ETSI TR 102 898 V1.1.1 (2013-04)

Technical Report

**Machine to Machine communications (M2M);
Use cases of Automotive Applications
in M2M capable networks**

Reference
DTR/M2M-00008

Keywords
3G, ITS, mobile, traffic

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Sous-Préfecture de Grasse (06) N° 7803/88

Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Machine-to-Machine communications (M2M).

The present document may be referenced by other TRs and Technical Standards (TS) developed by ETSI TC M2M. The present document is a TR and therefore, the content is informative, but when the present document is referenced by a TS, the referenced clauses may become normative with respect to the content of the referencing TS.

1 Scope

The present document includes Use Case descriptions for Automotive applications in context of Machine-to-Machine (M2M) communications. The described Use Cases will be used to derive service requirements and capabilities of the functional architecture specified in ETSI TC M2M.

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 reference 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.

Not applicable.

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 102 690: "Machine-to-Machine communications (M2M); Functional architecture".

[i.2] ETSI TS 131 102: "Universal Mobile Telecommunications System (UMTS); LTE; Characteristics of the Universal Subscriber Identity Module (USIM) application (3GPP TS 31.102)".

3 Definitions and abbreviations

3.1 Definitions

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

use case: system descriptions from the user point of view

NOTE: They treat the system as a black box, and the interactions with the system, including system responses, are perceived as from outside the system. Use cases typically avoid technical jargon, preferring instead the language of the end user or domain expert.

The present document on hand lists and defines **system use cases**, which are normally described at the system functionality level (for example, create voucher) and specify the function or the service system provides for the user. A system use case will describe what the actor achieves interacting with the system. For this reason it is recommended that a system use case specification begin with a verb (e.g. create voucher, select payments, exclude payment, cancel voucher). Generally, the actor could be a human user or another system interacting with the system being defined.

A brief use case consists of a few sentences summarizing the use case.

Use cases should not be confused with the features/requirements of the system under consideration. A use case may be related to one or more features/requirements, a feature/requirement may be related to one or more use cases.

3.2 Abbreviations

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

DTC	Diagnostic Trouble Code
EMS	Engine Management System
GPS	Global Positioning System
HAN	Home Area Network
ITS	Intelligent Transport Systems
M2M	Machine-to-Machine (Communications)
PAYD	Pay-As-You-Drive
PC	Personal Computer
SLA	Service Level Agreement
SVT	Stolen Vehicle Tracking
TCU	Telematics Control Unit
TV	Television
USIM	UMTS Subscriber Identity Module

NOTE: See TS 131 102 [i.2].

WAVE	Wireless Access in Vehicular Environments

4 Automotive Applications in M2M capable networks

4.1 General description of M2M automotive applications

In the context of the present document, M2M automotive applications encompass M2M use cases involving the automotive or transportation industries where the involved M2M communication modules can be embedded into a car or transportation equipment, for whatever purpose. This implies common requirements such as mobility management and environmental hardware constraints, despite the extended variety of applications addressed (insurance or road pricing, emergency assistance, fleet management, electric car charging management, traffic optimization, etc.). Use cases in the context of the present document are analyzed for their relevance to M2M communication services, i.e. derivation of specific requirements that can affect the TC M2M system.

4.2 Specific examples of M2M automotive applications

Automotive applications cover a wide variety of use cases and there is no typical configuration. This clause classifies example of existing services in the field under broader categories to illustrate the variety of possible applications. Actual use cases intended to derive requirements are the object of clause 5.

- Safety, security and other vehicle services: This includes the following:
    - bCall (Breakdown call): In its simplest form, a bCall (breakdown call) service will send the current vehicle position to a roadside assistance organization and initiate a voice call. The bCall trigger is usually a switch which is pushed by the user in order to activate the service. An 'enhanced' bCall service is one where current vehicle diagnostic information is transmitted in addition to the vehicle position. This could, in principle, allow the fault to be diagnosed remotely and appropriate action taken.

- Stolen vehicle tracking: The purpose of a Stolen Vehicle Tracking (SVT) system is to facilitate the recovery of the vehicle after theft. Usually, the owner first reports the theft to the police (obtaining a crime report number) prior to contacting their SVT service provider. The SVT service provider will request location data from the TCU in the vehicle periodically and liaise with the police. In some countries there are special requirements from insurers and the police covering the system specification and the robustness of the service. In more advanced systems, the TCU location will be protected against attack. The TCU can also be capable of sending out automatic theft alerts based on vehicle intrusion or illegal movement. The TCU can also be linked to the Engine Management System (EMS) to enable immobilization or speed degradation by remote command.

- Remote Diagnostics: Remote diagnostic services can broadly be grouped into the following different implementations:

  - Maintenance minder - when the vehicle reaches a certain mileage (e.g. 90 % of the manufacturer's recommended service interval since the previous service), the TCU will send a message to the owner or the owner's preferred dealership, advising them that the vehicle is due for service.

  - Health check - either on a periodic basis, or triggered by a request from the owner, the TCU compiles the vehicle's general status, using inbuilt diagnostic reporting functions, and transmits a diagnostic report to the owner, the owner's preferred dealership, or to the vehicle manufacturer.

  - Fault triggered - when a fault (DTC) is detected with one of the vehicle systems, this triggers the TCU to send the DTC code and any context information (e.g. snapshot data) to the owner's preferred dealer, or to the vehicle manufacturer.

  - Enhanced bCall - when a manual breakdown call is initiated by the owner, the TCU sends both position data and DTC status information to the roadside assistance service or the vehicle manufacturer. See Breakdown Services.

- Insurance services: Pay-As-You-Drive (PAYD) schemes offer insurers the chance to reduce costs, more accurately reflect actual risk and provide more competitive products to the end-user based on getting feedback from the vehicle as to when, where, how or how far the vehicle is being driven (or a combination of these factors). The first PAYD insurance schemes were small-scale trials and, where these were successful, they were launched as full-scale policies available to all owners. Insurance companies are starting to address issues such as privacy preservation, business models and service reliability.

• Connected Navigation: This includes the following:

  - Traffic reports: The purpose of a traffic report service is to inform the driver of traffic conditions relevant to the area in which they are driving, or a location on their intended route, so that they can alter their route to avoid heavy traffic if necessary. Traffic reports can be delivered to the driver verbally or visually. Where traffic information is given verbally, this can be from an operator in a call centre or using off-board text-to-speech conversion software. Where traffic reports are sent as data to the car, this can be using mobile phone or FM/HD/satellite radio (e.g. RDS-TMC) networks.Information can also include weather information.

  - Route planning: The purpose of this service is to provide the user with a means of planning their forthcoming journey using a PC, and to download the chosen destination to the vehicle. To access this service, the owner accesses to a PC and typically registers (e.g. user name and password) to use the service. This service can be provided via the vehicle manufacturer's web portal, or from a route planning website (e.g. Google Maps™). Once they are in the vehicle, the user typically has to manually request the destination download into the navigation system.

  - Infotainment - Information Provisioning: The purpose of this service is to provide information to driver and passengers, and may include:

    - Mobile TV

    - Internet connectivity for web browsing and email

    - Other types

5 Use cases for Automotive applications

The present clause details automotive-related use cases aimed at deriving specific requirements for the TC M2M system.

5.1 Overview

In clause 5.2, following a general introduction to each use cases, the stakeholders are introduced, then the use case scenario involving the stakeholders is described, and the involved information exchanges are highlighted. Then resulting requirements for the TC M2M System are derived. Clause 5.3 summarizes the resulting requirements on the TC M2M system.

5.2 Detailed use cases

5.2.1 Electric Vehicle Charging

5.2.1.1 General Use Case Description

The use cases described below address the particular needs of electricity vehicle charging. Three typical scenarios are considered; charging at the home; charging in an apartment complex; charging in a commercial complex. For each of these there are corresponding minor charge cycle scenarios; short duration boost charge; medium duration half charge; long duration slow charge.

The residential case considers a lightly populated urban environment with a low density of electric vehicles. The charging of vehicles then assumes that the load can be accommodated by the distribution network without the need for coordination with other charging stations. However, in use cases where electric vehicle owners cluster their charging this may result in excessive transformer loading. Similarly, where fast chargers are deployed, this will further increase transformer loading; both of the alternative residential scenarios necessitate coordination amongst charging stations.

The apartment complex case is a medium-high density urban environment with a corresponding density of vehicles. The charging of vehicles is assumed to occur over the same period, most likely during off peak periods, overnight or at weekends, necessitating some coordination amongst the vehicles on charge to assure that the distribution network capacity is not exceeded.

In the commercial complex case multiple simultaneous users are accommodated to assure that an adequate charge of the vehicles is achieved in the time available which can vary from a short interval, say half an hour, to an eight hour charge. In contrast with the apartment scenario the commercial case will involve charging of vehicles during peak and off-peak periods.

The associated minor charge cycles cover a short duration 30 minute boost cycle to accommodate an anticipated need for a limited capacity charge to accommodate a round trip of, say, 25 km. The medium term charge can be required within two hours to permit a round trip of 40 km. In both of these cases the tariff will be of less consideration to the consumer who has a time sensitive need. The overnight slow charge would assure a full charge with a charge cycle optimized to use low tariff electricity.

During a charging cycle and depending on the installation, 20 amps single phase to 100 amps three phase per connection point can be draw from the power network. In the medium and high density scenarios described above this can stress the supply network. In order to minimize the adverse effects of peak loading on the network and the longevity of network assets, a decentralized coordination and control system is envisaged.

5.2.1.2 Stakeholders

Asset Responsible Entity

Bill Responsible Entity

Distribution Network Operator

Efficiency Responsible Entity

Read Data Recipient

Consumer

5.2.1.3 Scenario

Pre-Conditions:

Distribution Network available.

Charging station in service.

Charging station compatible with vehicle.

Communication systems connecting the Vehicle, Charging station, HAN, Read Data Recipient, Distribution Network Operator and Bill Responsible Entity are in service.

The relevant service level agreements are in place with the designated network operator. e.g. The Pacific Gas & Electric Company (PG&E) envisaged approach is that each vehicle owner will have a fast charge station. The Consumer will sign a contract with the Distribution Network Operator ensuring a low tariff and the Distribution Operator's service level agreement with the Consumer will be to ensure that the car is fully charged by some contracted time, e.g. before 6AM.

Post Conditions:

Charging station terminates the charging cycle and performs the necessary system resets.

Necessary control information exchanged with collocated charging stations.

Necessary billing information sent to the read data recipient and billing responsible entities.

Trigger:

The Consumer initiates the charging cycle.

5.2.1.4 Information Exchanges

1) Charging station detects the presence of a vehicle and establishes the relevant communication links with the appropriate stakeholders. e.g. Consumer, Distribution Network Operator.
2) Consumer presents his credentials (e.g. enters user ID and Password; waves a key fob; swipes a card, logs in remotely).
3) Charging station verifies consumer details.
4) Consumer enters charge cycle required.
5) Charging station determines the current state of charge of the vehicle and signals the local control point.
6) Charging station searches for other connected vehicles under charge.
7) Local negotiation between charging stations to schedule charging.
8) Consumer advised of the charge time.
9) Charging station initiates the charge profile.
10) Charging station switches charge mode and current is drawn from the network.
11) Charging station coordinates with other local systems to maintain network loading within normal limits.
12) Charging station signals charging cycle complete to other locally connected users.
13) Payment details are signalled to the read data recipient and the consumer.
14) Charging station switches to self maintenance mode and signals standby.

Self maintenance mode completes and the charging station signals operational mode.

5.2.1.5 Potential new requirements

- *Responsive, reliable, adaptive, low latency, secure communications with localized control are required.*
- *Reliability and responsiveness are key, as the user cannot be trained to wait for his credentials to be authenticated/authorized.*
- *Low latency, adaptive communications with localized control are required for the real time negotiation and control of the distribution network by coordinating demand-response of multiple vehicle charging stations.*
- *High reliability and low latency is required to ensure effective and quick communication between vehicle and traffic information service; premium (paid) service might require QoS and SLA agreements.*

5.2.1.6 Use case source

Electric Vehicle and Plug-In Hybrid Electric Vehicle Use case scenarios: Open Smart Grid Users Group.

http://osgug.ucaiug.org/sgsystems/openhan/Use%20Case%20Contributions/Forms/AllItems.aspx

5.2.2 Fleet Management / Theft Tracking

5.2.2.1 General Use Case Description

One often-envisioned application for automotive M2M communications is to track mobile assets - either for purposes of managing a fleet of vehicles or to determine the location of stolen property.

The two applications are treated in one use case because the network topology and the information flow in both cases are identical.

This is an important M2M use case for two reasons. First, it employs a subset of the generic M2M architecture described in TS 102 690 (M2M Functional Architecture) [i.1] and this use case can serve as guidance to the industry on how to configure and deploy an M2M network for fleet management and/or theft tracking. Second, this use case captures requirements that are unique to a specific class of M2M applications involving devices that are highly mobile (i.e. moving at a high velocity over a wide geographic region) and that interface with location-determination technology.

5.2.2.2 Stakeholders

Asset Owners: These are the individuals or corporate entities that own (or are responsible for) the vehicles being tracked. Asset Owners can trigger an M2M communication session to determine asset location, and will receive location reports from assets.

High Value Assets: These are vehicles with embedded M2M Devices that can interface with location-determination technology and can communicate via a mobile telecommunications network to an entity (server) in the M2M Core. The M2M Devices will communicate directly with the telecommunications network and not via a gateway or proxy. The M2M Devices will interface with location-determination technology such as standalone GPS or network-based mechanisms such as assisted-GPS, Cell-ID, etc. For theft-tracking applications the M2M Device might be embedded in an inaccessible or inconspicuous place so that it cannot be easily disabled by a thief.

Location Infrastructure: This consists of the elements external to the M2M architecture that provide determination of the M2M device position. This could consist, for example, of a GPS receiver in concert with the GPS infrastructure, or telecommunications network location methods such as assisted GPS, Enhanced Observed Time Difference, or Cell ID.

Telecommunication Network and Operator: The M2M Devices interface directly with a mobile telecommunications network capable of servicing the geographic area within which the High Value Assets are expected to be located.

Tracking Server: The Tracking Server is an entity located in the M2M Core and owned or operated by the Asset Owner to receive, process, and render location and velocity information provided by the deployed High Value Assets. The Tracking Server can trigger a particular M2M Device to provide a location/velocity update, or the deployed M2M Devices can be configured to autonomously provide updates on schedule or upon an event-based trigger.

5.2.2.3 Scenario

The typical fleet management scenario presupposes that a fleet of vehicles has been deployed with M2M Devices installed that are able to:

- Interface with sensors on the vehicle that measure velocity.
- Interface with devices that can detect position.
- Establish a link with a mobile telecommunication network using appropriate network access credentials, such as a USIM.

The fleet owner wishes to track the vehicles - that is, to know, over time, the location and velocity of each vehicle - in order to plan and optimize business operations. A server in the fleet owner's employ receives, aggregates, and processes the tracking data from the fleet and provides this information to the fleet owner.

The network topology for this use case is a simplified version of the generic M2M network described in TS 102 690 [i.1], consisting of M2M Devices connected to an M2M Server through a telecommunication network, as shown conceptually in figure 1.

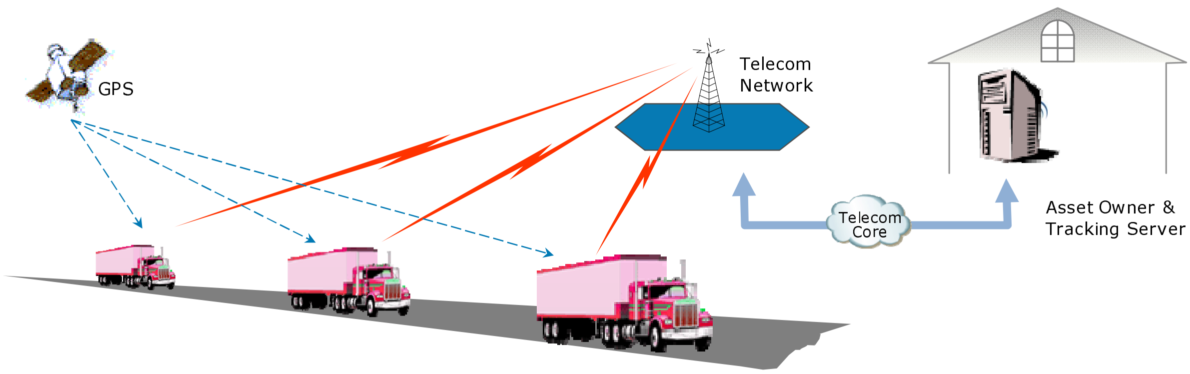

Figure 1

Devices could be configured to autonomously establish communication with the Server via the telecom network either at regular intervals, prescheduled times, or based on some event such as crossing a geographic threshold. Alternatively, the M2M Devices could be commanded by the M2M Server to report their location/velocity data.

In a typical fleet management scenario, a sequence of operations might be as follows:

1) The Fleet Management Server (M2M Server) downloads reporting parameters into the M2M Devices deployed in the fleet vehicles. These parameters might consist of scheduled times to measure location and velocity and report back to the Server, a reporting interval, or trigger conditions under which to report.

2) The fleet, containing the M2M Devices is deployed.

3) Upon schedule or trigger, the M2M Devices establish a position fix and vehicle velocity measurement.

4) The M2M Device attempts to establish a data connection with the Fleet Management Server via the mobile telecommunications network to which the fleet is subscribed, using credentials supplied by the network operator.

5) Data from the M2M device is uploaded to the Fleet Management Server.

6) The received data is processed by the M2M Server and formulated into a time vs. position map for each vehicle in the fleet.

The theft tracking scenario is similar to the fleet management scenario except that the M2M Device would not autonomously establish communication with the M2M Server but rather would do so upon command by the M2M Server.

5.2.2.4 Information Exchanges

In the Fleet Management use case, information is exchanged bi-directionally between the M2M Devices (vehicles) and the M2M Server (Fleet Management Server), as well as between the external location infrastructure and the M2M Devices.

M2M Server to M2M Devices:

1) Provisioning Information: This consists of reporting intervals, reporting schedule, or a set of triggering events under which the M2M Device is to establish a communication link and contact the M2M Server.

2) Position Request: A command from Server to Device to establish a position and velocity vector pair and report these back to the Server.

M2M Devices to M2M Server:

1) Position/Velocity Data: This is a set of data consisting of the position of the vehicle, its velocity and a time tag. The time tag can be generated either by the Device or the Server, depending upon the application.

Location Infrastructure to M2M Device:

Positioning Information: Depending on the location technology employed, this can be information received by the M2M device with which it establishes position (e.g. GPS data), or it can be the position information itself (e.g. Cell ID from the network).

5.2.2.5 Potential new requirements

The following basic requirements need to be satisfied:

a) *the capability of M2M Devices to receive, store, and execute scheduled measurements;*

b) *the ability of Devices to poll and check for occurrence of events;*

c) *the capability of Devices to autonomously establish a connection directly with a mobile telecommunication network;*

d) *the capability for Devices to be able to maintain M2M communications while moving at high velocity and over a wide geographic area;*

e) *the ability of devices to be able to be contacted ("called") directly by a mobile telecommunication network;*

f) *the inclusion of position-determination capability.*

5.2.3 Vehicle-to-Infrastructure communications

5.2.3.1 General Use Case Description

Proposed European ITS Directive paves way forward for the implementation of eSafety applications into vehicles, whilst the eCall as the European initiative will bring mobile communication into the vehicle at rapid pace.

Whilst Vehicle manufacturers have begun to drive Vehicle-to-Vehicle communication with - for instance - Wireless Access in Vehicular Environments (WAVE) and pWLAN - Vehicle to roadside use case has not been covered to its full extent in earlier M2M use cases and also improves the viability of the Automotive M2M business case.

5.2.3.2 Stakeholders

Asset Owners/Users

Assets: These are vehicles with embedded M2M Devices that can interface with location-determination technology and can communicate via a mobile telecommunications network to an entity (server).

Location Infrastructure

Telecommunication Network and Operator: The M2M Devices interface directly with a mobile telecommunications network capable of servicing the geographic area within which the Assets are expected to be located.

Traffic Information Server: The Traffic Information Server is an entity owned or operated by the Road Infrastructure Owner to receive, process, and transmit traffic (safety) information to and from vehicles.

5.2.3.3 Scenario

The typical scenario presupposes that vehicles have been deployed with M2M Devices installed that are able to:

- interface with sensors on the vehicle that measure velocity, external impacts - but also can interface with in-vehicle components such as braking systems, manoeuvring systems and external systems such as intersection assistants and road works beacons; or
- interface with devices that can detect position;
- establish a link with a mobile telecommunication network using appropriate network access credentials, such as a USIM;
- up- or download traffic and safety information to a Traffic Information Server.

The network topology for this use case is a simplified version of the generic M2M network described in TS 102 690 [i.1], consisting of M2M Devices connected to a Traffic Information Server through a telecommunication network.

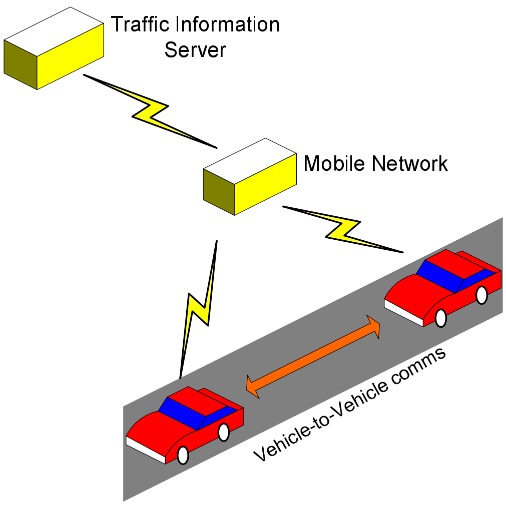

Figure 2

Devices could be configured to establish communication with the Server via the telecom network via a push or pull mechanism, and/or based on some event triggered by a vehicle sensor such as external impact, motor failure, etc.

A sequence of operations might be as follows:

External event:

- The traffic information server pushes roadside or emergency information out to vehicles that can be determined by:
  - Location (cell location or actual location)
  - Subscription base

Internal Event:

- Vehicle information is pushed to the traffic information server based on:
    - External sensor information
    - Internal sensor information
    - Subscription base, e.g. floating car data, etc.

5.2.3.4 Information Exchanges

Traffic Information Server to M2M Devices:

1) Configuration Information: This consists of reporting intervals, reporting schedule, or a set of triggering events under which the M2M Device is to establish a communication link and contact the Traffic Information Server.

2) Event Information; consisting of information regarding traffic status, traffic flow, incidents, road closures, hazard warnings, etc.

M2M Devices to Traffic Information Server:

1) Position/Velocity Data: This is a set of data consisting of the position of the vehicle, its velocity and a time tag.

2) Event information: this is a set of data providing why the exchange has been initiated (external impact, engine failure, etc).

5.2.3.5 Potential new requirements

a) The capability of M2M Devices to interface with in-car sensors.

b) The capability of M2M Devices to interface with vehicle to vehicle communication systems.

c) The capability of M2M Devices to autonomously establish a connection directly with a mobile telecommunication network.

5.3 Requirements resulting from use cases

From the above use cases and potential new requirements, the following directions for extending the TC M2M service layer requirements can deserve further investigations: system responsiveness (including latency and reliability, in relation with the velocity of the devices), and support of coverage over wide geographic areas (which can involve roaming across underlying networks).

History

Document history		
V1.1.1	April 2013	Publication