

The "facilities" layer also provides an open execution environment in which C-*ITS applications* can be developed, delivered, implemented and maintained during the life cycle of both service *applications* and equipment. Drivers and vehicle operators will be able to rely on their integrated *IVS* to allow C-ITS service provision.

NOTE Within the C-ITS environment, *applications* are deployed by *application service* providers to 'Host Management Centres' (HMC). The *HMC* provides a service gateway that supervises the secure provision of software and services for C-ITS service provision. *HMC*s manage the provisioning of *applications* to any authorized and subscribed user via its client system. After it is properly provisioned and installed on the client system, it can enact the *application*. Mechanisms for flexible software deployment and management are provided, and the overall framework and architecture is therefore already well proven in use in other domains, such as mobile telephony.

In order to have the required data available to support C-ITS assisted service provision, it is necessary that the data is available in what ISO 15638 refers to as a 'data pantry' (though other names are used elsewhere). Data provisioning is not generated by a single application, but by a number of small task specific 'Facilities apps', which are generally small JAVA® 'applets', organized as software bundles, that generally busy themselves keeping the data pantry provisioned with up-to-date data. This data provisioning is envisaged to be carried out by the facilities apps, each of which will service the updating of individual data elements in the 'basic vehicle data' such as that to maintain what ISO 15638 refers to as 'the local data tree', or in other scenarios to update a 'local dynamic map', or similar.

A key feature of this 'layering' is the principal that a particular layer can only communicate with the adjacent layer immediately above or below it or to its side. The communication infrastructure is therefore hidden from the application by the middleware, and the 'apps' are separated from the resultant data.

It is crucial also that the data pantry contains just end data. The data pantry is accessible to an app, so long as it has authorization, but the software app that generated the data is not available to the app online.

5.3 Roadside systems

5.3.1 Roadside host

These are the physical (ITS-station communications medium or media) network and transport layers used by the roadside system and core functionality of the roadside system, together with any local processing capability, and wired links *to core systems*.

5.3.2 Roadside gateway

The roadside gateway provides an ITS-s node in a roadside system used to interconnect two different OSI protocol stacks at layers 5 through to 7, including a firewall to protect both sides from unauthorised data access.

5.3.3 Access router

The access router has C-ITS specific functions like service announcement and cooperative awareness message (CAM) broadcast. It manages some aspects of (local/micro) mobility.

The access router provides access to ITS-stations within its communications zone, and containing the appropriate communications implementation and IPv6, NEMO (IETF network mobility support protocol) and non IP networking support.

5.3.4 ITS border router

ITS-s router with additional functionality that provides connectivity to other ITS communication nodes over external networks. It provides IP management and security (see IETF 4301).

5.4 'Core' systems

5.4.1 Core system overview

NOTE Much of the Core System conceptual context description has been obtained from various documents generated and publicised by US DoT RITA, and that source is acknowledged and thanks expressed for the contribution.

For a detailed description of operations and procedures for 'core systems', see ISO 14827-3.

Core systems for C-ITS envision the combination of the *applications*, services and systems necessary to provide the safety, mobility and environmental benefits through the exchange of data between mobile and fixed transportation users. They consist of the following:

— applications that provide functionality to realize safety, mobility and environmental benefits;

— communications that facilitate data exchange;

— Core Systems, which provide the functionality needed to enable data exchange between and among mobile and fixed transportation users;

— Support Systems, including security credentials certificate and registration authorities that allow devices and systems to establish trust relationships.

4.1 describes the different modes of C-ITS. While some of those modes are autonomous, many require, or will be improved by, the presence of a central core system.

The main mission of the *core system* is to enable safety, mobility and environmental communications-based applications for both mobile and non-mobile users. The scope of the *core system* includes those enabling technologies and services that will provide the foundation for *application* transactions. The *core system* works in conjunction with external support systems like the 'Certificate Authorities' security of wireless communications e.g. as defined in IEEE Standard 1609.2 with respect to 5,9 GHz systems. The system boundary for the *core system* is not defined in terms of devices or agencies or vendors, but by the open, standardized interface specifications that govern the behaviour of all interactions between *core system* users.

It is important to understand also that a *core system* is not a fixed entity, neither in the way it is instantiated, nor in the number and scope of the C-ITS services that it supports. It will be instantiated in different ways by different jurisdictions/operators, and, most importantly, it will evolve over time.

One does not define a television service by the title or content of particular programmes. To use a closer analogy; in system architecture we often use the term 'actor' to describe the participants in the system. If we borrow the analogy from our thespian friends, a good film or television series is characterized not by the plot of any one episode, but by the relationships and behaviour of and between the principal actors. We do not define our 'smartphone' by the particular *'apps'* that it supports on the day we purchased it, but by its ability to load and support *'apps'*. So it is with C-ITS, and, particularly, the capability and behaviour of its 'Core Systems'.

A deployment version of a C-ITS 'Core System' will need to define its supported application services (2.3) further with a Concept of Operations (ConOps), architecture and context diagrams that itemise and characterize the outputs that are produced. Activity diagrams, and recognized and standardised elaboration, are recommended to support and characterize the use cases and describe the interactions between system users, 'Core System' personnel and 'Core System' subsystems.

A critical factor driving the conceptual view of the entire Cooperative Vehicle and Highway Systems environment is the level of trustworthiness between communicating parties. While the core system is being planned for anonymity, it is also providing a foundation from which to leverage alternative communications methods for non-safety applications. These alternatives are typically available on the market today and the levels of anonymity and privacy inherent to these systems are typically governed by agreements between communication providers and consumers. So while privacy is not compromised for an individual, what happens between that individual and their communication provider (e.g. 3G service provider) very well may compromise privacy. Some *application* providers may require personal information in order to function, which would require the user of the application to opt-in to use that application.

Within C-ITS assisted service provision, the core system concept distinguishes communications mechanisms from data exchange and from the services needed to facilitate the data exchange. The core system supports C-ITS assisted service provision by being responsible for providing the services needed to facilitate the data exchanges. The contents of the data exchange are determined by applications unless the data exchange is used as part of the facilitation process between the user and the core system.

The core system provides the functionality required to support safety, mobility, and environmental applications. This same functionality may also enable commercial applications but that is not a driving factor for the development of the core system. The primary function of the core system is the facilitation of communications between system users and some of the communications may also be secure (bounded secure managed domain (2.4)). The core system may also provide data distribution and network support services depending on the needs of the core system deployment.

For additional information on the *core system*, please refer to ISO/TR 17427-3.

5.4.2 Single core systems

Within some jurisdictions, it is envisaged that a single administration operated core system can cover the whole jurisdiction in respect of ITS service provision, and there may be significant simplification and efficiency benefits in this route where it is practicable.

5.4.3 Multiple core systems

In some jurisdictions, it is expected that State Administrations, rather than a single National Administration, will separately operate 'core systems' (or in the case of the EU, Member states within the Union). In some cases, commercial competition between core system providers may also be allowed. In both of these cases, there is an added layer of complexity because it is essential that core systems interact and interoperate, and there is consistency in the operation of different core systems.

5.4.4 Other "Central" systems

Jurisdictions may also allow privately operated 'central' systems (for example, Sat/Nav systems with live traffic status based calculations, fee collection systems, such as road tolling, etc.), and again, there is the need for interaction and interoperability between these centrally managed systems and their clients, and there may well be the need for interoperability and communication between these 'central' systems and 'core' systems.

5.4.5 Core system functions

The core system's main mission is to enable safety, mobility and environmental communications-based applications for both mobile and non-mobile users. The scope of the core system includes those enabling technologies and services that will in turn provide the foundation for applications. The core system works in conjunction with external support systems for certification across wireless media, such as the 'Certificate Authority' for 5,9 GHz security, as defined in IEEE Standard 1609.2 (and ETSI 102 94x series of standards deliverables). The system boundary for the core system is not defined in terms of devices or agencies or vendors, but by the open, standardized, interface specifications that govern the behaviour of all interactions between core system users.

The core system supports a distributed, diverse set of applications. These applications use both wireless and wireline communications to provide the following:

- wireless communications with and between mobile elements including vehicles (of all types), pedestrians, cyclists, and other transportation users;
- wireless communications between mobile elements and field infrastructure;
- wireless and wireline communications between mobile elements, field infrastructure, and back office/centres.

A complicating factor is the need to maintain the privacy of participants, but not necessarily exclusively through anonymous communication. Core systems will normally plan anonymity into the trusted exchange of data, using the existing privacy principles as guidelines, and balancing privacy against security and safety.

While the core system is largely planned for anonymity, it is also providing a foundation from which to leverage alternative communications methods for other applications. These alternatives are typically available on the market today and the levels of anonymity and privacy inherent to these systems are typically governed by agreements between communication providers and consumers.

5.4.6 Control/Service centre

5.4.6.1 Central host management

The facility that manages communications with all supported wireless media and wireline connections, and provides processing and management.

5.4.6.2 Core system gateway

The core system gateway provides one or more ITS-s node(s) in a central "core" system used to interconnect two different OSI protocol stacks at layers 5 through to 7, including a firewall to protect both sides from unauthorised data access, connecting with ITS-stations (vehicles and personal) and roadside systems, and/or with ITS-stations via roadside systems. Roadside-Core system communications may be by ITS-stations but are more likely to be by wireline connection.

5.4.6.3 ITS border router

See 6.3.4.

5.4.7 Home agent

A network function which works as a forwarding office (C/O), so that an IPv6 (or v4) message can reach a mobile recipient anywhere in the world, defined by IETF as ‘A router on a mobile node’s home network which tunnels datagrams for delivery to the mobile node when it is away from home, and maintains current location information for the mobile node’ (IETF RFC 3344).

5.4.8 Authority/Jurisdiction databases

Jurisdictions and their authorities (in-house or appointed) may maintain databases for a number of reasons. These may be associated with registration and regulation of vehicles, local regulations and controls policing, fee and payment collection systems, etc.

Authorities/jurisdictions will also operate or approve the operation of certificate and registration authorities, manage security credentials that allow devices and systems to establish trust relationships.

All databases have, of course, to respect the local regulations in respect of privacy.

5.5 Personal Systems

‘Personal’ systems are ITS-stations linked to an individual, rather than a vehicle, typically an ‘app’ on a mobile phone, or a personal sat/nav system with C-ITS interactivity/capability.

5.5.1 Personal mobile

Typically, a 3G or LTE/4G phone, mobile wireless broadband, or WiFi connectivity with an ‘app’ that provides ITS-station functionality and one or more ITS ‘apps’ that benefit from C-ITS connectivity/data.

In terms of communications behaviour, these operate in the same way as any other ISO 21217 compliant ITS-station, or connect to the Internet via WiFi or cellular wireless network, or update via SMS/GPRS, etc.

5.5.2 Personal SatNav

Mobile ‘sat/nav’ device, or ‘app’ on a smartphone that provides ‘SatNav’ application services with the benefit of C-ITS data (for example, to calculate arrival times based on real time congestion, or to plot routes to avoid congestion), and the capability to provide data to such applications via a core system.

In terms of communications behaviour, these also operate in the same way as any other ISO 21217 compliant ITS-station, or connect to the Internet via WiFi or cellular wireless network, or update via SMS.

5.5.3 Mobility assistance

ITS applications to assist vulnerable road users (for example, sight impairment, hearing impairment, physical mobility impairment) may be assisted by specially designed apps that enable the user to better cope with their disability, and/or provide a safer travelling environment for the user especially by raising awareness of other road users. More advanced ‘apps’ may provide prioritization at road crossings and other assistances, or provide collision avoidance capabilities, etc.

Such ‘apps’ are most likely to be found as smartphone ‘apps’ or specific equipment with ‘smartphone’ capabilities. However, devices tailored to meet the special need, such as glasses, wheelchairs, etc., may be equipped with ITS-station capabilities.

In terms of communications behaviour, it will operate in the same way as any other ISO 21217 compliant ITS-stations.

5.5.4 Intermodal connection/display

NOTE These services are included in this grouping because they are largely tailored to ‘personal’ rather than ‘vehicular’ application services (such as information updates for multimodal journey, or connection guidance, etc. and more advanced multi-modal services such as dynamic reservations, ticketing, etc.), that can benefit from C-ITS connectivity.

In communications terms, intermodal connection/display systems are likely to largely be Internet based or wireline connections to an application service provider, then ITS-station or wireless Internet provision between the application service provider and personal end user of the application service. In other circumstances, they may simply be broadcast data interpreted by an ‘app’ on-board the device containing an ITS-station, usually, but not necessarily, a personal communication device such as a smartphone, or mobility assistance device.

In terms of communications behaviour, it will operate in the same way as any other wireline device or Internet application or ISO 21217 compliant ITS-station.

6 Summary of Framework overview

6.1 General

While C-ITS may be implemented in a casually collaborative manner between connected vehicles, in order to make the most of multi-modal transformational applications, the development and deployment of a fully connected transportation system requires a robust, underlying technological platform providing a ‘core’ backbone system.

Any such platform needs to be a combination of well-defined technologies, interfaces, and processes that, combined, ensure safe, stable, interoperable, reliable system operations that minimize risk and maximize opportunities.

It will require focus in the following areas:

— Cooperative Vehicle and Highway Systems Technology;

— Cooperative Vehicle and Highway Systems Applications;

— Cooperative Vehicle and Highway Systems Technology Policy and Institutional Issues;

— Cooperative Vehicle and Highway Systems Technology.

A successful platform will need to be developed through a process of thorough and considered research and will meet a set of rigorous criteria.

— The platform will need to allow for growth, expandability, and incorporation of newly evolving technologies;

— in knowing the architectural configuration and definition of interfaces, creative private-sector firms will be able to develop new applications that are not yet envisioned but remain for future imagination;

— the platform will be developed based on the complexity and range of human behaviours that will interact with and impact upon the system.

The following represent some, but not all, of the critical research efforts over the next five years that will address the underlying technological platform:

— Harmonization of International Standards and Architecture around the Vehicle Platform;

— Human Factors Research;

— Systems Engineering;

— Cooperative Vehicle and Highway Systems Certification;

— Cooperative Vehicle and Highway Systems Test Bed;

— Cooperative Vehicle and Highway Systems Applications.

6.2 Cooperative Vehicle and Highway Systems safety applications

Cooperative Vehicle and Highway Systems safety applications are designed to increase situational awareness and reduce or eliminate crashes through vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) data transmission that supports driver advisories, driver warnings, and vehicle and/or infrastructure controls. According to US DoT (RITA), these technologies may potentially address more than 80 % of crash scenarios with unimpaired drivers, preventing tens of thousands of automobile crashes every year (Source US DoT RITA).

6.3 Vehicle to infrastructure Communications for Safety

Vehicle to infrastructure communications for safety Cooperative Vehicle and Highway Systems mobility applications provide a connected, data-rich travel environment. The network captures real-time data from equipment located on-board vehicles (automobiles, trucks, and buses) and within the infrastructure. The data are transmitted wirelessly and are used by transportation managers in a wide range of dynamic, multi-modal applications to manage the transportation system for optimum performance.

6.4 Real-Time Data Capture and Management

6.4.1 Dynamic Mobility Applications

Cooperative Vehicle and Highway Systems environmental applications both generate and capture environmentally relevant real-time transportation data and use this data to create actionable information to support and facilitate ‘green’ transport choices. They also assist system users and operators with ‘green’ transport alternatives or options, thus reducing the environmental impacts of each trip. For instance, informed travellers may decide to avoid congested routes, take alternate routes, public transit, or reschedule their trip, all of which can make their trip more fuel-efficient and eco-friendly. Data generated from Cooperative Vehicle and Highway Systems can also provide operators with detailed, real-time information on vehicle location, speed, and other operating conditions. This information can be used to improve system operation. On-board equipment may also advise vehicle owners on how to optimize the vehicle’s operation and maintenance for maximum fuel efficiency.

6.5 Cooperative Vehicle and Highway Systems Technology Policy and Institutional Issues

The implementing jurisdiction will need to work actively to engage a wide range of stakeholders to help guide the policy research program so that it is based on sound, real-world application of new technologies that give vehicles the capability to communicate with one another and with devices located on the surrounding infrastructure for the purpose of improving transportation outcomes in the areas of safety, mobility, and impact on the environment. Research into Cooperative Vehicle and Highway Systems technologies needs to be multimodal.

6.6 Cooperative Vehicle and Highway Systems Policy and Institutional Issues

Coordinated research can support and accelerate the deployment and adoption of Cooperative Vehicle and Highway Systems (also termed connected vehicle) systems and help to preclude the development and adoption of redundant standards and systems. Cooperative systems enabling vehicle-to-vehicle and vehicle-to-infrastructure communications have the potential to contribute to a safer, more energy-efficient and environmentally friendly transportation system.

Any Cooperative Vehicle and Highway Systems Policy program needs to research and analyse policy issues and institutional issues considered critical because these issues may limit or challenge successful deployment. Structured recommendations for policy and decision makers are needed in order to provide clear guidance.

If it is to be effective, the vision for a Cooperative Vehicle and Highway Systems Policy program needs to be one of a collaborative effort among the jurisdiction, key industry stakeholders, vehicle manufacturers, state and local governments, representative associations, citizens, and others. Collectively, this group will structure and conduct a research agenda that weighs the benefits and risks and results in strong institutional foundation for the successful deployment of cooperative vehicle and highway systems technologies and applications.

Policy issues fall into two categories: (a) those that are global and cross-cutting, and will be researched through the Policy program and (b) those that are specific to a program's technical roadmap, and thus require research and resolution in tandem with the technical research staff and partners to ensure continued progress.

Policy and Institutional Issues are likely to work best if they are designed to do the following:

a) identify the specific trade-offs that occur along the path of research and development, prototyping, testing, and model deployments;

b) facilitate discussion among stakeholders and decision makers to enable continued progress in the technical research.

One such example is the potential trade-off between privacy and system security. For the technical team to move forward in designing a working prototype for testing, such 'technical policy issues' require analysis.

The end result of the policy research and analysis is better clarity on policy options and their implications.

Annex A
(informative)

ISO 14813-1 ITS Service domains and services

This Annex identifies those services whose provision is likely to be enabled or enhanced by C-ITS (in red), and those which can only probably operate within a C-ITS environment (as currently envisaged) (underlined).

NOTE Variants of these services may also be provided in a non-C-ITS paradigm.

Table A.1 shows the structure of each of the 13 service domains identified in ISO 14813-1. Within each domain are a number of groups, each of which can have one or more constituent services. This list represents the services identified as *ITS services* by ISO TC204 participants. It is comprehensive, but not definitive, in that new *ITS services* will be identified/evolve over time, some will be phased out or become redundant, and there will be services that can be classified as ITS that have not been embraced by ISO TC204.

Table A.1 — Structure of the 13 service domains identified in ISO 14813-1

Service Domain	Service Group	Service	Relevance to Cooperative-ITS
Traveller Information	Real-time transport Status Information	Traffic and roadway information	*Adds Value*
		Public transport information	*Adds Value*
		Intermodal facility information	*Adds Value*
		Airport information	*Adds Value*
		Parking information–external to facilities	*Adds Value*
	Real-time in-vehicle display	In-vehicle signing–guidance and regulatory	*Essential*
		In-vehicle signing–parking information	*Essential*
		In-vehicle signing–speed and lane control	*Essential*
		In-vehicle signing–advance warning and advisory	*Essential*
		Specific public transport vehicle related information	*Essential*
	Real-time route guidance and information	Dynamic in-vehicle route guidance using real-time information	*Essential*
		Dynamic personal route guidance using real-time information	*Essential*
		Public Transport-specific trip guidance	*Essential*
	Multi-modal trip planning	Multi-modal comparative trip guidance	*Essential*
		Centralized trip planning using real-time and policy inputs	*Essential*
	Travel services information	Travel services information – destination	*Essential*
		Travel services information – current location	*Essential*
Traffic Management and Operations	Traffic management and control	Traffic monitoring	*Adds Value*
		Surface street control (signals)	*Adds Value*
		Freeway traffic control – ramp control	*Adds Value*
		Freeway traffic control – mainline speed and lane management	*Adds Value*
		Preferential treatment for specific vehicle types (signal priority and pre-emption)	*Essential*
		Reversible lane management	*Adds Value*

Table A.1 — *(continued)*

Service Domain	Service Group	Service	Relevance to Cooperative-ITS
		Coordination of surface street and freeway control	*Adds Value*
		Intermodal highway junction management	*Adds Value*
		Parking management	*Adds Value*
		Work zone traffic management	*Adds Value*
		Traffic advisory and warning information	*Adds Value*
		Incident monitoring and confirmation	*Adds Value*
	Transport-related incident management	Incident on-site driver assistance	*Adds Value*
		Incident on-site traveller assistance	*Adds Value*
		Incident co-ordination and clearance	*Adds Value*
		Hazardous materials monitoring and management	*Essential*
		Collection of incident details from other transport mode	*Adds Value*
	Demand management	Variable road pricing – dedicated lane	*Adds Value*
		Variable road pricing – entire facility	*Adds Value*
		Cordon and zone-based congestion pricing	*Adds Value*
		Access management	*Adds Value*
		High-occupancy lane management	*Adds Value*
		Air quality-based transport management	*Adds Value*
	Road transport infrastructure maintenance management	Roadway construction and maintenance management	*Adds Value*
		Winter maintenance	*Adds Value*
		Pavement management	*Adds Value*
		Automated road management	*Adds Value*
		Work zone safety management	*Adds Value*
	Policing/enforcing traffic regulations	Access control	*Adds Value*
		High-occupancy vehicle facility usage	*Adds Value*
		Parking regulation enforcement	*Adds Value*
		Speed limit enforcement	*Adds Value*
		Signal enforcement	*Adds Value*
Vehicle Services	Road transport related vision enhancement	In-vehicle driver vision management	*Essential*
		External driver vision management	*Adds Value*
		Pedestrian and cyclist vision management	*Adds Value*
	Automated vehicle operation	Automated highway operation	*Essential*
		Automated low-speed manoeuvring	*Essential*
		Precision docking for public transport vehicles	*Essential*
		Automated cruise control	*Essential*
	Collision avoidance	Longitudinal collision avoidance	*Essential*
		Lateral collision avoidance	*Essential*
		Intersection collision avoidance	*Essential*
	Safety readiness	Vehicle internal systems monitoring	*Essential*
		Vehicle external conditions monitoring	*Essential*

Table A.1 — *(continued)*

Service Domain	Service Group	Service	Relevance to Cooperative-ITS
Freight transport	Pre-crash restraint deployment	Pre-crash restraint deployment	*Essential*
	Commercial vehicle pre-clearance	Weigh-in-motion	*Adds Value*
		Non-stop pre-clearance	*Adds Value*
		Vehicle safety records monitoring	*Adds Value*
	Commercial vehicle administrative processes	Freight movement information exchange	*Adds Value*
		Automatically identify, monitor and exchange emergency response information for dangerous goods	*Essential*
		Automated credential filing	*Adds Value*
		Automated commercial vehicle administration	*Adds Value*
		Automated border crossings	*Adds Value*
	Automated roadside safety inspection	Remote access to commercial vehicle safety data	*Adds Value*
		Remote access to commercial vehicle driver data	*Adds Value*
	Commercial vehicle on-board safety monitoring	Commercial vehicle internal systems monitoring	*Essential*
		Commercial vehicle driver alertness monitoring	*Essential*
		Commercial vehicle cargo state monitoring	*Essential*
	Intercity freight transport fleet management	Intercity commercial vehicle fleet tracking	*Adds Value*
		Intercity commercial vehicle fleet dispatching	*Adds Value*
	Intermodal information management	Vehicle and container arrival information exchange	*Adds Value*
		Customer freight information access	*Adds Value*
		Freight container tracking	*Adds Value*
	Management and control of intermodal centres	Intermodal centre facility management	*Adds Value*
		Intermodal vehicle and container control	*Essential*
	Management of dangerous freight	Dangerous goods movement data collection and sharing	*Adds Value*
		Dangerous goods movement data registry	*Adds Value*
		Dangerous goods movement fleet coordination	*Essential*
		Dangerous goods movement police/safety coordination	*Essential*
		Dangerous goods movement location monitoring	*Essential*
	Management of heavy goods vehicles	Heavy goods vehicle data collection and sharing	*Adds Value*
		Heavy goods vehicle registration processing	*Adds Value*
		Heavy goods vehicle location monitoring	*Essential*
	Management of local delivery vehicles	Delivery vehicle fleet tracking	*Adds Value*
		Delivery vehicle fleet dispatching	*Adds Value*
		Delivery zone and parking information services	*Essential*
	Telematics applications for regulated vehicles (TARV)	Procedures and enforcement provisions for the providers of regulated services	*Adds Value*
		Provision of system security	*Adds Value*
		Provision of vehicle information	*Adds Value*
		Provision of vehicle access management	*Adds Value*
		Provision of remote tachograph monitoring	*Adds Value*

Table A.1 — *(continued)*

Service Domain	Service Group	Service	Relevance to Cooperative-ITS
		Provision of Emergency messaging system/eCall	*Adds Value*
		Provision of driver work records	*Adds Value*
		Provision of vehicle 'mass' monitoring	*Adds Value*
		Provision of vehicle location, speed and consignment data	*Adds Value*
		Provision of vehicle parking facilities	*Adds Value*
	Freight transport content identification and communication	Collection of freight transport identification data	*Adds Value*
		Communication of freight transport identification data	*Adds Value*
Public Transport	Public transport management	Public transport operational management	*Adds Value*
		Public transport fleet management	*Adds Value*
		Public transport vehicle equipment monitoring	*Adds Value*
		Public transport service monitoring and scheduling	*Adds Value*
		Public transport operational strategies	*Adds Value*
		Public transport wayside status display	*Essential*
	Demand responsive and shared transport	On-demand public transport fleet management	*Essential*
		On-demand ridesharing management	*Essential*
		On-demand freight transport	*Essential*
Emergency Service	Transport-related emergency notification and personal security	User-initiated distress calls	*Adds Value*
		Automated emergency call and mayday (eCall) dispatch	*Adds Value*
		Automated vehicle intrusion and theft warning	*Adds Value*
	After-theft vehicle recovery	Remote vehicle immobilization	*Adds Value*
		Stolen vehicle tracking	*Adds Value*
	Emergency vehicle management	Emergency vehicle fleet tracking	*Adds Value*
		Emergency vehicle fleet management	*Adds Value*
		Emergency vehicle traffic management coordination	*Essential*
	Hazardous materials and incident notification	HAZMAT vehicle tracking and monitoring	*Essential*
		HAZMAT vehicle route management	*Essential*
		Automated HAZMAT emergency call/mayday notification	*Adds Value*
		HAZMAT pre-clearance services	*Adds Value*
Transport-related electronic payment	Transport-related electronic financial transactions	Electronic Fare Collection	*Adds Value*
		Electronic Fee Collection	*Adds Value*
		Electronic Transport Services Payment	*Adds Value*
		Demand management based on road user pricing	*Adds Value*
	Integration of transport-related electronic payment services	Interoperable Electronic Fee Collection, e.g. EETS	*Adds Value*
		Interoperable Fare Management Systems (IFMS)	*Adds Value*
		Multi-modal transport services related electronic payment systems.	*Adds Value*
Road transport related	Public travel security	Silent alarm	*Adds Value*
		Emergency call/mayday alert for public transport	*Essential*

Table A.1 — *(continued)*

Service Domain	Service Group	Service	Relevance to Cooperative-ITS
Personal safety		Intrusion detection	*Adds Value*
		Public transport surveillance	*Essential*
	Safety enhancements for vulnerable road users	Non-motorized vehicle and pedestrian monitoring	*Essential*
		Systems to monitor specialized vehicles	*Essential*
	Safety enhancements for disabled road users	Intersection monitoring of specialized conveyances	*Adds Value*
		Driver warnings for specialized conveyances	*Essential*
	Safety provisions for pedestrians using intelligent junctions and links	Signal display advance warning	*Essential*
		Oncoming vehicle advance warning (for non-signalized juntion)	*Essential*
		In-vehicle signage and warning systems	*Essential*
Weather and environmental conditions monitoring	Weather monitoring	Road weather information monitoring	*Adds Value*
		Road weather prediction	*Adds Value*
	Environmental conditions monitoring	Water level/tidal monitoring and prediction	*Adds Value*
		Seismic monitoring	*Adds Value*
		Pollution monitoring	*Adds Value*
		Avalanche, mud slide and fallen rock monitoring	*Adds Value*
Disaster response management and coordination	Disaster data management	Disaster and emergency data collection	*Adds Value*
		Disaster and emergency data sharing	*Essential*
	Disaster response management	Disaster response planning for the transport network	*Essential*
		Disaster response implementation	*Essential*
	Coordination with emergency agencies	Disaster response coordination	*Essential*
National security	Monitoring and control of suspicious vehicles	Vehicle monitoring for HAZMAT and explosives presence	*Essential*
		Identification of suspicious vehicles	*Essential*
		Disablement of vehicles believed to be suspicious	*Essential*
		Road traffic management for suspicious vehicles	*Essential*
		Emergency notification to key agencies or suspicious vehicles	*Essential*
	Utility or pipeline monitoring	Pipeline and utility HAZMAT/explosives monitoring	*Adds Value*
		Implementation of mitigation strategies	*Adds value*
		Emergency notification to key agencies	*Essential*
ITS Data Management	Data registries	Registration of ITS data concepts for reuse and interoperability	*Adds Value*
		Registration of ITS subroutines for reuse and interoperability	*Adds Value*
	Data dictionaries	Registration of the definition of terms used in ITS	*Essential*
Performance Management	Data Storage	Data archiving (formerly traveller information domain)	*Adds Value*
		Data warehousing (formerly traveller information domain)	*Adds Value*
		Emissions monitoring	*Adds Value*
	Simulation	System performance simulation (on line)	*Adds Value*

Table A.1 — *(continued)*

Service Domain	Service Group	Service	Relevance to Cooperative -ITS
		System performance simulation (offline)	*Adds Value*

Bibliography

[1] ISO 17427-1, *Intelligent transport systems — Cooperative systems — Roles and responsibilities in the context of co-operative ITS based on architecture(s) for co-operative systems*

[2] ISO 17515, *Intelligent Transport Systems — Communications access for land mobiles (CALM) — E-UTRAN (LTE)*

[3] ISO 21210, *Intelligent transport systems — Communications access for land mobiles (CALM) — IPv6 Networking*

[4] ISO 21212, *Intelligent transport systems — Communications access for land mobiles (CALM) — 2G Cellular systems*

[5] ISO 21213, *Intelligent transport systems — Communications access for land mobiles (CALM) — 3G Cellular systems*

[6] ISO 21214, *Intelligent transport systems — Communications access for land mobiles (CALM) — Infra-red systems*

[7] ISO 21215, *Intelligent transport systems — Communications access for land mobiles (CALM) — M5*

[8] ISO 21216, *Intelligent transport systems — Communication access for land mobiles (CALM) — Millimetre wave air interface*

[9] ISO 21217, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

[10] ISO 21218, *Intelligent transport systems — Communications access for land mobiles (CALM) — Access technology support*

[11] ISO 24102, *Intelligent transport systems — Communications access for land mobiles (CALM) — Management*

[12] ISO 24103, *Intelligent transport systems — Communications access for land mobiles (CALM) — Media adapted interface layer (MAIL)*

[13] ISO 25111, *Intelligent transport systems — Communications access for land mobiles (CALM) — General requirements for using public networks*

[14] ISO 25112, *Intelligent transport systems — Communications access for land mobiles (CALM) — Mobile wireless broadband using IEEE 802.16*

[15] ISO 25113, *Intelligent transport systems — Communications access for land mobiles (CALM) — Mobile wireless broadband using HC-SDMA*

[16] ISO 29281-1, *Intelligent transport systems — Communication access for land mobiles (CALM) — Non-IP networking — Part 1: Fast networking & transport layer protocol (FNTP)*

[17] ISO 29281-2, *Intelligent transport systems — Communication access for land mobiles (CALM) — Non-IP networking — Part 2: Legacy system support*

[18] ISO 29282, *Intelligent transport systems — Communications access for land mobiles (CALM) — Satellite networks*

[19] ISO 29283, *ITS CALM Mobile Wireless Broadband applications using Communications in accordance with IEEE 802.20*

[20] ISO/TS 17419, *Intelligent transport systems — Cooperative systems — Classification and management of ITS applications in a global context*

[21] ISO/TR 17427-3, *Intelligent transport systems — Cooperative ITS — Concept of operations (ConOps) for 'Core' systems*

[22] ISO/TR 17427-4, *Intelligent transport systems — Cooperative ITS — Minimum system requirements and behaviour for core systems*

[23] ISO/TR 17427-5, *Intelligent transport systems — Cooperative ITS — Common approaches to security (in preparation)*

[24] ISO/TR 17427-6, *Intelligent transport systems — Cooperative ITS — 'Core System' risk assessment methodology*

[25] ISO/TR 17427-7, *Intelligent transport systems — Cooperative ITS — Privacy aspects*

[26] ISO/TR 17427-8, *Intelligent transport systems — Cooperative ITS — Liability aspects*

[27] ISO/TR 17427-9, *Intelligent transport systems — Cooperative ITS — Compliance and enforcement aspects*

[28] ISO/TR 17427-10, *Intelligent transport systems — Cooperative ITS — Driver distraction and information display*

[29] ISO/TR 17465-1, *Intelligent transport systems — Cooperative ITS — Part 1: Terms and definitions*

[30] ISO/TR 17465-2, *Intelligent transport systems — Cooperative ITS — Part 2: Guidelines for standards documents*

[31] ISO/TR 17465-3, *Intelligent transport systems — Cooperative ITS — Part 2: Release procedures for standards documents*

[32] IETF*IPv6*

[33] IETF rfc 4301, *Security Architecture for the Internet Protocol*

[34] IETF rfc 3963, *Network Mobility (NEMO) Basic Support Protocol*

[35] CVIS CI Communications Interface http://www.cvisproject.org/

[36] Technology C.V. US DoT http://www.its.dot.gov/research/systems_engineering.htm

[37] Architecture C.V.R.I. (CVRIA) http://www.iteris.com/cvria

[38] Cooperative ITS Regulatory Policy Issues. National Transport Commission, Australia

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