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Road vehicles — Software update over the air using mobile cellular network

DTR stage

A model document of an International Standard (the Model International Standard) is available at:
Véhicules routiers — Mise à jour du logiciel à distance (OTA) à l'aide d'un réseau cellulaire mobile

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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 22, *"Road vehicles"*, Subcommittee SC 32, *"Electrical and electronic components and general system aspects"*.

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

~~ECU~~The electronic control units (ECUs) and their software have become major components of road vehicles in recent years. ~~In~~Software, in particular, ~~software needs to~~must be updated as it is frequently revised.

— The need for updating software is more prominent as cybersecurity and passenger safety become more dependent on software.

— The software-update operation was usually performed at workshops, which was very inconvenient for vehicle users.

The ECUs requiring software-update ~~operation~~operations range from a smart key to power train ECUs.

— These days, the software-update operation for ECUs has become possible even while vehicles are serviced in gas stations. Moreover, mobile cellular networks can be used to update vehicle software regardless of the vehicle location.

ISO 24089~~:2023~~ was published as the standard for vehicle software update engineering. ~~This standard~~ISO 24089 addresses the requirements on the organization, software-update project, infrastructure level, vehicle and vehicle-systems level, software-update package~~,~~ and software-update campaign, among others. However, ISO 24089~~:2023~~ does not address the actual technologies and procedures for updating software.

This ~~technical report~~document describes an actual experience involving technologies and systems for updating software using mobile cellular networks. In addition, the results of verification by mounting the ECU developed in this ~~technical report~~document on an actual vehicle are included.

Road vehicles — Software update over the air using mobile cellular network

1 Scope

This technical reportdocument describes use cases and activities for updating software in vehicles over the air using mobile cellular network. This document provides a case study on the use of international standardsInternational Standards in preparing software-update packages, managing infrastructure and operation within the vehicles.

This document includes descriptions of a reference model for software-update operations and metadata which can be used during the software-update operations.

2 Normative references

There are no normative references in this document.

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 24089, *Road vehicles — Software update engineering*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 24089:2023 and the following apply.

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

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

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

~~3.1~~

3.1

to archive

to store logs and records on a permanent medium such that they may be *retrieved* (3.9) at a later date

~~3.1~~3.2 ~~3.2~~

authentication

act of proving an assertion, such as the identity of a computer system user

~~3.2~~3.3 ~~3.3~~

authorization

formal permission to use a product within specified application constraints

~~3.3~~3.4 ~~3.4~~

cryptography

discipline that embodies the principles, means, and methods for the transformation of data in order to hide their semantic content, prevent their unauthorized use, or prevent their undetected modification

[SOURCE: ISO/IEC 2382-~~8:1998~~:2015, 2126278]

3.43.53.5
Ethernet
communication protocol specified in ISO/IEC/8802-3:2021

3.53.63.6
metadata
data that provides information about other data

3.63.73.7
mobile cellular network
telecommunications network where the link to and from end nodes is wireless and the network is distributed over land areas called cells

3.73.83.8
non-repudiation
ability to prove the occurrence of a claimed event or action and its originating entities

[SOUCRESOURCE: ISO/IEC 27002:2022, 3.1.19]

3.9
3.9
to **retrieve**
to restore from the *archived* (3.1) data

3.83.10 3.10
validation
confirmation, through the provision of objective evidence, that the cybersecurity goals of the item are adequate and are achieved

[SOURCE: ISO/SAE 21434:2021, 3.1.36]

3.93.11 3.11
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

[SOURCE: ISO/SAE 21434:2021, 3.1.37]

4 Abbreviated terms

ACC Accessory

AVB Audio Video Bridge

AVN Audio Video Navigation

AVTP Audio Video Transport Protocol

BCU Body Control Unit

BSB Binary Software Block

CAN Controller Area Network

CM Campaign Management

DoIP	Diagnostic communication over Internet Protocol
DS	Digital Signature
ECU	Electronic Control Unit
EOL	End of Line
E2E	End to End
HMI	Human Machine Interface
HSM	Hardware Security Module
ITS	Intelligent Transport Systems
IVN	In-Vehicle Network
KMIP	Key Management Interoperability Protocol
KMS	Key Management Server
LDM	Local Dynamic Map
LKAS	Lane Keeping Assist System
MAC	Message Authentication Code
MFA	Multi Factor Authentication
NIST	National Institute of Standards and Technology
OTAM	OTA Master
OTP	One Time Password
SM	Software Management
SUP	Software Update Package
SUV	Sport Utility Vehicles
TSN	Time-Sensitive Networking
UDS	Unified Diagnostic Services
URL	Uniform Resource Locator
VCI	Vehicle Configuration Information
VIN	Vehicle Identification Number
VM	Vehicle Management
VMG	Vehicle Mobile Gateway

ACC	Accessory
AVB	Audio Video Bridge
AVN	Audio Video Navigation
AVTP	Audio Video Transport Protocol
BCU	Body Control Unit
BSB	Binary Software Block
CAN	Controller Area Network
CM	Campaign Management
DoIP	Diagnostic communication over Internet Protocol
DS	Digital Signature
ECU	Electronic Control Unit
EOL	End of Line
E2E	End to End
HMI	Human Machine Interface
HSM	Hardware Security Module
ITS	Intelligent Transport Systems
IVN	In-Vehicle Network
KMIP	Key Management Interoperability Protocol
KMS	Key Management Server
LDM	Local Dynamic Map
LKAS	Lane Keeping Assist System
MAC	Message Authentication Code
MFA	Multi Factor Authentication
NIST	National Institute of Standards and Technology
OTA	Over The Air
OTAM	OTA Master
OTP	One Time Password
SM	Software Management
SUP	Software Update Package
SUV	Sport Utility Vehicles
TLS	Transport Layer Security
TSN	Time-Sensitive Networking
UDS	Unified Diagnostic Services
URL	Uniform Resource Locator
VCI	Vehicle Configuration Information
VIN	Vehicle Identification Number
VM	Vehicle Management

VMG Vehicle Mobile Gateway

5 General

5.1 Purpose

The purpose of this document is to share the technical experiences in using mobile cellular networks for updating software in vehicle ECUs, and to share the experience in the adoption of related ~~international standards~~International Standards such as ISO 24089~~:2023~~.

5.2 Structure of ~~the report~~this document

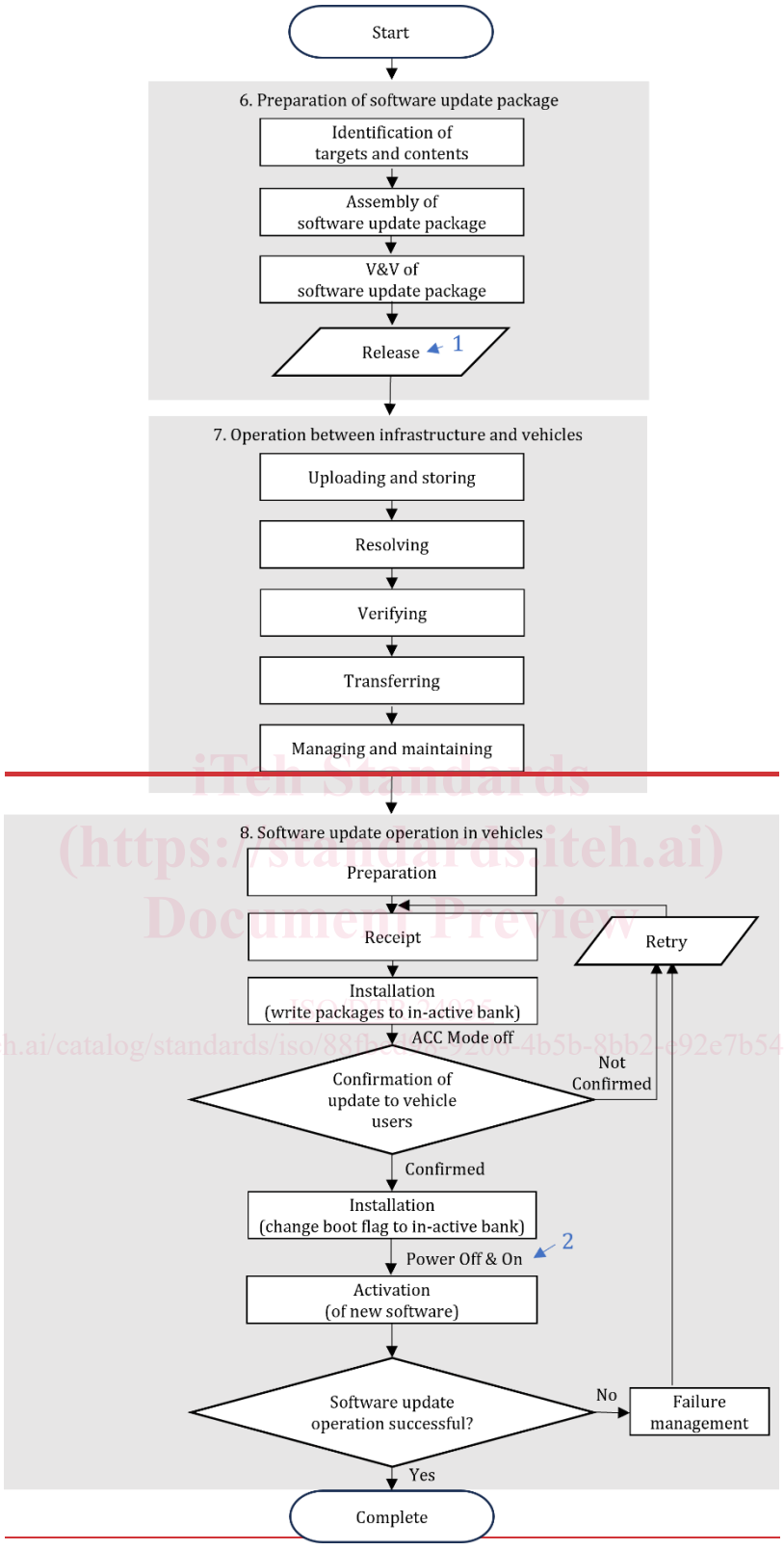
Clause 5 describes the purpose and the structure of this ~~technical report.~~document. It also describes basic and cybersecurity models for the software-update operation.

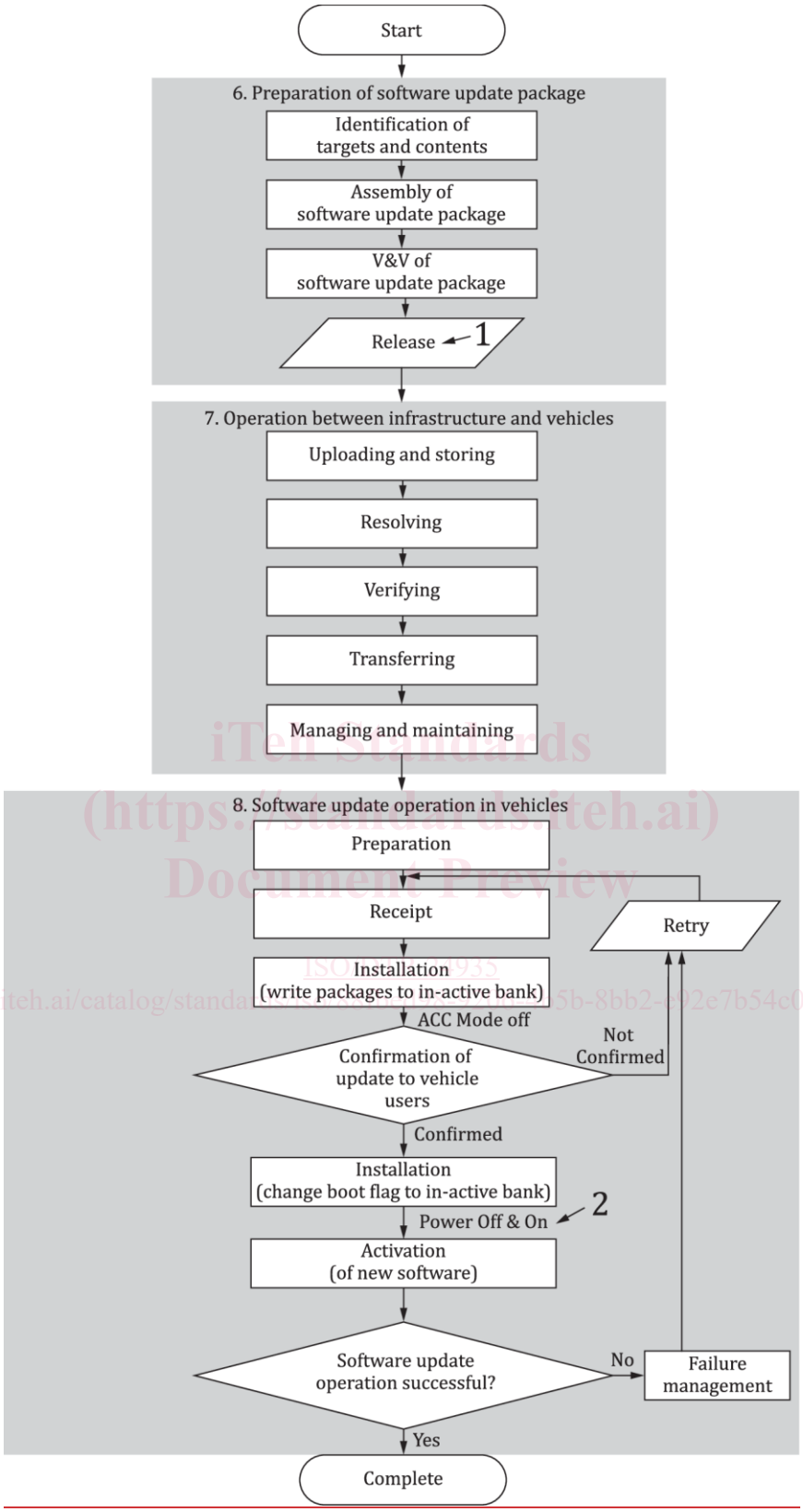
Clause 6 describes the preparation of the software-update package. This clause includes roles of vehicle manufacturers and suppliers in the software-update process for vehicle ECUs.

Clause 7 describes the capabilities and functions, which are used to perform the activities during the software-update campaign in the update server. It also describes the flow of activities involved during the software-update operation.

Clause 8 describes the software-update operations. This clause includes software-update operations in the IVN.

Clause 9 describes the results of evaluating the software-update operation in actual vehicles.





Key

~~1 Software update packages are released.~~

~~2 The vehicle is powered off and on.~~

1 software-update packages (SUPs) are released

2 vehicle is powered off and on

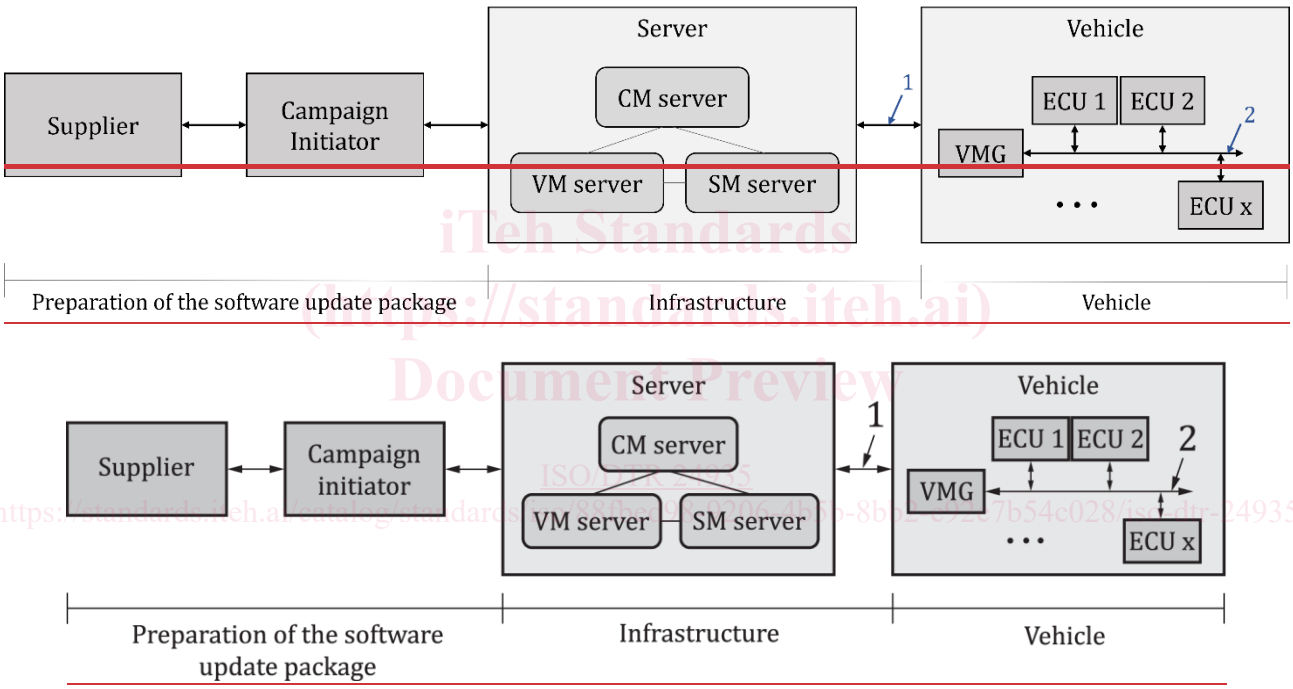
Figure 1 — Overview of software-update activities

Figure 1 shows the overview of the software-update activities and the corresponding clauses which explain the activities.

Once the ~~software update package~~SUP is ready, ~~the software update package~~it is released. Then the interaction of the infrastructure and the vehicle takes place. When the vehicle is turned on (power on), the vehicle is ready to install a new SUP in ACC mode and begins to write the SUP in an in-active bank. After the ACC mode is turned off, the installation and activation take place if the vehicle user agrees to the software-update operations.

5.3 Reference model

The basic model, which is used in this ~~technical report~~document, consists of three parts: preparation of the ~~software update package~~SUP, infrastructure~~,~~ and vehicle (see Figure 2).



Key

~~1 Mobile cellular network~~

~~2 In-vehicle network (e.g. CAN or automotive Ethernet)~~

1 mobile cellular network

2 in-vehicle network (e.g. CAN or automotive Ethernet)

Figure 2 — Reference model for the software-update activities

The preparation of the ~~software update package~~SUP part covers the development of the software to be updated, and tools or methodologies for identifying the target vehicles whose ECU is to be updated by the software-update operation. It also addresses generation of the metadata which can be used by infrastructure or vehicles during the software-update operation, and creation of the ~~software update package~~SUP by adding appropriate additional information such as cybersecurity-related information. However, the development of the software itself is out of scope in this ~~technical report~~document.