ETSI TR 103 545 V1.1.1 (2018-08)

SmartM2M;
Pilot test definition and guidelines for testing cooperation between oneM2M and Ag equipment standards

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Smart Machine-to-Machine communications (SmartM2M).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Executive summary

Agricultural and Forestry accidents have a relevant social impact in the farming and forestry sector. A consistent number of accidents are involving agricultural machinery and road vehicles. In some cases, they cause heavy or fatal injuries. To increase and manage a proactive collaboration between the agriculture sector and the automotive industry, AEF, Agricultural Industry Electronics Foundation, decided to define a technical solution to mitigate the risk of collision. This solution intends to inform the drivers circulating at a higher speed on the public network that a slow-motion vehicle is entering the road or is on the road.

AEF had already started machine to machine (M2M) communication and through a collaboration with ETSI, AEF wants to extend these specifications in relation with the oneM2M and ITS environments.

The purpose and goal of oneM2M is to develop technical specifications which address the need for a common M2M Service Layer that can be readily embedded within various hardware and software and relied upon to connect the myriad of devices in the field with M2M application servers worldwide.

ITS "Intelligent Transport Systems" refers to the application of Information and Communication Technologies (ICT) to transport. These applications are being developed for different transport modes and for interaction between them.

AEF is the primary hub for ISOBUS knowledge and support, and the ITS and oneM2M environments combined with AEF Certified products were constituting the proper test environment to broadcast the warning message from agriculture and forestry equipment to the on-road vehicles via Cooperative ITS (C-ITS).

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The present document has the purpose of specifying a pilot test aiming at the dissemination of a warning message to road vehicles. The coordination between the detection of this event and the sending of the notification message will be done using an oneM2M platform in the tractor as a starting point.

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1 Scope

The present document provides the necessary input for a pilot Plugtests™ event to validate the possible cooperation between the oneM2M platform and AEF ISO 11783 standards implemented for communication inside and between agriculture & forestry machines. The document focuses on the description and planning of the pilot test, it is not intended to be at the level of a developer guide.

The pilot use case will consider a tractor entering a road from the fields. The collaboration of Agri IoT and the oneM2M platform will enable to trigger the transmission of an alarm to the cars on the road. ETSI TC ITS standards, such as ETSI EN 302 637-3 [i.4] (Decentralized Environmental Notification Basic Service) are also part of this cooperation between standards in the use case to be demonstrated.

2 References

2.1 Normative references

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2.2 Informative references

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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.

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

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 118 101: "oneM2M; Functional Architecture (oneM2M TS-0001)".

[i.2] ETSI TS 118 103: "oneM2M; Security solutions (oneM2M TS-0003)".

[i.3] ETSI EN 302 637-2: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".

[i.4] ETSI EN 302 637-3: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

[i.5] ISO 11783-7: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network -- Part 7: Implement messages application layer".

[i.6] ISO 11783-9: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network -- Part 9: Tractor ECU".

[i.7] AEF web site.

NOTE: Available at https://www.aef-online.org/home.html.

[i.8] ETSI TS 102 894-2 (V1.2.2): "Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary".

[i.9] 5th Cooperative Mobility Services Plugtests event; ETSI CTI Plugtests Guide V1.1.1 (2016-11).

NOTE: Available at https://portal.etsi.org/Portals/0/TBpages/CTI/Docs/ITS_CMS_Plugtest5_Tests_FINAL.pdf.

[i.10] ISO 11783-6: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network -- Part 6: Virtual terminal".

[i.11] ISO 11783-10: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network -- Part 10: Task controller and management information system data interchange".

[i.12] ETSI TS 118 104: "oneM2M; Service Layer Core Protocol (oneM2M TS-0004)".

[i.13] ETSI TS 118 109: "oneM2M; HTTP Protocol Binding (oneM2M TS-0009)".

[i.14] ISO 11783-1: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network -- Part 1: General standard for mobile data communication".

[i.15] ISO 11783-2: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network -- Part 2: Physical layer".

[i.16] ISO 11783-3: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network -- Part 3: Data link layer".

[i.17] ISO 11783-4: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network -- Part 4: Network layer".

[i.18] SAE J1939-2: "Agricultural and Forestry Off-Road Machinery and Communication Network".

[i.19] ISO 11898-2: "Road vehicles - Controller area network (CAN) -- Part 2: High-speed medium access unit".

[i.20] W3C Recommendation: "RDF 1.1 Concepts and Abstract Syntax", 25 February 2014.

[i.21] ETSI TS 118 113: "oneM2M; Interoperability Testing (oneM2M TS-0013)".

[i.22] ETSI EN 302 663: "Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band".

[i.23] ETSI TS 103 264: "SmartM2M; Smart Appliances; Reference Ontology and oneM2M Mapping".

[i.24] ETSI TS 118 112: "oneM2M; Base Ontology (oneM2M TS-0012)".

[i.25] ISO 11783 (all parts): "Tractors and machinery for agriculture and forestry -- Serial control and communications data network".

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3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

agriculture and forestry equipment: tractor, self-propelled machines (sprayer, combine harvester machine, tree harvester, forwarder, etc.)

implement: pulled equipment

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AE Application Entity
AEF Agricultural industry Electronics Foundation
AE-ID Application Entity Identifier
API Application Programming Interface
CAM Cooperative Awareness Message
CAN Controller Area Network
CCH Control Channel

CF	Control Function
C-ITS	Cooperative ITS
CMS	Cooperative Mobility Services
CoAP	Constrained Application Protocol
CRUD	Create Retrieve Update Delete
CSE	Common Services Entity
CSF	Common Services Function
DA	Destination Address
DENM	Decentralized Environmental Notification Message
DEULA	Bundesverband der Deutschen Lehranstalten für Agrartechnik
DIS	Discovery
DLG	Deutsche Landwirtschafts-Gesellschaft
DMR	Data Management and Repository
ECU	Electronic Control Unit
ECU-P	Electronic Control Unit in Private/proprietary vehicle network
ETSI	European Telecommunication Standards Institute
G5-CCH	ITS-G5 (ITS 5,9 GHZ frequency band) Control Channel
GN	Geo-Networking
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HAE	Host Agriculture or forestry Equipment
HF	High Frequency
HIL	Hardware In the Loop
HMI	Human Machine Interface
HT	Header Type
HTTP	HyperText Transfer Protocol
HV	Host Vehicle
ICT	Information and Communications Technologies
ID	IDentifier
IN	Infrastructure Node
IN-CSE	CSE which resides in the Infrastructure Node
IoT	Internet of Things
IP	Internet Protocol
IPC	Inter-Process Communication
IPE	Interworking Proxy application Entity
ISO	International Organization for Standardization
ISOBUS	ISO (11783) Bus
ITS	Intelligent Transport System
ITS-S	ITS Station
KPI	Key Performance Indicator
LF	Low Frequency
M2M	Machine to Machine
Mca	Reference Point for M2M Communication with AE
Mcc	Reference Point for M2M Communication with CSE
MCG	Management Computer Gateway
MN	Middle Node
MN-CSE	CSE which resides in the Middle Node
MQTT	Message Queuing Telemetry Transport
N&T	Networking and Transport
NSE	Network Service Entity
OBU	On-Board Unit
OSI	Open Systems Interconnection (model)
OWL	Web Ontology Language
PDU	Protocol Data Unit
PGN	Parameter Group Number
PT	Project Team
RDF	Resource Description Framework
REG	REGistration
REST	Representational State Transfer
RN	Resource Name
RSU	Road Side Unit
RTK	Real-Time Kinematics

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SA	Source Address
SAE	Society of Automotive Engineers
SAREF	Smart Appliances REFerence ontology
SEC	SECurity
SEM	SEMantics engine
SP	Service Provider
SUB	SUBscription and notification
TC	Technical Committee
TCP	Transmission Control Protocol
TECU	Tractor ECU
TMC	Traffic Monitoring Centre
UC	Use Case
UDP	User Datagram Protocol
URI	Uniform Resource Identifier
USB	Universal Serial Bus
UTC	Coordinated Universal Time
V2V	Vehicle to Vehicle
VT	Virtual Terminal
XML	eXtensible Markup Language

4 Global Overview

4.1 Rationale

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In many cases, the definition proposed by horizontal sectors is not correlated to the needs of the end-users in vertical applications. It is thus necessary to collect the real needs from the end-users or at the level of the machine producers. In the agricultural domain, the soil definition, the certification of the pulled equipment, all these KPIs are developed at the level of the vertical sector and an alignment of the sector with the main stakeholders of the industry already exists. Without a consolidation between the vertical domain and the horizontal domain, the KPIs can hardly be considered as benefits from the sector, and silos will remain. Security and safety also needs to be addressed across sectors as trust is a vital requirement between the different sectors.

The agricultural industry is supplying a diverse market and is driven by innovations of numerous manufacturers. The objective of the Agricultural Industry Electronics Foundation (AEF [i.7]) is the interoperability of different manufacturer's equipment via common standards. This is being facilitated by joint approaches of the industry to technical challenges around electrical systems, electronics and software in agricultural technology and farming.

Initially established in order to address standardization work for ISOBUS systems (ISO 11783, e.g. [i.5] and [i.6]), the AEF's focus was expanded to a wider range of topics including electrification, camera systems, farm management information systems, Ethernet communication and wireless in-field communication. Specifically, Project Team 11 (PT 11) handles wireless in-field communication. PT 11's focus spans from technology decisions for suitable radio standards and corresponding transport layer protocols for machine-to-machine (M2M) communication to vehicle security and functional reliability.

ISO 11783 [i.25] is a family of fourteen standards that specify the communication between connected Electronic Control Units (ECU) on the vehicle network of tractors and self-propelled agricultural machines as well as on detachable, pulled farm equipment. Parts 1 to 14 of the standard cover all layers of the protocol stack ranging from a Controller Area Network (CAN) topology at the physical layer up to the specification of control functions (CF) and Virtual Terminal (VT, remote control) sessions on application layer. All communication utilizes industry-wide standardized data dictionaries.

A typical ISO 11783 scenario comprises a tractor pulling a planter connected to the tractor's main ECU (Tractor ECU, TECU) via the ISOBUS network: The planter's domain-specific functionalities are being remote controlled via the VT (display) in the tractor cabin. At the same time the planter is receiving wheel speed and positioning signals from the TECU in order to adjust the planting rate to a user-defined target rate. The planter sends sensor data on work coverage and precision to the tractor network in order to be recorded by the corresponding ISO 11783 applications. In particular, via ISO 11783-7 [i.5] (Implement Messages Application Layer) and ISO 11783-9 [i.6] (Tractor ECU), the ISO 11783 implement network provides a gateway for the exchange of information between all the platforms of the agriculture & forestry industry.

The objective of the present document is to provide the necessary input for a pilot Plugtests™ event to validate the possible cooperation between the oneM2M platform [i.1] and AEF ISO 11783 standards [i.5], [i.6], [i.10], [i.11], [i.14], [i.15], [i.16] and [i.17] implemented for communication inside and between agriculture & forestry machines. ETSI TC ITS standards, such as ETSI EN 302 637-3 [i.4] (Decentralized Environmental Notification Basic Service) are part of this cooperation in the use case to be demonstrated.

The pilot Plugtests™ will focus on the interworking between the oneM2M platform and AEF ISO 11783 standards implemented for communication inside and between agriculture & forestry machines. The demonstrated use case will also make use of Cooperative ITS messages, described in ETSI TC ITS standards, such as ETSI EN 302 637-3 [i.4] (Decentralized Environmental Notification Basic Service).

4.2 Objective

The main scenario envisioned for the pilot Plugtests™ event consists in the dissemination of a warning message to road vehicles as soon as an agriculture or forestry equipment leaves the field for road transport. The coordination between the detection of this event and the sending of the notification message will be done using an oneM2M platform in the tractor.

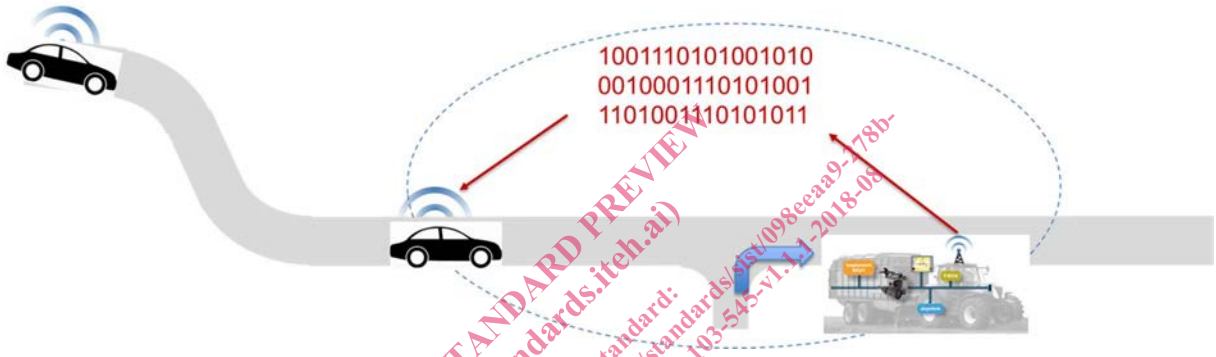

Figure 1: Schematic: Agriculture or forestry equipment leaves field and enters a road

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5 Scenario definition and collection of requirements

5.1 Detection of slow agriculture or forestry equipment on the road

5.1.1 Description

The scenario addresses the case when an agriculture or forestry equipment manoeuvring in a field enters a public road where other vehicles are passing by. This scenario is an adaptation and evolution of the test "UC2: Detection of dangerous goods information and local dissemination" described in clause 6.2 of the 5th Cooperative Mobility Services (CMS) Plugtests™ event (CMS5) [i.9].

The information related to the situation of the agriculture or forestry equipment is analysed and detected by a specialized ECU on the vehicle. In addition to the ISO 11783 stack, this ECU is connected to a M2M service platform (service and application entities) that collects the relevant data from the ECU. The M2M platform is also able to trigger the dissemination of C-ITS messages as needed to passing-by vehicles. The information that the equipment is entering the road is provided to neighbouring vehicles by a "slow vehicle" event, disseminated as a CAM (Cooperative Awareness Message) [i.3] and notified as needed as a DENM (Decentralized Environmental Notification Message) [i.4]. An alternate safety scenario can be envisioned in the reverse direction, i.e. when a CAM received from a car approaching on the road is transposed to the M2M platform and triggers an alert on the Human Machine Interface (HMI) of the agriculture or forestry equipment using its internal ECU. Due to the low network coverage in rural areas, V2V (Vehicle to Vehicle) communication is envisioned but dissemination of the information to an M2M application server through a road side unit (RSU) is also considered as a third alternate scenario.

The present clause describes the normal flow and the two alternative flows. The latter are presented for the purpose of completeness, they are considered as optional implementations. Only the normal flow will be studied in clause 6 and evaluated in the pilot test.

The envisioned protocol stack in the tractor is provided in Figure 2. Figure 2 shows the M2M service platform sitting on top of three pillars: an eMobility pillar on the left (or ITS station), able to send and receive C-ITS messages; an ISO 11783 pillar on the right, which provides selected data available on the vehicle network through a specific interface; and finally, an IoT communications pillar in the middle for sensors able to interface directly with the M2M platform. The definition of the mechanism for interfacing the M2M platform with the vehicle network for the pilot test is one of the main objectives of the present document. It should be noted that the third pillar is shown here (greyed) but most of the sensors on board of the agriculture or forestry equipment are expected to be connected through the ISO 11783-9 [i.6] TECU and comply with its security rules.

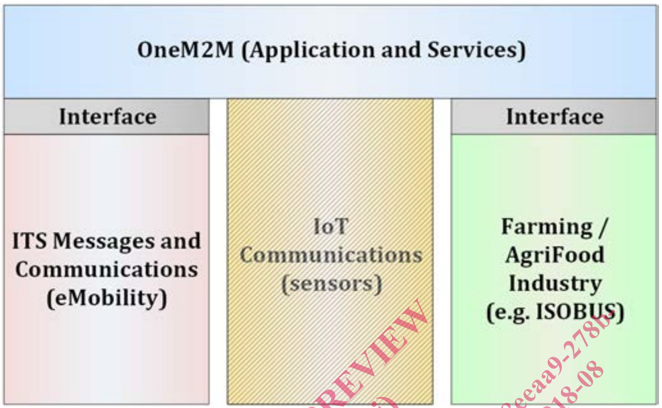

Figure 2: Envisioned protocol stack

5.1.2 Actors

- Vehicles from the agricultural domain are in the following being referred to as Host Agriculture or forestry Equipment (HAE). This includes tractors with and without pull-behind equipment as well as self-propelled equipment such as combine or forage harvesters, sprayers, potato or beet harvesters, forestry harvesters and forwarders.

- ISO 11783 certified agricultural vehicles are equipped with an ISOBUS terminal in order to read or adjust machine values and for remote control functionalities. The ISOBUS terminal in general includes a touch screen or several hardware buttons for user input. It is the central interface for machine information and safety warnings. In the following this on-board display is referred as the HAE HMI, which is considered an optional component for the below test scenario.

- One or several Host Vehicles (HV) are passing by on the road. A HV is equipped with a device capable to send, receive and process the C-ITS messages.

- The HMI of the HV is located in the on-board telematics unit. It is able to notify a warning to the driver of the vehicle through means such as a beep sound, a short text message appearing on a reduced screen, a visual sign on a larger screen or even a map showing the blinking position of the HAE.

- The RSU is an optional equipment used only for the alternative flow 2 as a communication relay between the devices in the vehicles. The RSU is able to receive and process all the received messages. It may be able to work autonomously to detect the safety issue or it may use an internet connection to the cloud, for example to connect to a traffic monitoring centre (TMC). In this case the RSU acts as a gateway between the vehicles (including the HAE) and the TMC.

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5.1.3 Pre-conditions

- The HV is driving on the road and approaches the pilot test area.
- The HAE is in the field and not in work state: HAE vehicles are likely to exceed the maximum allowed transport width for road traffic. Therefore, in case of a tractor with pull-behind equipment, the transport ("not-in-work") state refers to the implement being folded and not ready-to-work. For a self-propelled farm vehicle, the header required to pick up the harvest is folded as well or detached from the front of the HAE.
- For the HAE to determine its location change from field to road, it is essential to receive a reliable GNSS positioning signal. Besides that, ISO 11783 defines a set of signals considered helpful for the classification of the HAE's current position. The required information is sent out by one or more ISO 11783 certified ECUs on the vehicle's CAN bus. Additional manual indicators for the HAE operator's intention to enter the road are turn signals and the activation of a beacon light.
- The HV ITS Station OBU disseminates awareness messages (e.g. C-ITS CAMs), indicating its position, speed and direction, as provided by the HV sensors.

5.1.4 Triggers

The primary trigger for the use case in the normal flow described below is defined as the HAE's position change from "in the field" to "on (or entering) the road". An important objective for the warning sign is to avoid false positive notifications in order to preserve the significance of the warning information content. For the slow vehicle warning it is therefore crucial to rely on an accurate classifier for the two states of the HAE "operating in the field" and "participating in road traffic".

5.1.5 Normal Flow

In this flow, the HAE sends a notification and an alert is visualized in the HV HMI:

1) The HAE detects the change of location based on its GNSS receiver.
2) The HAE determines that the current position interferes with road traffic via offline map information. For additional validation of the intention to enter the road, it detects the transport mode from the machine state or a relevant operator input (e.g. turn signal).
3) The HAE disseminates the information using an event notification message (e.g. DENM).
4) The HV receives the event notification message. It is processed by the C-ITS stack and transferred to the relevant application for validation and comparison with the HV's own internal data (e.g. position and speed).
5) The application in the HV determines that the received notification is relevant and a safety issue may happen. It notifies the driver through the HV HMI to inform her/him that an action may be needed, for example slowing down.

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