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Cooperative intelligent transport systems (C-ITS) — Global transport data management (GTDM) framework

Systèmes de transport intelligents coopératifs (C-ITS) - Cadre de gestion globale des données de transport (GTDM)

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Foreword

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

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 278, *Intelligent transport systems,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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

Introduction

This document is part of a family of deliverables from Standard Development Organizations (SDOs) for Cooperative Intelligent Transport Systems (C-ITS), which is a subset of standards for Intelligent Transport Systems (ITS).

ITS aims to improve surface transportation in terms of:

— **safety**

e.g. crash avoidance, obstacle detection, emergency calls, dangerous goods;

— **efficiency**

e.g. navigation, green wave, priority, lane access control, contextual speed limits, car sharing;

— **comfort**

e.g. telematics, parking, electric vehicle charging, infotainment; and

— **sustainability**,

by applying information and communication technologies (ICT).

The whole set of standards for deployment of C-ITS is difficult to understand for developers of equipment and software, especially ITS application software, and thus guidelines explaining a beneficial choice of standards (C-ITS release), the purpose and interaction of standardized features, beneficial implementation approaches, and guidance in developing ITS applications are a prerequisite for a fair and open market allowing early deployment of interoperable and future-proof solutions; see ISO/TR 21186-1. More details on the C-ITS domain can be found in the Brochure[14] produced by CEN/TC 278.

Referencing other SDOs and their respective deliverables is in no way to be understood as an endorsement, but rather as an informative piece of information.

At the time of writing this document, no applicable Intellectual Property Rights (IPR) issues were known related to this document. However, this document references standards for which IPRs are known. Information on such IPRs is expected to be provided in those respective standards, which might be from any one of the SDOs working on ITS or C-ITS.

Cooperative intelligent transport systems (C-ITS) — Global transport data management (GTDM) framework

1 Scope

This document specifies a global transport data management (GTDM) framework composed of

— global transport basic data model,

— global transport access control data model,

— global transport function monitor data model, and

— sensor and control network data model

to support data exchange between applications.

This document defines standardized data classes in a Global Transport Data Format (GTDF), and the means to manage them.

Application and role-based access control to resources in GTDF are specified in accordance with IEEE 1609.2 certificates.

This document specifies GTDM as an ITS-S capability which is an optional feature (ITS-capabilities are specified in ISO 24102-6).

The GT access control (GTAC) data model specifies access permissions to data and function control by defining role-based mechanisms.

The GT function monitor (GTFM) data model specifies a configuration method to generate a flow logic for monitoring purposes, e.g. observing data parameters with respect of a defined limit.

2 Normative references

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

ISO/IEC 8824-1, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation — Part 1:*

ISO/IEC 8825-7, *Information technology — ASN.1 encoding rules — Part 7: Specification of Octet Encoding Rules (OER)*

ISO 14229-1, *Road vehicles — Unified diagnostic services (UDS) — Part 1: Application layer*

ISO/TS 17429, *Intelligent transport systems — Cooperative ITS — ITS station facilities for the transfer of information between ITS stations*

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

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

ISO 22900-2, *Road vehicles — Modular vehicle communication interface (MVCI) — Part 2: Diagnostic protocol data unit (D-PDU API)*

ISO 24102-6, *Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management — Part 6: Path and flow management*

CEN/TS 17496, *Cooperative intelligent transport systems — Communication profiles*

IEEE 1609.2, *IEEE Standard for Wireless Access in Vehicular Environments — Security Services for Applications and Management Messages*

RFC 5646, *Tags for Identifying Languages*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 21177, CEN/TS 17496, ISO 21217 and the following apply.

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

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

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

3.1
class
<class>
an extensible programme-code-template for creating objects, providing initial values for state (member variables) and implementations of behaviour (member functions or methods) in object-oriented programming

3.2
convention
Cvt
indicates if specification is "M" (mandatory), "O" (optional), or "C" (conditional)

3.3
global transport protocol client
GTP client
entity that instigates the provision of the GTP service

3.4
global transport protocol server
GTP server
entity that provides the GTP service

3.5
raw data
data of a sensor control network (SCN) in the untreated format as specified by the SCN owner

3.6
raw data source identifier
unique identifier of an entity in an *SCN* (3.9)

3.7
retrofit
addition of new technology or features to existing systems

3.8
secure data interface
SDI
gateway providing bidirectional means for security and access control

3.9
sensor control network
SCN
communication bus with measured inputs and controlled outputs

4 Abbreviated terms

ADU	application data unit
AMQP	advanced message queuing protocol
ASN.1	abstract syntax notation one
BP	basic principle
CAN	controller area network
cId	common identifier
C-ITS-SU	central ITS station unit
C-ITS-S	central ITS station
CUP	CAN utility protocol
Cvt	convention
dId	data identifier
D-PDU	diagnostic protocol data unit
dpId	data parameter identifier
DTC	diagnostic trouble code
eCall	emergency call
ECU	electronic control unit
ecuId	electronic control unit identifier
enh-diag	enhanced diagnostic
FSH	facilities service handler
GNSS	global navigation satellite system
GPIO	general purpose input/output
GT	global transport
GTAC	global transport access control
GTBasic	global transport basic
GTDF	global transport data format
GTDM	global transport data management
GTDF2SCNPDU	global transport data format to sensor control network protocol data unit

GTFM	global transport function monitor
GTP	global transport protocol
i	internal
IEEE	Institute of Electrical and Electronics Engineers
IMU	inertial measurement unit
IP	internet protocol
IPR	intellectual property rights
itid	info type identifier
ITS-AID	ITS application identifier
ITS-SU	ITS station unit
IVN	in-vehicle network
K-line	communication line
KWP2000	Keyword Protocol 2000
lid	local identifier
LDM	local dynamic map
LSb	least significant bit
LSB	least significant byte
MIL	malfunction indicator light
MQTT	message queuing telemetry transport
MVCI	modular vehicle communication interface
OBD	on-board diagnostics
odt	object description table
OTL	on-board diagnostic threshold limits
PDU	protocol data unit
pgn	parameter group number
pid	parameter identifier
ProtBuf	protocol buffers
P-ITS-S	personal ITS-station
P-ITS-SU	personal ITS-station unit
PSID	provider service identifier
r	read

rid	routine identifier
R-ITS-S	roadside ITS-station
R-ITS-SU	roadside ITS-station unit
SAP	service access point
SCNDF	sensor and control network data format
SCNPDU2GTDF	sensor and control network protocol data unit to global transport data format
snsid	sensor identifier
SNI	secure network interface
spn	suspect parameter number
SPaT	signal phase and timing
SSP	service specific permission
tid	test identifier
TLS	transport layer security
u	user optional
UDS	unified diagnostic services
UGP	unified gateway protocol
VIS	vehicle information service
V-ITS-S	vehicle ITS-station
V-ITS-SU	vehicle ITS-station unit
w	write
W3C	world wide web
WWH-OBD	world wide harmonized on-board-diagnostic
x	execute
XCP	universal measurement and calibration protocol
xml	extensible markup language

5 Conventions

This document conforms to the OSI Service Conventions specified in ISO/IEC 10731.

6 Global Transport Data Management (GTDM) framework

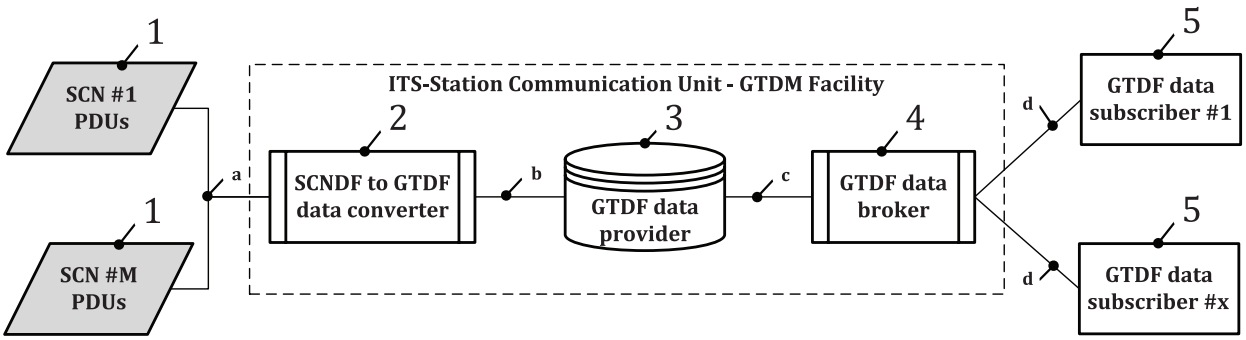
6.1 General

The data flow from sensor and control networks (e.g., in-vehicle networks, roadside station unit networks) to a data server, which functions as a data publisher, is illustrated in Figure 1. The technical

solution specified in this document addresses the complexity of converting protocol data units (PDUs) with raw (device-specific) data of any sensor and control network, of any kind of technical equipment, as part of the ITS eco-system into a standardized data format, called global transport data format (GTDF).

The state-of-the-art conversion of sensor and control network raw data is an implementation of conversion routines hard-coded in software in a gateway/an electronic control unit (ECU). The gateway/ECU provides the PDUs upon request/response scheme to a client.

The global transport data framework (GTDM) fulfills the function of data conversion of sensor and control network raw data in a flexible way, using configuration data specific for the sensor and control network connected to. The advantage of the configuration concept is the flexibility to use the same implementation architecture for different sensor and control networks.



Key

1 sensor and control network #1 to #s protocol data units

2 sensor and control network PDUs converted into GTDF data

3 GTDF data provider containing all data parameter values specified in the configuration(s)

4 GTDF data broker performs event-based transfer of instant updates or historically measured data according to subscription(s)

5 clients (GTDF data subscribers) subscribe to data parameters based on the implementation of use cases

a Sensor and control network protocol data units, containing raw signals in raw data format, forwarded to the SCNDF to GTDF data converter.

b GTDF data parameter values forwarded to the GTDF data provider.

c GTDF data provider provides data parameter values to the GTDF data broker for publishing to subscriber(#1 to #x).

d The GTDF data broker publishes data parameter values based on subscription by clients.

Figure 1 — Data flow from SCN data format to global transport data format

Figure 2 depicts the overall GTDM framework. Use cases are to be defined by stakeholders to identify the objectives, actors, input data and output data to achieve their objectives. Once the use cases are defined, the use case information is converted into requirement statements. Such requirements are implemented in use case-specific applications. The use case input and output information are converted into data parameters compatible to the GTDF specified in this document. GTDF defined data are based on data types specified in this document. One or more configurations are created based on use cases definitions. Applications can share their data in the same data format (GTDF). GTDF configurations are the data necessary to interpret data exchange between entities. The data flow is determined by the GTDF configurations.

NOTE Use cases and stakeholder task definitions are not within the scope of this document.

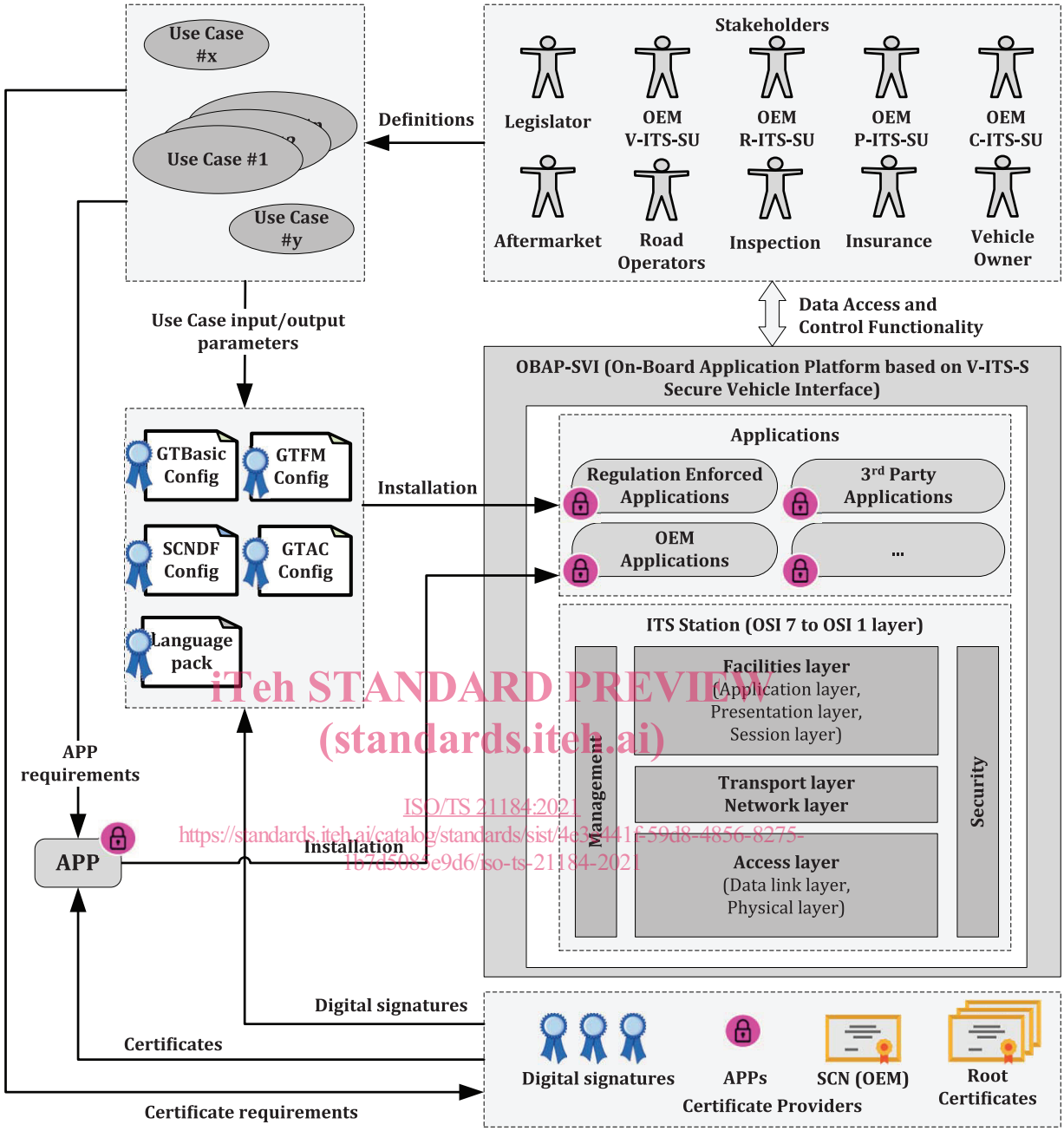


Figure 2 — GTDM framework

6.2 Applicable use case groups

6.2.1 General

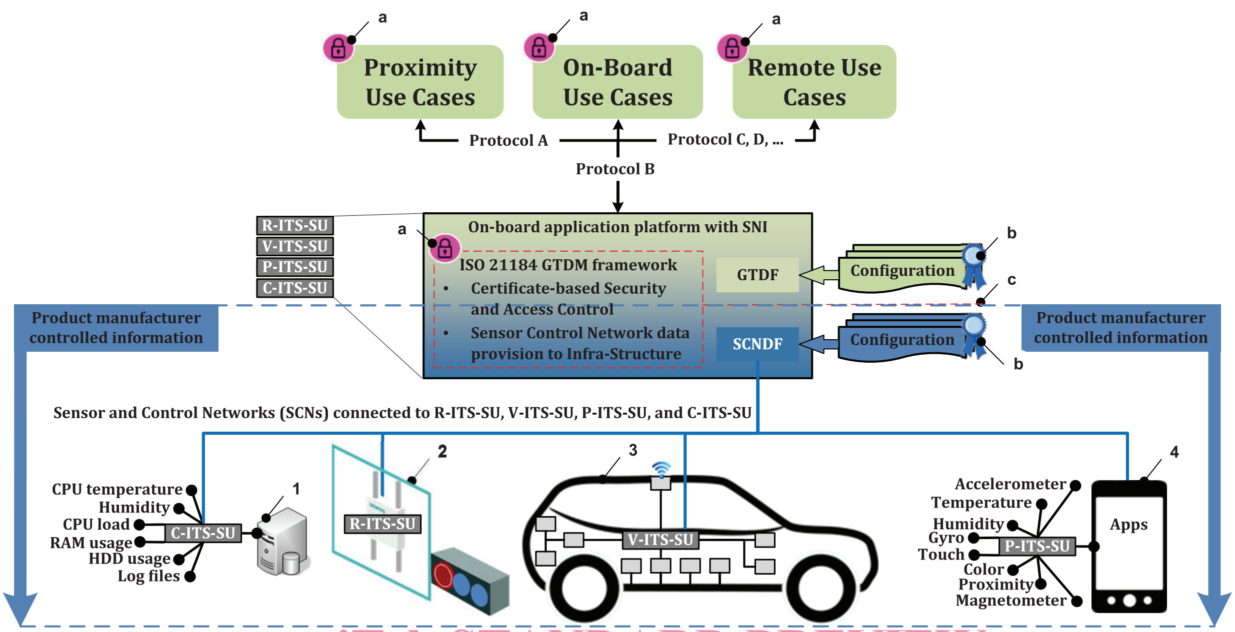
The use case groups (Proximity, On-Board, Remote) illustrated in Figure 3 are candidates for diagnostics inspection and maintenance, on-board applications, remote ITS applications and remote ITS applications and neutral backend server(s) applications, which utilize the GTDM framework (this document) implemented on a secure network interface (SNI). The secure communication interface software implements at least the requirements stated in the following documents:

— ISO/TS 21177;

— ISO/TS 21184 (this document); and

— ISO/TS 21185.

SNI implementations utilize the GTDM framework in combination with ISO 22900-2 D-PDU, the diagnostic protocol data unit, to interface to the SCN



Key

1 central station unit (C-ITS-SU) e.g. traffic management system backoffice server specific sensor and control network

2 roadside station unit (R-ITS-SU) specific sensor and control network

3 on-board unit (V-ITS-SU) specific sensor and control network

4 personal (smartphone) station unit (P-ITS-SU) specific sensor and control network

a IEEE 1609.2 certificate with Provider Service Identifier (PSID) and Service-Specific Permission (SSP) identifier.

b Digital signature for verifying the authenticity of digital configuration documents.

c Integrated firewall based on GTDF and SCNDF configuration file information.

Figure 3 — Application use cases and sensor and control networks

R-ITS-SU, V-ITS-SU, P-ITS-SU and C-ITS-SU products, implemented in accordance with the documents specified in Clause 2, are applicable for new designed products and retrofits.

The various use case-based applications illustrated are described in 6.2.4 to 6.2.6 and based on access to SCN examples. The same or similar use cases apply to R-ITS-SUs, for example.

6.2.2 GTDM framework operation

At startup, the GTDM framework software loads the GTDF configurations and optionally SCNDF configurations. Based on the content of the configurations, the software starts the communication with the SCN(s) and accesses raw information as specified in the SCNDF configurations. Once the protocol data units (PDUs) are available, the relevant information converted into the global transport data format (GTDF). Conversion information is contained in the SCNDF configuration. The timing of accessing raw data on the SCN(s) is defined in the scheduler as part of the SCNDF configuration. Various access methods (e.g. on event, periodic, request and response scheme) are available on how to access the data on the SCN(s). Each data item is assigned a raw data source identifier corresponding to its source function or physical unit, and a data parameter identifier. The combination of both identifiers makes it a unique identifier for a newly created or updated data item in the GTDM framework.

All data items (ECU data parameters) in GTDF are time stamped at the time of raw data reception. After conversion of the data from the raw data format to the standardized format, the information is forwarded to the GTDM Data Provider, which also supports a GTDM data broker function. The global transport protocol (GTP) services specified in this document are used to access and control data items. The GTP services provide a superset of functionality of the most common protocols (e.g. ISO 13185-2 UGP[2], ISO/IEC 19464 AMQP[4][15], MQTT[11], ProtBuf[12], W3C VIS[13]) used in the industry. A protocol service mapping and a data format converter needs to be installed for each protocol to interface with the GTP services.

6.2.3 GTDM certificate-based access control

The access control specified in this document is dedicated to the GTP services (see 8.4.3.2) and individual ECU data parameter depending on the content of the IEEE 1609.2 compatible certificates. The certificate contains a Provider Service Identifier (PSID) which is the equivalent of an ITS Application Identifier (ITS-AID), see 8.3.2. The certificate also includes a BitmapSsp (Bitmap Service-Specific Permission) structure, see 8.3.3. Figure 27 illustrates an example of a BitmapSsp including a role identifier. Examples of role are: predicitve maintenance, read-only vehicle diagnostics, enhanced vehicle diagnostics and station software update. A prerequisite of a client application accessing data and controlling functions of a station as shown in Figure 3 (R-ITS-SU, V-ITS-SU, P-ITS-SU, C-ITS-SU) requires an ITS-AID (PSID) and a BitmapSsp with an appropriate role identifier, which is compatible with the ITS-AID.

This example describes a diagnostic application (ITS-AID) which is limited to "predictive maintenance" (BitmapSsp: role = predictive maintenance) and therefore is not authorized to clear diagnostic trouble code information.

Table 1 describes an example of access control applied to GTP services and EcuDataParams.

Table 1 — Example of access control applied to GTP services and EcuDataParams

GTP service	EcuDataParam	BitmapSsp (role id)		
		1[a]	2[b]	3[c]
GetSupportedInfo(EcuDataParams)	provides a list of all supported combinations of ECU and data parameter: e.g., ECM.Calculated LOAD Value, ECM.Engine RPM, TCM.Vehicle Speed Sensor, ECM.Engine Idle Speed;	X[d]	X[d]	X[d]
GetSupportedInfo(DTCs)	provides a list of all supported DTCs by the SNI or a specific ECU connected to the SCN;	---[e]	---[e]	---[e]
GetSupportedInfo(Messages)	provides a list of all supported messages by the SNI: e.g., eCall Minimum Set of Data;	---[e]	---[e]	---[e]
SubscribeValues	ECM.Calculated LOAD Value	X[d]	X[d]	---[e]
	ECM.Engine RPM	X[d]	X[d]	---[e]
	TCM.Vehicle Speed Sensor	X[d]	X[d]	---[e]
PublishValues	ECM.Calculated LOAD Value	X[d]	X[d]	---[e]
	ECM.Engine RPM	X[d]	X[d]	---[e]
	TCM.Vehicle Speed Sensor	X[d]	X[d]	---[e]
SetValues	ECM.Engine Idle Speed	---[e]	X[d]	---[e]
ControlValues	ECM.Engine RPM	---[e]	X[d]	---[e]
SubscribeMessages	e.g. server application subscribes to eCall Minimum Set of Data message	---[e]	---[e]	---[e]

[a] Predictive maintenance application.

[b] Enhanced vehicle diagnostics.

[c] Station software update.

[d] Cell selected/feature defined.

[e] Empty cell/feature not selected.