ETSI TS 101 556-1 V1.1.1 (2012-07)

Technical Specification

**Intelligent Transport Systems (ITS);
Infrastructure to Vehicle Communication;
Electric Vehicle Charging Spot Notification Specification**

Reference

DTS/ITS-0010014

Keywords

application, interoperability, ITS, service

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00   Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or
perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF).
In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive
within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status.
Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Copyright Notification

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://ipr.etsi.org).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

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

Introduction

ITS cooperative communications enable the broadcasting of information about Points of Interest to ITS Stations. In the case of Electric Vehicle ITS Stations, an important interest lies in the capability to be notified of the up-to-date availability and characteristics of charging stations and spots.

The present document starts with definitions and abbreviations specific to this topic. It continues with a general description of the use case and the target application. Next clause provides some functional requirements to be fulfilled by the application, according to the acting station. The format of the notification message is then specified, followed by the application operation requirements. In (the normative) annex A, the ASN1 description of the notification message can be found, followed by the description of data elements in (the normative) Annex B. (Informative) Annex C provides guidance to select a communication profile when broadcasting this notification with the G5 access layer. It is followed by some informative annexes which provide examples of extensions of this application.

1   Scope

The present document specifies the application responsible for the broadcasting of dynamic information from a roadside ITS station, or any other appropriate node (e.g. EV charging spot) in possession of this information and compliant to the ITS specifications, to Electric Vehicle ITS Stations (EV) related to the availability and characteristics of the EV Charging Spot(s) in the vicinity and/or surrounding areas of the vehicle. The roadside ITS station can be the EV charging spot itself.

Broadcasting is defined as a communication configuration attribute which denotes a point-to-multipoint mode of transmission, i.e. unidirectional distribution to all ITS Stations connected to the network and tuned for receiving. Further interactions with the infrastructure and Central ITS Stations, like reservation or payment of a Charging Spot, are out of the scope of the present document, but will be another part of the global ITS system specifications.

2   References

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

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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

2.1   Normative references

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

[1]   ETSI TS 102 860 (V1.1.1): "Intelligent Transport Systems (ITS); Classification and management of ITS application objects".

[2]   ETSI TS 102 637-1 (V1.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 1: Functional Requirements".

[3]   ETSI TS 102 637-2 (V1.2.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".

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

[5]   ETSI ES 202 663: "Intelligent Transport Systems (ITS); European profile standard for the physical and medium access control layer of Intelligent Transport Systems operating in the 5 GHz frequency band".

[6]   ITU-T Recommendation X.691 (2002): "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)".

[7]   IEC 62196-2 Ed. 1: Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories.

2.2   Informative references

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

[i.1]   ETSI TS 102 894-2: "Intelligent Transport Systems (ITS); Users and applications requirements; Applications and facilities layer common data dictionary".

[i.2]   ETSI TS 102 890-2: "Intelligent Transport System (ITS); Facilities layer Function; Services Announcement specification".

[i.3]   EC 62196-3: "Plug, socket-outlets, vehicle connectors and vehicle inlets - Conductives charging of electric vehicles - Part 3: Dimensional interchangeability requirements for pin & contact-tube coupler, rated operating voltage & current, up to 1 000 V d c., 400 A for dedicated d.c. charging".

3   Definitions and abbreviations

3.1   Definitions

For the purposes of the present document, the terms and definitions given in [4] and the following apply:

broadcast: communication configuration attribute which denotes a point-to-multipoint mode of transmission, i.e. unidirectional distribution to all ITS Stations connected to the network and tuned for receiving

central exploitation station: central ITS Station dedicated to traffic management

   NOTE: It is connected to Roadside ITS Stations and to the management and traffic monitoring systems.

electrical vehicle charging spot: set of 1 to 4 parking places, arranged around a pole, where it is possible to recharge an electrical or hybrid vehicle

   NOTE: It can be of different types: standard, fast, ultra-fast, equipped with special connectors, etc.

electrical vehicle charging station: infrastructure which provides one or several EV Charging Spots to supply electric energy for recharging EVs

energy provider: organization that produces the energy made available in the EV Charging Station

energy utility distributor: organization that commercializes the energy and operates the EV Charging Station

3.2   Abbreviations

For the purposes of the present document, the abbreviations given in [4] and the following apply:

   CAM   Cooperative Awareness Message
   CCH   Control Channel
   CES   Central Exploitation Station
   CS   Charging Spot
   DNS   Domain Name System
   EV   Electrical Vehicle ITS Station
   EVCS   Electrical Vehicle Charging Spot
   EVCSN   EVCS Notification
   GUI   Graphical User Interface
   HMI   Human Machine Interface
   PDU   Protocol Data Unit
   POI   Point Of Interest
   RTP   Real-time Transport Protocol
   SAM   Service Announcement Message
   TCP   Transmission Control Protocol
   UDP   User Datagram Protocol
   URL   Uniform Resource Locator
   UTC   Universal Time Coordinated

4   Application Description

4.1   General Overview

The Cooperative Location Based Services described in [1] and [2] provide local services to ITS vehicle Stations' drivers and passengers. These services include the Point Of Interest notification applications. The EV Charging Spot Notification application is part of these applications.

The objective of this application is to notify the EV drivers about the existence of one or more EV charging station and spots in their vicinity. The characteristics of the charging spots can be both, static and dynamic. By using this application, the driver is enabled to choose a charging spot for re-charging his electrical vehicle. Furthermore, the driver is enabled to reserve, measure and pay for the access to one of the spots.

This notification can be performed either by the EVCS itself, by some selected Roadside ITS Station previously informed by the Central Exploitation Station (CES), a Central ITS station serving as EV Mobility Information Server, or by other appropriate ITS Stations that have possession of the needed information and are capable of broadcasting the information compliant with the ITS specifications. In the case where the EVCS is not the entity transmitting the notification, the server may update periodically the Roadside ITS Stations, or other appropriate ITS Stations, with real time information.

4.2   Application General Description

This application is split into three parts, one part residing in each of the ITS stations (as defined in [4]) mentioned below:

- The up-to-date information is gathered at a central ITS Station providing location-based services, hereunder referred as a Central Exploitation Station (CES).

- It is provided to ITS Roadside Stations or other appropriate ITS Stations which then broadcast the notification to the ITS Vehicle Stations. The notification can also be disseminated directly by the EV charging spot.

- The notification is received and processed in the ITS Vehicle Stations, which filters it according to its needs. Any further processing in the ITS Vehicle Station (e.g. after receiving the notification) is out of scope of the present document and should be addressed as a separate TC ITS TS. As an example, the local EV Charging Spot location information received may be displayed on the vehicle screen in real time operation. The processing of this information by the vehicle, including or not some action from the driver, is implementation dependant.

The main message handled by this application is a POI Notification that should be processed by the application.

The electric vehicle charging spot system being targeted by this technical specification is represented in figure 1.
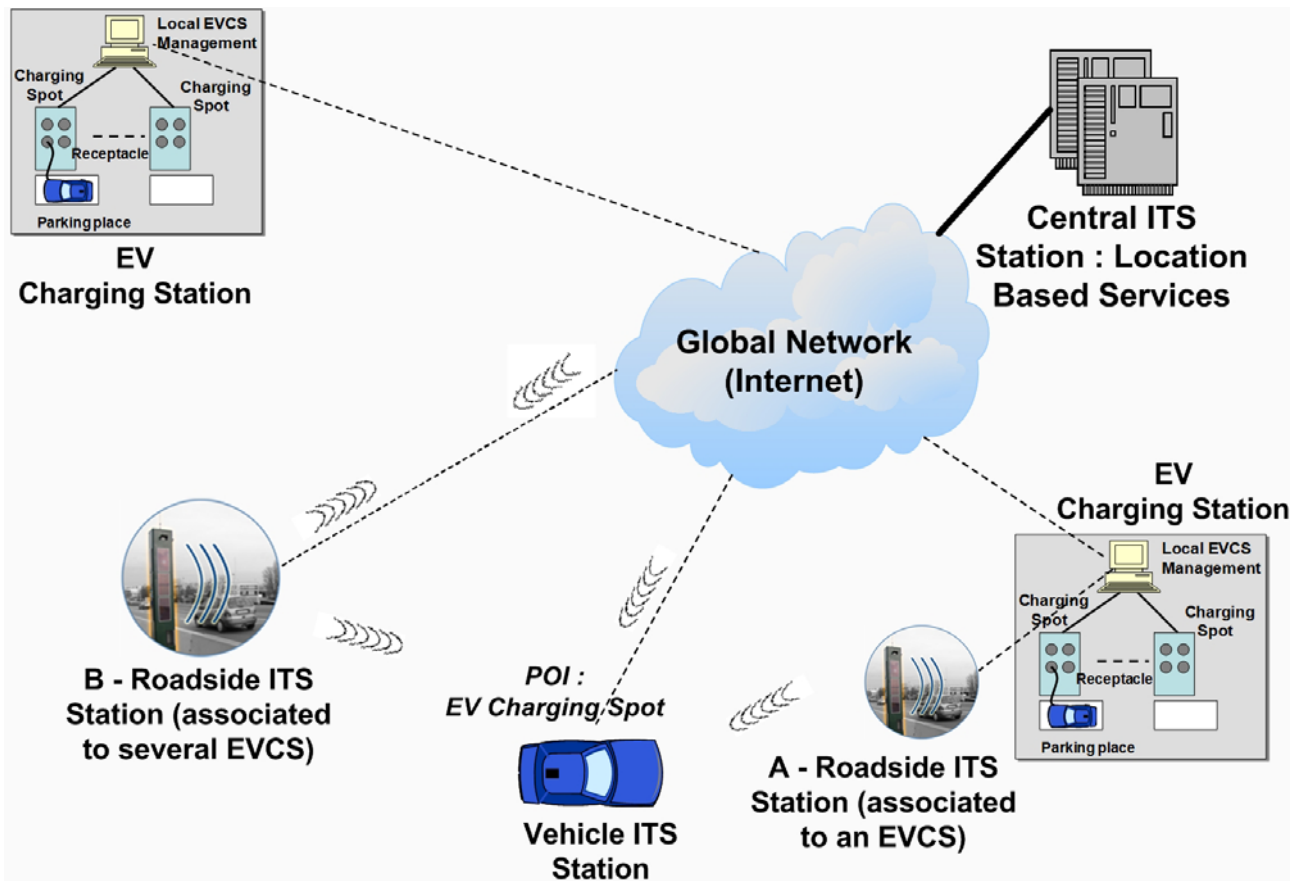
Figure 1: Use case for the dissemination of the EV Charging Spot Notification

The ITS stations involved in this application can be split in two groups:

- The transmitting ITS stations. The notification message originates either from the EV Charging Station itself, from a Central ITS Station or from another appropriate ITS Station as described in clause 4.1. In the case where a Central ITS Station gathers the information related to the EVCS, the notification is forwarded by the available Roadside ITS Stations or by other appropriate ITS stations as described in clause 4.1.

- The receiving ITS stations. The notification is received and processed by EV vehicle ITS stations. It can also be processed by any other interested ITS Station, including a Personal ITS Station. For simplification, in the rest of the present document, the receiving ITS Station will be mentioned as a Vehicle ITS Station.

4.3   Communication and possible deployment scenarios

Figure 1 shows some possible deployment scenarios. The notification may be disseminated according to one of the following cases, given as deployment examples:

Scenario A: A Roadside ITS Station is associated with one EV Charging Station which may contain a certain number of charging spots with associated parking places. These charging spots may present the same technical characteristics or may enable the charging of Electrical Vehicles having different characteristics in terms of EV outlet, voltage / current characteristics, etc.

In this scenario, the Roadside ITS Station is connected to the local EV Charging Station management center and collects in real time the dynamic information which will be broadcasted to all vehicles moving in the communication area of the ITS Roadside Station.

Scenario B: An ITS Roadside Station is positioned judiciously in a key area, e.g. at the entry of a city, and is providing dynamic information related to several EV Charging Stations located in a relevant area surrounding the ITS Roadside Station, e.g. in the city or in an area of several 10 kilometers around the ITS Roadside Station. Each EV charging station may be similar to the one described in Scenario A. In such case, the Roadside ITS Station which is not associated to a particular EV Charging Station may be remotely controlled by the means of a central energy distribution center (ITS Central Station). The central energy distribution center builds an updated list of EV Charging Stations and sends it to the Roadside ITS Station. This service is advertised and broadcasted to the ITS Vehicle Stations.

In these scenarios, the non-EV ITS stations which receive this message discard it. The EV ITS stations which receive the message transfer it to the relevant application in the vehicle for further processing. The internal details of this application are out of scope of the present document.

Other possible scenarios not shown in figure 1, and out of scope of the present document, are presented below.

- An appropriate node not associated with a specific EV Charging station but provided with all the necessary information can implement a Roadside ITS Station and disseminate the required information.

- The ITS Vehicle Station indicates in its CAM message that it is an EV. When receiving such a CAM, the ITS Roadside Station then starts broadcasting the notification periodically for a certain amount of time (e.g. 10 minutes, based on internal configuration). This scenario assumes that the CAM message contains the EV qualification of the ITS station.

- The information about EVCS POI service is advertised in the SAM message. Interested ITS Stations make a point-to-point request to the ITS Roadside Station which retrieves the Notification directly from the ITS Central Station and forwards it to the EV.
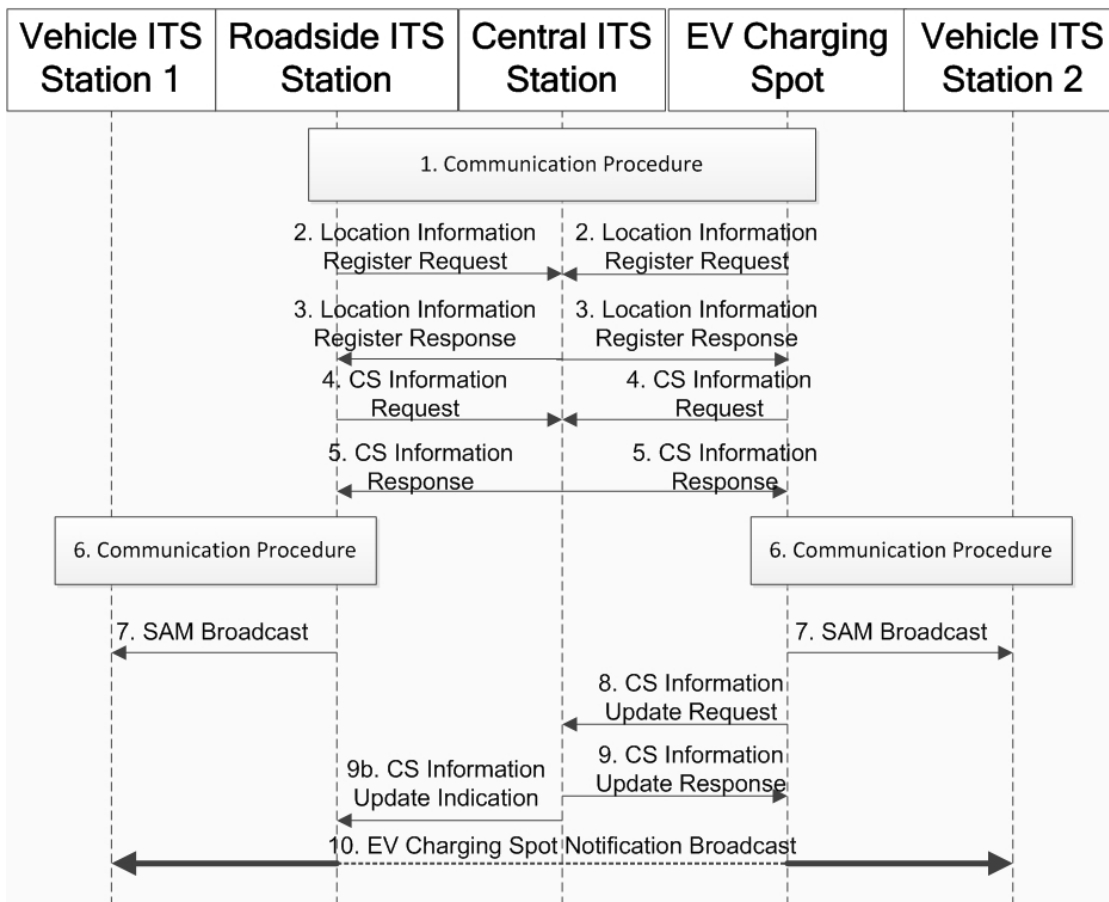
4.4   Application Flow Diagram

**Figure 2: Application flow diagram among ITS Central station,
ITS Roadside station and ITS Vehicle stations**

Figure 2 shows a possible flow diagram between the ITS Central station, the ITS Roadside station and the ITS Vehicle station. Message 10 is the only message in the scope of the present document. The detailed procedure is as follows:

1) The ITS Central Station communicates with the ITS Roadside Station or EV Charging spot via any private or public network.

2) The ITS Roadside Station or EV Charging spot already knows the local EV Charging Spot information (e.g. through Location Information Register Request message) or can acquire it from the ITS Central Station.

3) The ITS Central Station replies Location Information Register Response message to the ITS Roadside Station or EV Charging Spot.

4) The ITS Roadside Station or EV Charging spot sends Global EV Charging Spot(s) Information Request message to the ITS Central Station (optional).

5) The ITS Central Station shall reply Global EV Charging Spot(s) Information Response message to the ITS Roadside Station or EV Charging spot (optional).

6) The ITS Roadside Station or EV Charging spot communicates with the ITS Vehicle Station via a broadcast communication.

7) The ITS Roadside Station or EV Charging spot broadcast the SAM to the ITS Vehicle Stations. The ITS Vehicle Station checks the available communication profiles (static/dynamic) and selects a compatible broadcasting station in the vicinity.

8) The ITS Roadside Station or EV Charging spot may optionally trigger the request of updated data from the ITS Central Station (e.g. through Location Information Update Request message) (optional).

9) The ITS Central station may reply Location Information Update Response message to the ITS Roadside Station or EV Charging spot (optional).
The ITS Central Station may push updated data as Location Information Update Indication to the ITS Roadside Station (optional).

10) The ITS Vehicle Station receives and processes the EV Charging Spot Notification message according to its needs. Further description of the internal processing inside the ITS Vehicle Station or communication with the ITS Central Station and/or EV Charging Spot are out of scope of the present document.

NOTE: According to clause 4.1, the EV Charging Spot Notification message can be broadcasted from a Roadside ITS station, a Central ITS station, or from another appropriate ITS Station.

5   Application Functional Requirements

5.1   Application Functional Overview

In clause 4.2, figure 1 shows the reference system for Electric Vehicle (EV) Charging Spot Notification application. This system comprises three communicating entities: ITS Central Station, ITS Roadside Station or another appropriate node that can implement the functions performed by the ITS Roadside station, and ITS Vehicle Station. In this system, we assume that the ITS Roadside Station already knows the local EV Charging Spot information (e.g. through registration process) or can acquire it dynamically from the ITS Central Station. All of the functional requirements are introduced in the following clauses.

5.2   Requirements in ITS Central Station

The operation of an ITS Central Station for originating this notification is optional. If an ITS Central Station is present, it acts as a CES and the following requirements shall apply.

The CES shall gather the information related to the managed charging spots. It is responsible for the maintenance of location based services (e.g. global EV Charging Spot's location information, geographical area to be covered, DNS and Web configuration, etc.) as well as the provisioning of this information to Roadside ITS Stations or other appropriate nodes, using appropriate communication mechanisms.

Moreover, the CES shall periodically update the required information and define its validity duration. The message exchanged between the CES and the broadcasting ITS station is out of scope of the present document.

5.3 Requirements in ITS Roadside Station or other broadcasting Station

A Roadside ITS Station, another appropriate node able to broadcast the notification, or a charging spot acting as such and handling this use case, appropriately positioned, shall initially announce this service [i.2]. It may communicate with a Central ITS Station to request global EV Charging Spot(s) information. It shall check the validity of the information (i.e. if expired) and optionally trigger the request of updated data from the EVCS or the CES.

In parallel, the transmitting ITS Station shall broadcast the static and dynamic information related to the EVCS complying with the message format described in clause 6.

5.4 Requirements in ITS Vehicle Station

In the case where a SAM announces the local presence of an EV charging spot notification service, a vehicle ITS Station receiving the SAM shall initially check if the application and a communication profile allowing it to access this service are installed. If this is the case, it shall then check if the application is interested in receiving this notification service. In the case where it is interested in using the notification service, it shall be put in a state where it is able to receive the "EV charging spot notification" broadcasted messages.

In all cases, on reception of the notification messages, the vehicle ITS Station shall process the contained information to possibly select a charging spot compatible with its own requirements (battery type, provider Id, etc.). Further processing inside the vehicle application is left implementation dependant.

6 Message Format Specification

6.1 General Structure

This clause specifies the EVCS Notification message. The information relative to this application located in other messages, such as the CAM or the SAM messages, are defined in their respective specifications: [3] for CAM and [i.2] for SAM. Whenever possible, this message reuses information from the common data dictionary [i.1].

This notification complies with the format of POI Notification messages. It contains the following fields, described with more details in table 1 and illustrated in figure 3.

- The ITS PDU header includes basic information to identify the message at Facilities layer. The format is compliant with [i.1].

- The POI header identifies the type of POI, the timestamp of the last update of this POI type and whether the originating station is able to relay subsequent reservation messages (this capability depends on the POI and is future work).

- The EVCS payload contains the description of the Charging Spots. It first contain the information related to the EV charging station hosting the EVCS, then the information related to the EVCS itself.
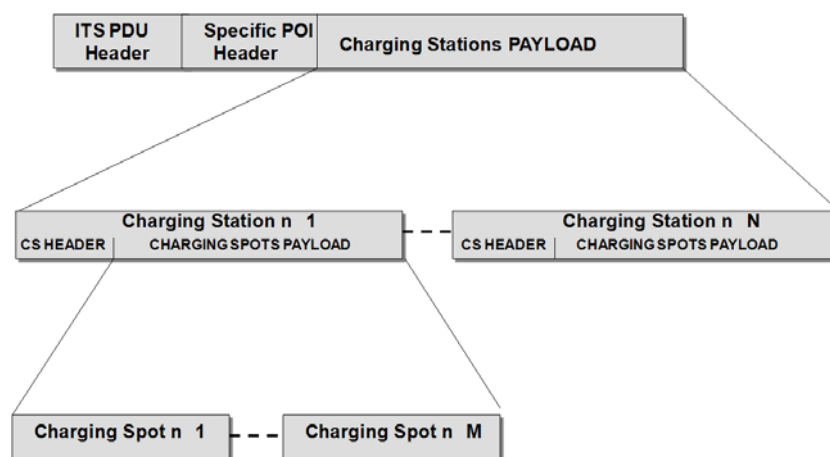
```
┌──────────┬──────────┬─────────────────────────────┐
│ ITS PDU  │Specific POI│                             │
│ Header   │ Header   │  Charging Stations PAYLOAD  │
└──────────┴──────────┴─────────────────────────────┘

┌─────────────────────────────┐        ┌─────────────────────────────┐
│     Charging Station n  1   │        │     Charging Station n  N   │
│ CS HEADER │ CHARGING SPOTS PAYLOAD│ ─ ─ │ CS HEADER │ CHARGING SPOTS PAYLOAD│
└─────────────────────────────┘        └─────────────────────────────┘

┌──────────────────┐      ┌──────────────────┐
│ Charging Spot n  1│ ─ ─ │ Charging Spot n  M│
└──────────────────┘      └──────────────────┘
```

Figure 3: General Structure of the EVCS Notification message

In order to keep the message at a reasonable size, the message can contain a variable number of charging stations, with a maximum of 16 charging spots each. As defined in clause 3.1, a charging spot is a set of 1 to 4 parking places, arranged around a pole. Other information related to the message size depending on the applied access technology can be found in informative annex E.

6.2 Detailed Message Format

This clause explains in a table format the fields contained in the EVCS notification message and gives further explanation on their content. This table can be found in annex B. The message format makes use of the Common Data Dictionary as defined in [i.1]. Where applicable, data elements and data frames that are not defined in the present document should be imported from [i.1]. In case of discrepancy with the ASN1 definition defined in clause 6.3, the ASN1 will serve as reference.

6.3 ASN1 Specification and encoding rules

The encoding of the EVCS Notification Message is provided in annex A. The message format is presented in ASN.1. Unaligned packed encoding rules (PER) as defined in ITU-T Recommendation X.691 [6] shall be used for encoding and decoding the message.

7 Application Operational Requirements

7.1 Conformance Requirements

OR001: The EV POI application shall be developed in conformity to the present document. The conformance testing of this application shall be achieved in respect of the related ETSI conformance testing specification.

7.2 Interoperability Requirements

OR002: Interworking between the vehicles and the broadcasting node shall be ensured.

OR003: Interworking between the broadcasting node and the CES shall be ensured.

7.3 Security Requirements

7.3.1 Confidentiality

The following security requirements related to the confidentiality of transmitted ITS information are specified:

OR004: An ITS-S shall have the means to protect location and identity information during transmission.

OR005: An ITS-S shall have the means to use multiple identifiers.

7.3.2 Integrity

The following security requirement related to the integrity of transmitted ITS information is specified:

OR006: An ITS-S shall implement one or more methods for preventing the modification or manipulation of data that it transmits or receives.

OR007: An ITS-S shall permit only authorized ITS applications to modify or delete its EVCS information.

7.3.3 Availability

The following security requirement related to the availability of transmitted ITS information is specified:

OR008: An ITS-S should be able to detect easily recognizable Denial of Service attack patterns.

7.3.4 Accountability

The following security requirements related to the accountability of transmitted ITS-S and ITS information are specified:

OR009: An ITS-S shall record all requests for changes to security parameter information and ITS applications.

OR0010: An ITS-S shall record the results of all requests for changes to security parameter information and ITS applications.

7.3.5 Authenticity

The following security requirements related to the authenticity of transmitted ITS information are specified:

OR0011: An ITS-S shall be permitted to send an ITS message only if suitably authorized.

OR0012: An ITS-S shall reject an incoming ITS message received from an unauthorized source.

OR0013: An ITS-S shall have means to validate the identity of an authorized ITS-S while an authorized authority should have means to provide and distribute information about compromised ITS-S.

OR0014: An ITS-S shall have means to obtain certificates from an authorized authority.

7.4 Performance Requirements

OR0015: Application performance: The application shall interact with the driver only in some specific cases of charging requirements. It should disturb him the least possible according to his driving status.

OR0016: Communication performance: The total latency between the transmission of a Charging Spot Notification message and its treatment in the vehicle should be below 1second to 10 seconds.

7.5   ITS Communication Profile Requirements

OR0017: The application shall be able to execute over any communication profile supported by the ITS-S. Examples of communication profiles are described in annex E.

OR0018: The application shall be able to receive the notification information over all implemented communication profiles.

7.6   Operational Management

OR0019: This application and its parameters shall offer the possibility to be updated remotely.

7.7   Actors' Responsibility

OR0020: The system being distributed, in case of failure, one actor cannot be made responsible of the whole system.

Annex A (normative):
ASN1 description module of the EVCS Notification Message

```
-- Point of Interest (POI) notification for charging spot
-- for electric vehicle
-- EVCSN Message definition

-- ASN.1 Start Definition

EVCSN-PDU-Descriptions {
 itu-t (0) identified-organization (4) etsi (0) itsDomain (5)
 wg1 (1) ts (101556) evcsn (1) version (1)
} DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS
    ItsPduHeader,
    StationID,
    Timestamp,
    ReferencePosition
FROM ITS-Container {
 itu-t (0) identified-organization (4) etsi (0)
 itsDomain (5) wg1 (1) ts (102637) cc (0) version (2)
};

-- Root Message PDU: EvcsnPdu

EvcsnPdu ::= SEQUENCE {
    header  ItsPduHeader,
    evcsn   EVChargingSpotNotificationPOIMessage
}

EVChargingSpotNotificationPOIMessage ::= SEQUENCE {
    poiHeader   ItsPOIHeader, -- Specific POI Message Header
    evcsnData   ItsEVCSNData  -- Electric Vehicle Charging Spot Data Elements
}

ItsPOIHeader ::= SEQUENCE {
    poiType             POIType, -- set to "EV charging station POI ID = 1"
        timeStamp           Timestamp,
    relayCapable        BOOLEAN
}


ItsEVCSNData ::= SEQUENCE {
    totalNumberOfStations   NumberStations,
    chargingStationsData    SEQUENCE (SIZE(1..256)) OF ItsChargingStationData
}

ItsChargingStationData ::= SEQUENCE {
    chargingStationID       StationID,
    utilityDistributorId    UTF8String (SIZE(1..32))    OPTIONAL,
    providerID              UTF8String (SIZE(1..32))    OPTIONAL,
    chargingStationLocation ReferencePosition,
    address                 UTF8String              OPTIONAL,
    phoneNumber             NumericString (SIZE(1..16))     OPTIONAL,
    accessibility           UTF8String (SIZE(1..32)),
    digitalMap              DigitalMap              OPTIONAL,
    openingDaysHours        UTF8String,
    pricing                 UTF8String,
    bookingContactInfo      UTF8String              OPTIONAL,
    payment                 UTF8String              OPTIONAL,
    chargingSpotsAvailable  ItsChargingSpots,
    ...
}


ItsChargingSpots ::= SEQUENCE (SIZE(1..16)) OF ItsChargingSpotDataElements


ItsChargingSpotDataElements ::= SEQUENCE {
```

```
    type            ChargingSpotType,
    evEquipmentID   UTF8String  OPTIONAL,
    typeOfReceptacle    TypeOfReceptacle,
    energyAvailability  UTF8String,
    parkingPlacesData   ParkingPlacesData   OPTIONAL
}

DigitalMap ::= SEQUENCE (SIZE(1..256)) OF ReferencePosition

ChargingSpotType ::= BIT STRING {
    standardChargeMode1(0),
    standardChargeMode2(1),
    standardOrFastChargeMode3(2),
    fastChargeWithExternalCharger(3),
    quickDrop(8),
    inductiveChargeWhileStationary(12),
    inductiveChargeWhileDriving(14)
}

TypeOfReceptacle    ::= BIT STRING

ParkingPlacesData   ::= SEQUENCE (SIZE(1..4)) OF SpotAvailability

SpotAvailability    ::= SEQUENCE {
    maxWaitingTimeMinutes INTEGER (0..1400), -- 0 if available or max waiting
                         -- time (minutes)
    blocking            BOOLEAN             -- true if the spot can be blocked
}

POIType             ::= INTEGER(0..65535)
NumberStations      ::= INTEGER(1..256)

END

-- ASN.1 End
```

Annex B (normative):
Description for data elements

Table B.1: General structure of the EVCS Notification

Element		Name	Type	M/O	Description
ITS PDU Header		Protocol Version	Integer	M	"0" for the present document
		Message ID	Integer	M	POI message type number 3
		Originating Station ID	Station ID	M	Identification of the ITS originating station, ITS ID (on 4 bytes)
Specific POI Header		Type of POI	Integer	M	"EV Charging Station" POI ID 1
		Message Generation Timestamp	UTC Time	M	Timestamp of notification message, in millisecond, as defined in [i.1]
		Relay-capable ITS Station	Boolean	M	Indicates whether the originating ITS station is able to relay further reservation messages
		Total Number of EV Charging Stations	Integer	M	Total number of EVCS Stations advertised by this ITS Station
		Current number of EV Charging Stations			Number of EV Charging Stations described in this message
EV Charging Station 1	Charging Station Header	EV Charging Station Id	Station ID	M	ITS Identification of the EV charging station
		Utility Distributor Id	String	O	Identification of the Utility service distributor. Max size is 32 characters
		Provider Id	String	O	Energy provider identification. Max size is 32 characters
		EV Charging station geographical location	Reference Position	M	Longitude, Latitude, Altitude of the EV charging station
		EV Charging station address	String	O	Address of the charging station
		EV Charging station telephone number	String	O	Telephone number of the charging station. The format shall be up to 16 digits
		EV Charging station accessibility	String	M	Open to all or restricted to some communities. Free of access or paying access. Max size is 32 characters
		Digital map of the area including the charging station		O	To help the application to guide the driver from its vehicle position to the EV charging station. See Note 1 below
		Opening Days and Hours	String	M	Opening days and hours of the EV charging station
		Pricing	String	M	Sequence of current energy or battery rates, each including: - charging type (energy, battery, etc.) - active time interval in seconds starting from EVCSN generation time - unit of charging - price level per unit

Element		Name		Type	M/O	Description
		Booking contact information		String	O	When possible to book a parking place, booking contact information (URL or Ipv6 address of the site). See Note 2 below
		Payment		String	O	Accepted payment facilities including identification of accepted payment methods when relevant - contract - external payment: electronic wallet - external payment: credit card - external payment: cash - other
		Number of EV Charging spots available (M)				Provide the number of available charging spots, from 1 to 16
	Charging Spot n° 1 Data Elements	Type of Charging Spot		Bit String	M	4 bits (see [7]): 0: Mode 1 standard charging, 1: Mode 2 standard charging, 2: Mode 3 standard or fast charging (3,7 kW to 43 kW), 3 : Mode 4 fast charging using external charger (DC charging beyond 43 kW), 4: Reserved for new charging type, 5: Reserved for new charging type, 6: Reserved for new charging type, 7: Reserved for new charging type, 8: Quick drop (battery replacement), 9: Reserved for new quick drop, 10: Reserved for new quick drop, 11: Reserved for new quick drop, 12: Inductive charge while stationary, 13: Reserved for new inductive charge while stationary, 14: Inductive charge while driving, 15: reserved for new inductive charge while driving.
		EV equipment ID		String	O	When available, this field matches the EV Spot "Electric Vehicle Supply Equipment ID" described in ISO 15118.
		Types of receptacles (Cables and sockets)		Bit String	M	4 bits: See coding in Note 3 below
		Energy availability		String	M	Minimum and maximum power available per socket. For quick drop, number and types of available batteries
		Number of parking places		String	O	Number of available parking places (1 to 4 places around a pole)
		Parking place data	Max waiting time	Integer		immediate availability or maximum waiting time in minutes if not immediately available
			Blocking	Boolean		possibility to hold it or not
	Charging Spot n° 2 [... up to 16 spots] Data elements - -					
Charging Station 2 [... up to 4 stations] Data Elements -						

NOTE 1: In option, the message can contain a digital map made of a set of waypoints (series of GPS coordinates) allowing the navigation system to guide the user from the roadside unit that broadcast the POI notification towards the POI itself (thus independent of the reference map used).

NOTE 2: When present, this field includes the information (such as the URL or the IPv6 address) for the establishment of a session with the charging spot manager to negotiate the access to a certain quantity of energy. The specification of this session is out of scope of the present document.

NOTE 3: A charging spot may deliver AC (socket) or DC (cable). The following table defines a coding of the type of receptacle compliant with current standards, including IEC 62196-2 [7].

Table B.2: Coding of the type of receptacle field

Coding	Charging spot type	Standard plug / cable	Type of current	Number of phases	Maximum Voltage	Maximum Current
0000	Socket	IEC 62196-2 [7] type 1	AC	Single	240 V	16 A
0001	Socket	IEC 62196-2 [7] type 1	AC	Single	240 V	32 A
0011	Socket	IEC 62196-2 [7] type 1	AC	Single	240 V	80 A
0011	Socket	IEC 62196-2 [7] type 1	AC	Single	120 V	12 A
0100	Socket	IEC 62196-2 [7] type 1	AC	Single	120 V	16 A
0101	Socket	Standard Household	AC	Single	250 V	16 A
0110	Socket	Standard Household	AC	Three phases	480 V	16 A
0111	Socket	IEC 62196-2 [7] type 2	AC	Single	230 V	16 A
1000	Socket	IEC 62196-2 [7] type 2 (CEEform)	AC	Single	250 V	32 A
1001	Socket	IEC 62196-2 [7] type 2 (CEEform)	AC	Three phases	480 V	32 A
1010	Socket	New IEC 62196-2 [7] type 2 connector	AC	Three phases	400 V	32 / 250 A
1011	Socket	IEC 62196-2 [7] type 3A EV plug alliance.	AC	Single phase	250 V	32 A
1100	Socket	IEC 62196-2 [7] type 3B EV plug alliance.	AC	Three phases	480 V	32 A
1101	Cable for DC charging	Reserved for Future IEC 62196-3 [i.3]	DC		1 000 V	400 A
1110	Cable for DC charging	Reserved				
1111	Cable for DC charging	Reserved				

Annex C (informative):
Communication Profiles

This clause describes some communication profiles that can be used to exchange the POI related notifications.

The communication profile is defined by a coded integer value, representing one combination of one access technology, communication stacks and QoS requirement level. Besides, this communication profile is managed by the communication management functions, and will be known by all layers as defined in [4].

C.1   G5 Communication profile

Applications implementing the ITS G5 [5] communication profile comply to table C.1.

Table C.1: Communication Profile for Notifications based on ITS G5 Technology

Transport Protocol	Basic Transport Protocol
Networking Protocol	GeoNetworking, Topological Scoped Broadcast , single-hop
Access Technology	ITS G5B, channels can be either SCH3 or SCH4, as indicated in the SAM

In order to avoid congestion of the wireless access, this message should include a limited list of the EVCS available in the vehicle neighbourhood. In any case, it should not contain the information relative to the full geographical area in which the vehicle is located unless none else is available. To keep the message to a moderate size, restrictions apply on the number of spots per station and parking places per spot. In addition, when using G5 technologies, the size can be further reduced by using two fields of the Specific POI Header:

- Total Number of EV Charging Stations: This is the total number of EVCS Stations that are being advertised by this transmitting ITS Station.

- Current number of EVCS: This is the number of EV Charging Stations described in the current message. When different from the previous one, it indicates that the original message to be advertised by the transmitting ITS Station was too long and has been split into several smaller messages. The application at the receiver ITS Station should then be careful to listen to the whole number of messages to get a complete information.

C.2   3GPP Communication profile

Applications implementing 3GPP communication profile should comply to table C.2.

Table C.2: Communication Profile for Notifications based on Cellular Technology

Transport protocol	UDP, RTP, TCP
Networking protocol	IPv6/IPv4
Access technology	LTE/HSPA/GSM

C.3   Other Communication profiles

In the future, other communication profiles may be used to broadcast this notification.

Annex D (informative):
Example of Charging Spot Routing and Notification Service

This is a proposal for an enhanced routing service (located in the ITS central station) which includes charging spot notification, but goes beyond it. It is a personalized service, therefore it requires a bidirectional service channel (when using ITS G5 [5]), whereas the charging spot notification gets by with a broadcast as defined in clause 7.5.

The use case can be divided in the following sub cases:

- Before or during the trip: the user searches actively for a charging station in the vicinity of the destination of the trip (stop).

- Emergency scenario: the search is performed in the neighbourhood of the actual location, being triggered by context such as state of charge, energy consumption, congested traffic, or resulting from a previous subscription (see below).

- Economy charging: the service is based on a location based notification about available charging stations, interesting offers, etc.

    a) Destination centred search of charging spots

        The application on the vehicle ITS station has information about the state of charge of the battery in terms of required energy. We assume that the user knows the location of the next stop in the travel path and enters this location (using navigation GUI, etc.).

        The user can query at anytime the charging stations in walking distance of that location. The availability of the stations is returned by the service, it may however change until the user performs a reservation. The latter cannot be done earlier than a certain time before the expected arrival time (in order to avoid abuse).

    b) Emergency scenario

        In this case the search in scenario a) returns that all charging stations are busy (corresponding to an emergency situation) and the user is either driving or parking in the vicinity. The user (or an automate, context driven agent) may subscribe to receive a notification about charging spots that become available in the area specified in the subscription message. The eventual notification message received by the user specifies a charging location that became available, therefore it should be immediately followed by a reservation. In case the first notified user does not reserve (or acknowledge) the offer within a certain time, the next user subscribed for the same region receives the notification, and so on.

It makes sense to combine the different use cases in one service, as shown in the figure D.1. In this figure, the application combines query, reservation, subscription in case all charging stations are busy, notification of available CS, and finally the handling of too early reservations.
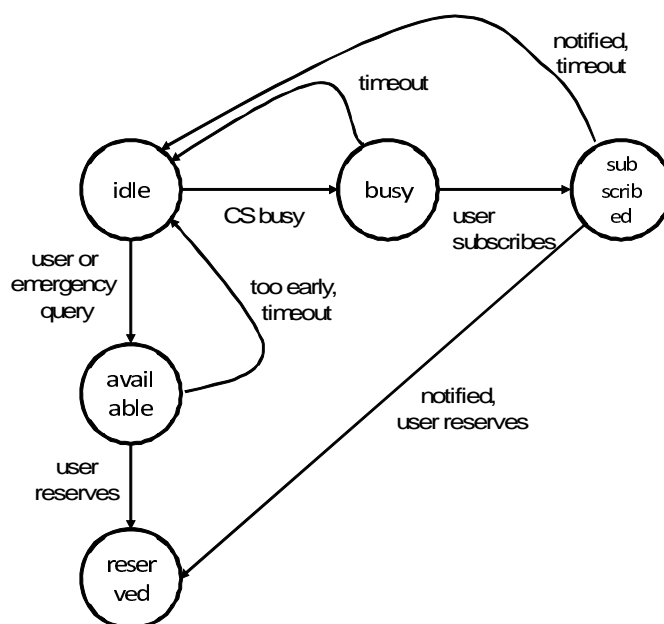
Figure D.1: State diagram of the vehicle routing and notification application

Specification of the interface between EV and routing/notification service.

This clause describes the overview of the interface between the mobile client and the routing service.

The following application protocol primitives are sketched below:

- Query availability request

- Query availability response

- Reservation request

- Reservation response

- Subscribe

- Notify

Query availability request message:

- Request timestamp

- Stop location [longitude, latitude, altitude]

- Estimated arrival time

- Estimated departure time

- Charging energy needed in kWh (estimated at arrival time)

- Type of charging spot multiple selections possible

- Preferences/priority:

  - Price importance: high, low, null (one of)

  - Waiting importance: high, low, null

  - Preferred provider: ProviderName, null

  - RenewableEnergy: high, low, null

  - Preferred payment means: CardName1, …, (multiple selections possible)

Query availability response message:

One of the messages:

- Ordered list of (decreasing preference matching)

  - Station-name, EV charging station ID, station location, pricing

- "No station found in the area"

- "All [n] stations in range are busy"

Reservation request:

- Request timestamp

- Station-ID

- Estimated arrival time

- Estimated departure time

- Charging energy needed in kWh (estimated at arrival time)

- User contact (SMS/email)

Reservation response:

- Reservation-ID

- Station name

- Charging spot No.

- Reservation start time

- Reservation end time

- Arrival Tolerance (e.g. 15 minutes)

Reservation Confirmation (from vehicle application):

- reservation-ID

Reservation Cancellation (user request):

- Reservation-ID

Reservation Expiration Notification (from service):

- Reservation-ID (needs async messaging, e.g. SMS)

Subscription request:

- User contact SMS/email

- Estimated arrival time

- Estimated departure time

- Area (vehicle coordinates, radius)

- Subscription expiration time

Notification (from service):

- Charging Station Name

- Charging Station-ID

- Charging Station location

- Price

Annex E (informative):
Example of Charging Spot Discovery Application

This annex provides an example of the "Charging Spot Discovery" application which could be implemented at a Vehicle ITS Station level to exploit the EV Charging spot notification service provided by an Road Side ITS Station. The application and its interfaces to other Vehicle ITS Station functions are represented on the figure E.1.
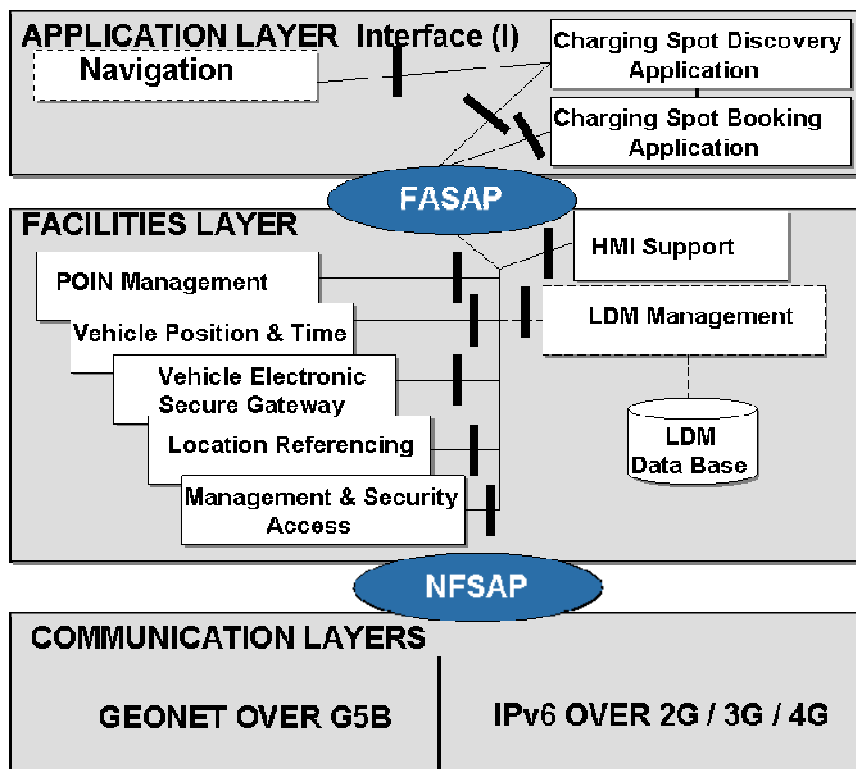

Figure E.1: Example of Architecture for a Charging Spot Discovery Application

When the Vehicle identifies a need for battery recharging or quick drop, or when the user intends to recharge or change its battery, the Charging spot discovery application is activated either:

- Directly by the vehicle electronic system (through its secure gateway) which monitors the constantly the remaining level of electricity and compare it to the user need.

- Indirectly through by the user through requests provided via the user HMI.

When being in active state, upon reception of a EV Charging Spot Notification message, the Charging Spot Discovery application analyzes the data elements being received and selects the most relevant charging station accordingly.

Another way of discovering the presence of a relevant charging station is to interrogate some central ITS Station through a cellular network until finding a relevant charging station being in the vicinity of the vehicle. This annex does not consider this way of discovering a charging spot.

If the selected station is offering the possibility to book a socket of a relevant charging spot with an associated parking place, then the charging spot booking application may be activated and a booking and payment transaction may be started with the relevant Central ITS Station being in charge of this service. This transaction may be achieved using standard Internet service based on IPv6.

The availability of the EV Charging Spot Notification service is announced using the Service Announcement facility of the Roadside ITS Station. Upon reception of the relevant SAM (Service Announcement message), announcing the EV Charging Spot Notification, the Vehicle ITS Station Charging Spot Discovery Application will request the communication management to switch to the G5 channel assigned to the EV Charging Spot Notification service.

When the user has selected a relevant charging spot, he may be directly guided to the selected charging station and to the assigned charging spot using his navigation application.

Annex F (informative):
Example of Application Functional Entities Implementation

This annex presents an example for the possible implementation of the application in the functional entities for clauses 5.2, 5.3 and 5.4 in the case of a network deployed with ITS G5 access technology.

F.1   Application Functional Entities in ITS Central Station

An ITS Central Station is responsible for location and communication based services provision for EV Charging Spot Notification application. Therefore, an ITS Central Station has two major parts: The Location part is responsible for the location based services provision (e.g. global EV Charging Spot's location information, DNS and Web configuration). The Communication part can communicate with Roadside ITS Stations via Wi-Fi, 3.5G, WiMAX, or any other communication and send global EV Charging Spot information to Roadside ITS Stations, if necessary.

F.2   Application Functional Entities in ITS Roadside Station

An ITS Roadside Station typically sends local EV Charging Spot information and can diagnose information to the vehicle. Therefore, an ITS Roadside Station has four parts: The Communication part can communicate with a Central ITS Station and EV Charging Spot(s) via Wi-Fi, 3.5G, WiMAX, or any other communication. The Communication part also can communicate with Vehicle ITS Station(s) via ITS 5,9 GHz. A Roadside ITS Station exchanges charging information and notification message with Vehicle ITS Station(s). The Location part is responsible for recording local EV Charging Spot's information. The Diagnose part can analyze charging information received from Communication part to determine the condition (e.g. battery utilization) of the Vehicle ITS Station. The Log part can log charging information received from the Vehicle ITS Station and the EV Charging Spot.

F.3   Application Functional Entities in ITS Vehicle Station

An ITS Vehicle Station is, typically, a roaming vehicle and is connected to an ITS Roadside Station and an EV Charging Spot (through connector part). From the vehicle point of view, the local EV Charging Spot location information is received and displayed on the screen in real time operation. In this application, the process of charging batteries is more complicated than the process of traditional re-fuelling of vehicles, partly because the properties and types of batteries vary significantly. Methods to measure the amount of electricity charged are useful, because the measurement from several parts, such as Meter part, Tolerance Calculator part and Diagnose part in an Electrical Vehicle ITS Station, may differ from the measurement from a traditional Electrical Vehicle Station. Therefore, an ITS Vehicle Station can have six major parts: The Connector part may be coupled with an EV Charging Spot for receiving power. The Meter part may measure the power quantities received from an EV Charging Spot. In some embodiments, the measurements may occur periodically or at request, such as by a request from a driver. The Communication part can transmit an EV Charging Spot message (e.g. invite message or request message) to the Roadside ITS Station, or any appropriate node providing the service. Examples of a communication part may include a wireless device like ITS G5, or any other communication or information access technologies. The Tolerance Calculator part can collect charging information from Meter part to calculate Charging Tolerance Value. The Charging Tolerance Value is calculated such as using the following equation:

$$Charging\ Tolerance\ Value = \frac{\left| PowerReceived - PowerTransmitted \right|}{PowerReceived}$$

If Charging Tolerance Value exceeds a threshold, it may trigger Communication part to send an EV Charging Spot message (e.g. invite message or request message) to the Roadside ITS Station/Charging Spot to stop charging. The Roadside ITS Station may choose another EV Charging Spot from Location part database and send the information to the Vehicle ITS Station. The Diagnose part can analyze charging information received from an EV Charging Spot to determine the health condition of Vehicle ITS Station. The Notify part can send notification to the driver when Charging Tolerance Value exceeds the threshold. The driver can decide whether to continue charging.

F.4   Application Functional Entities Diagram

Figure F.1 shows the application functional entities diagram between the ITS Central station, the ITS Roadside station and the ITS Vehicle station. The detailed parts for each application functional entity are showed in figure F.1.
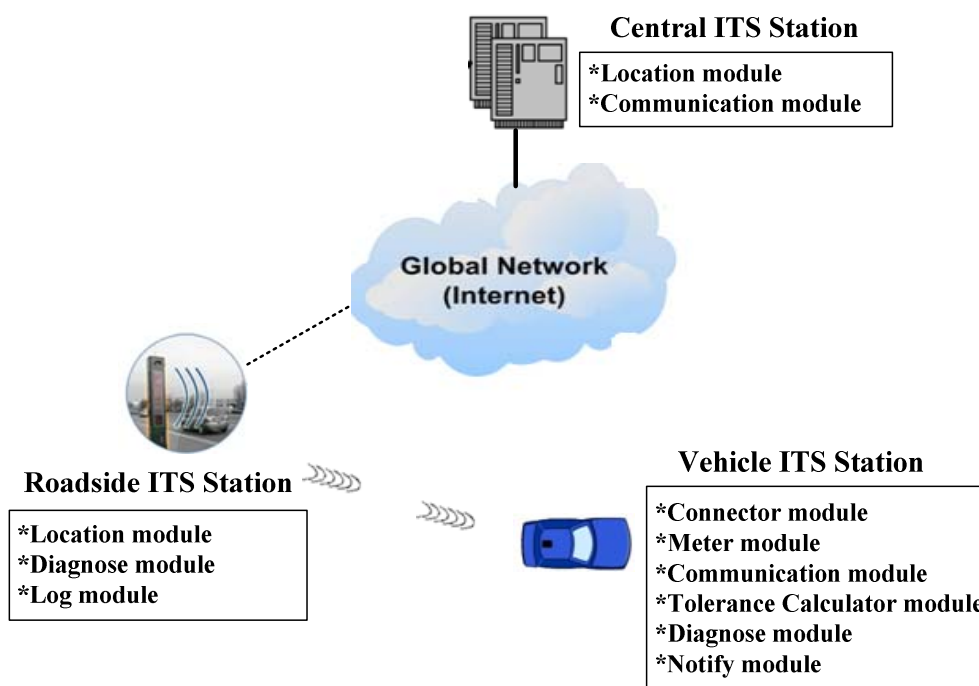

Figure F.1: Use case for the application functional entities diagram

Annex G (informative):
Example of Broadcasting using a Cellular Network

In this example, the notification message distribution is performed through a cellular communication profile in a wide area. Figure G.1 depicts the EV charging spot systems using different communication links to send their information to a central ITS station. The central ITS station acting act as aggregator of information from several EV charging spots apply geographic filtering rules to transmit the relevant EV stations information to the ITS vehicle stations. LTE/eMBMS is used to broadcast the notification message in a service area of larger scale. In this use case, the Vehicle ITS station should have been subscribed to a geo-referenced multicast group.
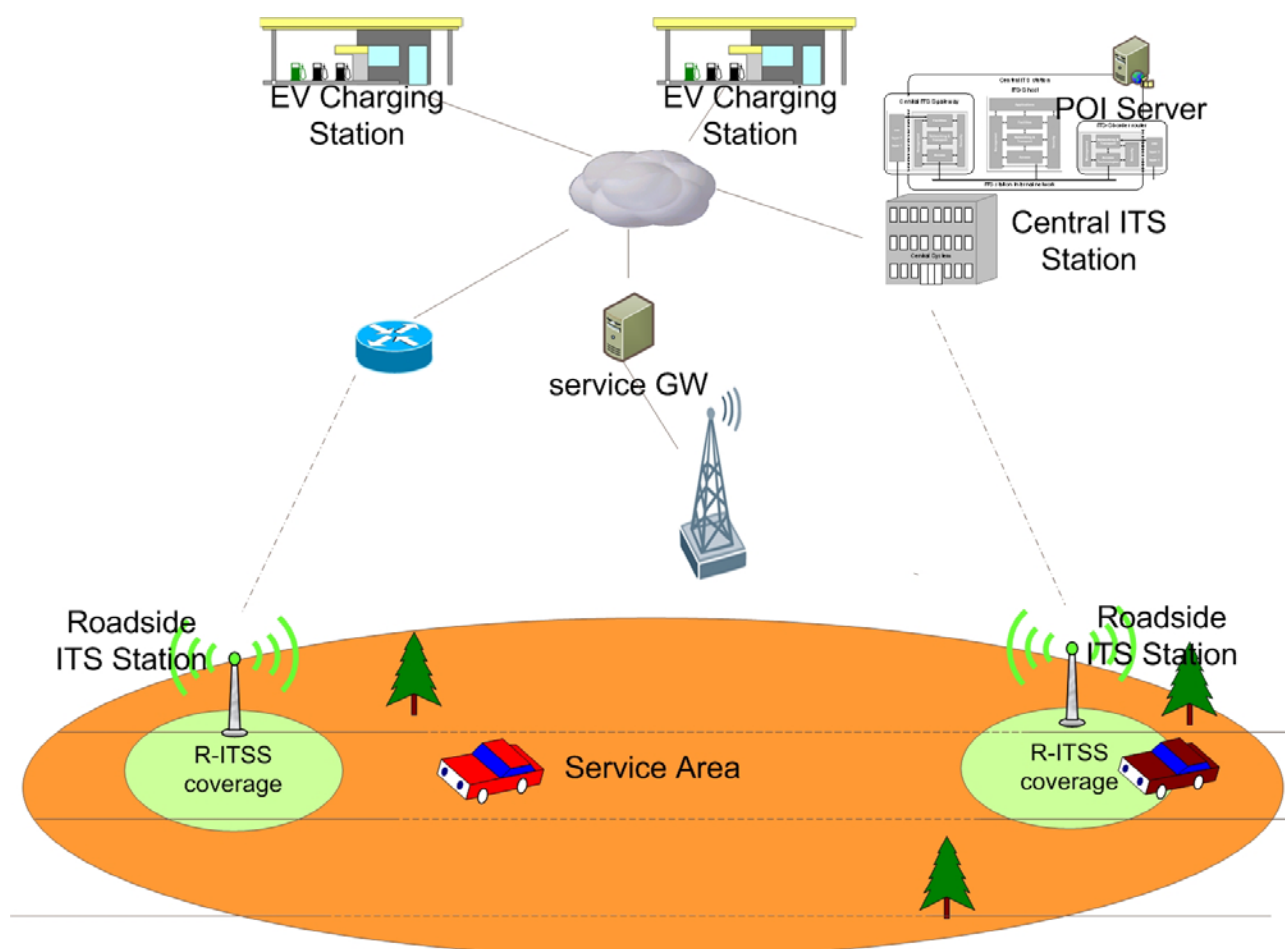

Figure G.1: Example of use case for the dissemination of the EV Charging Spot notification message

Annex H (informative):
Bibliography

ETSI TR 102 893: "Intelligent Transport Systems (ITS); Security; Threat, Vulnerability and Risk Analysis (TVRA)".

ETSI TR 102 638: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Definitions".

ETSI TS 102 636-3: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 3: Network architecture".

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

ISO 15118: "Road vehicles. Vehicle to grid communication interface".

History

Document history		
V1.1.1	July 2012	Publication