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Navigation data delivery structures and protocols

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The UK participation in its preparation was entrusted to Technical Committee EPL/278, Road transport informatics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Navigation data delivery structures and protocols

Structures et protocoles pour la diffusion de données dans les systèmes de navigation

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 24099 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

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Introduction

This International Standard was developed in relation to growing market demand for dynamic update services for map-related data in navigation systems. Map-related data includes not only feature geometry and attributes but also point of interest (POI) data such as hotels, restaurants, and dynamic content such as traffic, weather, movie schedules, parking availability, etc. Currently, most map data updates are provided on physical media whose map data content begins aging rapidly once it is delivered to the user. In the future, it is anticipated that the transmission of these data will most often, but not exclusively, be via wireless means. The advantage of wireless data delivery is that it simplifies the distribution logistics thereby accelerating the ability of a consumer to receive fresher data. This International Standard facilitates the potential for on-demand updates of on-board map databases. Further, the updates do not necessarily require the replacement of an entire map database. Rather, the updates can be limited to a portion of a dataset or a specific list of attributes or POI changes can also be provided.

The services described above have begun to be deployed in a non-interoperable manner by various car manufacturers and information system providers. This International Standard is intended to promote the successful widespread adoption of such services through user access to an interoperable network of servers offering more content choices than is available through a single provider.

This International Standard defines the data structures and protocol needed to enable interoperability between multiple content providers and consumers of map-related data content in a wireless environment. As far as possible the data structures are compatible with the ISO geographic data file (GDF) data model. Different software profiles can be developed to support various system configurations: systems which store all data in the vehicle (on-board), systems which store all data in a central server (off-board), and systems which use both on-board and off-board data storage (hybrid).

Furthermore, this International Standard is designed to utilize the communications protocols such as those under development in TC 204/WG 16. This International Standard recognizes the possible need for security mechanisms in the provision of this data.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning procedures, methods and/or formats given in this document.

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Navigation data delivery structures and protocols

1 Scope

This International Standard defines the data structures and protocol(s) used in intelligent transport system (ITS) applications for the delivery and update of map-related data from Service Centre (SC) to users [(In-vehicle Systems (IVS)].

This International Standard also specifies the message generation protocols in the Service Centre and the message receiving protocols in the In-vehicle Systems.

The map centre specified in this International Standard represents the supplier of map data and the Service Centre provides data and services to user devices.

The term protocol as used in this International Standard is a temporal sequence of map-related data interactions between system components that implement map-related data delivery and update. The delivery and update of map-related data rely on existing communication technology. The protocols associated with communication technology, and the other application control protocols and non-map-related data, for example images to display independent of the map database such as HTML images, are outside the scope of this International Standard.

Definitions of security mechanisms and business transaction mechanisms are also outside the scope of this International Standard.

Figure 1 below illustrates the scope of this International Standard.

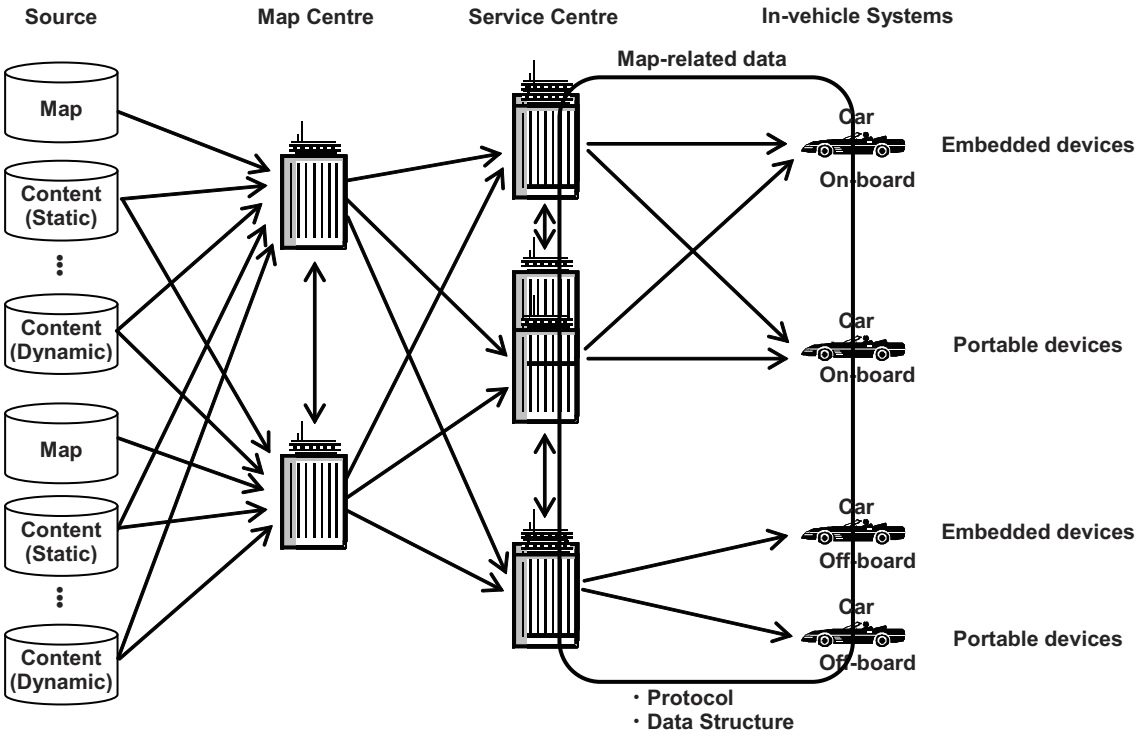

Figure 1 — Scope of this International Standard

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2 Conformance

Protocols and data structures shall be provided as specified in Clauses 8 and 9.

Any protocols and data structures claiming conformance with this International Standard shall pass the requirements presented in the abstract test suite in Annex A.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
address location
application category that deals with the task of expressing a real world position in terms of the physical storage format (PSF) data representation

NOTE One of the six application categories supported by the physical storage format (PSF) and the application programming interface (API) and defined in ISO/TS 20452.

3.2
application category
basic sub-function within the set of functionality for vehicle navigation and traveller information system applications

NOTE ISO/TS 20452 identifies six application categories: positioning, route planning, route guidance, map display, address location, services and point of interest (POI) information access.

3.3
data broadcasting
one-way communication by a Service Centre

3.4
data providing
two-way communication of data initiated by the In-vehicle System in which the version is controlled by the Service Centre

3.5
data pushing
two-way communication of data initiated by the Service Centre

3.6
data retrieving
two-way communication of data initiated by the In-vehicle System in which the version is controlled by the In-vehicle System

3.7
emergency data
data that is safety and/or security related

NOTE This data can be unilaterally sent by a sender to a user (such as data of accidents or disasters).

3.8
incremental update
action allowing for the replacement, insertion or deletion of features and/or attributes only when they change from a previous version of the data set

3.9
in-vehicle system
function that receives update data and provides navigation and traveller information system applications

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3.10
map centre
supplier of map data

3.11
map data
shape data composed from road, background and topology data (such as features, geometry, and attributions)

3.12
map display
application category that deals with graphical information presentation

NOTE One of the six application categories supported by the physical storage format (PSF) and the application programming interface (API) and defined in ISO/TS 20452.

3.13
point of interest (POI) data
destination and/or site of interest to travellers (such as restaurants)

3.14
positioning
application category that deals with the determination of vehicle location and map matching

NOTE One of the six application categories supported by the physical storage format (PSF) and the application programming interface (API) and defined in ISO/TS 20452.

3.15
protocol
computer language enabling computers that are connected to each other to communicate

NOTE Protocol here is as sequence.

3.16
route guidance
application category that deals with the generation of graphical, textual, and/or audio instructions for following a planned route

NOTE One of the six application categories supported by the physical storage format (PSF) and the application programming interface (API) and defined in ISO/TS 20452.

3.17
route planning
application category that deals with the determination of routes between specified points

NOTE One of the six application categories supported by the physical storage format (PSF) and the application programming interface (API) and defined in ISO/TS 20452.

3.18
update target
the object of update, which is sometimes specified by area, and the other times by features and attributes

NOTE One of the six application categories supported by the physical storage format (PSF) and the application programming interface (API) and defined in ISO/TS 20452.

3.19
services and point of interest (POI) information access
application category that deals with the provision of point of interest (POI) information to the navigation application

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3.20
Service Centre
function that provides update data to In-vehicle Systems

3.21
status data
data that represent a status of a road or traffic (such as real time geographic traffic data)

3.22
update
sequence of flow of data between a Service Centre and an In-vehicle System to change the data inside a map database in an In-vehicle System

3.23
update by geographic area
action allowing for the complete replacement of data for a specific geographic area or for an entire data set

4 UML Expressions for diagrams

This International Standard uses UML to express specific circumstances; the graphical elements are used to express specific constraints and structural relationships. A full definition can be found in ISO 19501. However, a short introduction of elements is given in Annex B.

5 Abbreviated terms

ADAS	Advanced Driver Assistance System
API	Application Programming Interface
CU	Close Update
CPU	Central Processing Unit
DB	Database
FTP	File Transfer Protocol
GDF	Geographic Data File
HTTP	Hyper Text Transfer Protocol
IP	Internet Protocol
ITS	Intelligent Transport System
IVS	In-vehicle System
LDO	Logical Data Organization
LR	Location Referencing
NetBEUI	NetBIOS Extended User Interface
NetBIOS	Network Basic Input/Output System
OSI	Open Systems Interconnection

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POI	Point of Interest
PPP	Point-to-Point Protocol
PSF	Physical Storage Format
ROD	Request of Data
RUC	Request of Update Category
SC	Service Centre
SMTP	Simple Mail Transfer Protocol
TCP	Transmission Control Protocol
TOD	Transmission of Data
TUC	Transmission of Update Category
UML	Unified Modelling Language

6 Requirements

6.1 User-related requirements

User-related requirements are defined as follows.

— R-1. The data delivery structures and protocols shall support the six application categories: map display, positioning, route planning, route guidance, address location, service and POI information access.

— R-2. The protocols and data structures shall be designed in such a way that they do not force degradation of system performance before, during or after their use.

— R-3. The data exchanges between the Service Centre and In-vehicle Systems shall use an open (non-proprietary) data format (see example). The specification of the sender's address of data is described under the open data form, but the description of the content may be done by binary representation.

EXAMPLE XML.

6.2 Data requirements

Data requirements are defined as follows.

— R-4. The data shall include, at a minimum, map data (see Example 1), and it may also include some status data, and POI data. Advanced driver assistance system (ADAS) related map data may be included as an extension. Some of the data shall be distinguished as emergency data (see Example 2).

EXAMPLE 1 Features, geometry, and attributes.

EXAMPLE 2 Real time geographic traffic data.

— R-5. Data structures shall be easy to handle by In-vehicle Systems.

— R-6. The data structures shall minimize dataset size as much as possible for both transmission and processing in In-vehicle Systems coming on the market.

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6.3 Protocol requirements

Protocol requirements are defined as follows.

— R-7. The update protocol(s) shall be compatible with both wireless and wired methods.

— R-8. The protocol shall not require more storage or computing power than is expected to be available in In-vehicle Systems coming on the market.

— R-9. The protocol in this International Standard shall be written with sufficient flexibility both to support existing communication technology and to improve the capability to address future communication technologies.

— R-10. The protocol defines how to deliver map-related data between Service Centre and In-vehicle Systems.

— R-11. The protocol is expected to be used in a mobile environment in which communications may be interrupted (see Example). The protocol shall support complete and efficient recovery from interruptions of communication. For example, it shall avoid retransmission of an entire update when only a small part is not received.

EXAMPLE By driving through tunnels or driving in areas of poor or no reception.

— R-12. The protocol shall minimize dataset size as much as possible for both transmission and processing in In-vehicle Systems coming on the market.

6.4 Communication requirements

Communication requirements are defined as follows.

— R-13. The general update process shall be independent from the (technical) communication link between the Service Centre and the In-vehicle Systems.

— R-14. Within reason, the update process shall support communication links with a limited bandwidth.

6.5 Update strategies

Update strategies are defined as follows.

— R-15. The design of the update process shall be independent from the data supplier (see Example 1). The design of the update process shall be independent from the in-vehicle application.

EXAMPLE 1 Map Centre.

— R-16. This International Standard shall support updates of different categories of data (see Example 2) at different frequencies.

EXAMPLE 2 Map features and attributes, status data and POI data.

— R-17. In-vehicle System functionality is affected by real world changes to spatial features and their attributes (see Example 3). Therefore, the data available in the In-vehicle System shall be kept up-to-date.

EXAMPLE 3 New roads are built, road names can change, and previously existing errors can be corrected.

— R-18. This International Standard supports two methods for supplying updates:

  — Update by geographic area: this method allows the complete replacement of data for a specific geographic area or for an entire data set.

  — Incremental update of Spatial Features and Attributes: this method allows the replacement, insertion or deletion of features and/or attributes only when they change from a previous version of the data set.

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— R-19. This International Standard supports four strategies for supplying updates:

  — Data Providing: two-way communication of data initiated by the In-vehicle System in which the version is controlled by the Service Centre.

  — Data Retrieving: two-way communication of data initiated by the In-vehicle System in which the version is controlled by the In-vehicle System.

  — Data Pushing: two-way communication of data initiated by the Service Centre.

  — Data Broadcasting: one-way communication by the Service Centre.

6.6 Others

Other requirements are defined as follows.

— R-20. The process of defining requirements in this International Standard shall not favour any particular logical data organization (LDO) and/or physical storage format (PSF). Existing LDOs and/or PSFs may be taken into account in defining requirements.

— R-21. This International Standard shall be scalable and generic to support future communication technologies and data structures.

— R-22. The interfaces shall be designed in such a way that a newer interface shall still support older PSFs on the market, and older interfaces shall support newer PSFs, potentially restricted to the content of the older version.

7 Reference architecture and framework concept

7.1 Reference architecture

Figure 2 represents the general architecture that supports the navigation data delivery by a Service Centre to an In-vehicle System according to this International Standard.

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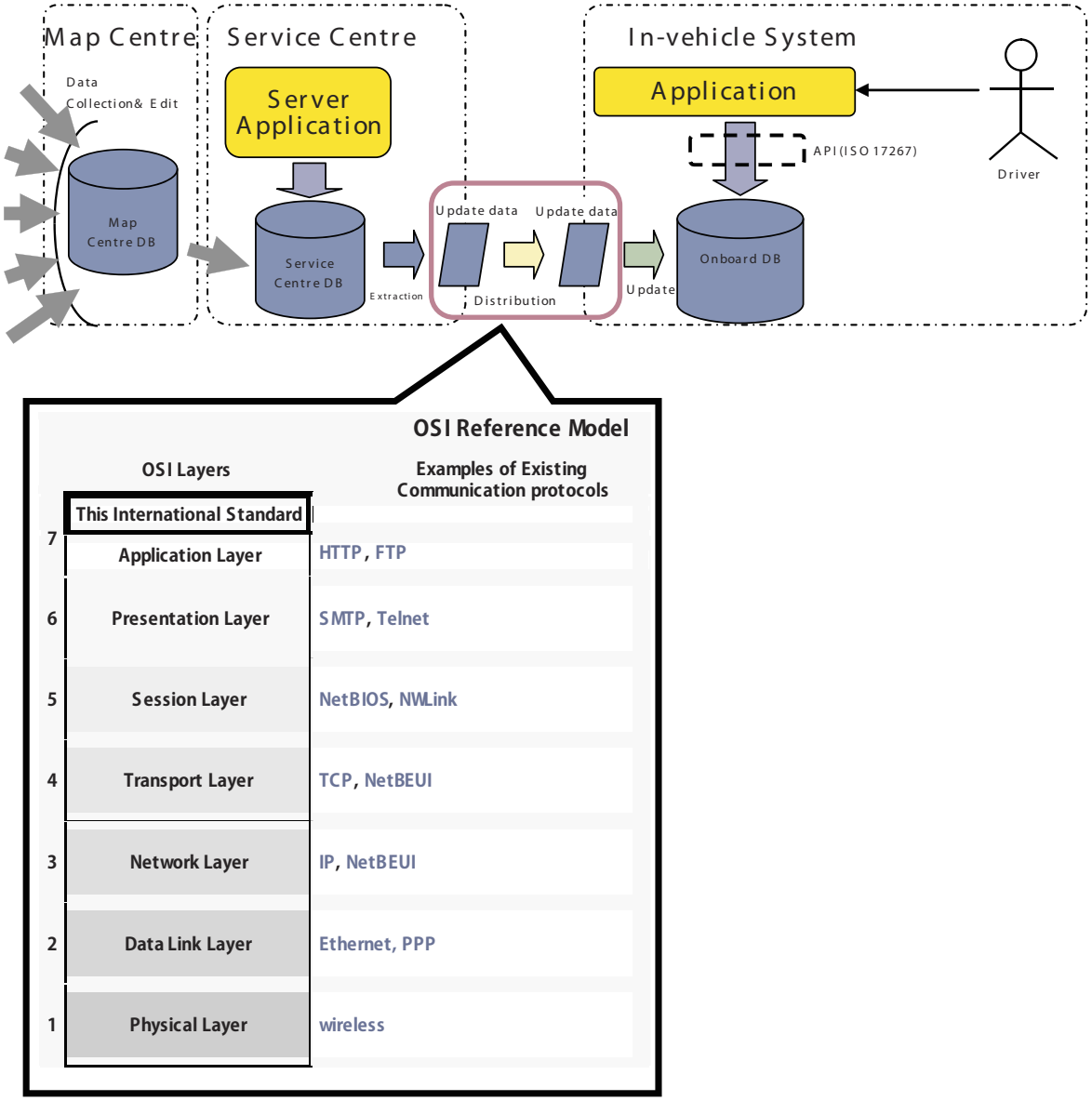

Figure 2 — Reference architecture

This International Standard can be used with widely used standardized protocols such as transmission control protocol/internet protocol (TCP/IP) and hyper text transfer protocol (HTTP). The delivery data is composed of a header and bodies.

This International Standard mainly defines the header information used in the In-vehicle System to judge whether the delivered data can be used or not. An In-vehicle System can skip the unnecessary data by reading the header information.

The data sent as body are map data, status data, POI data or emergency data.

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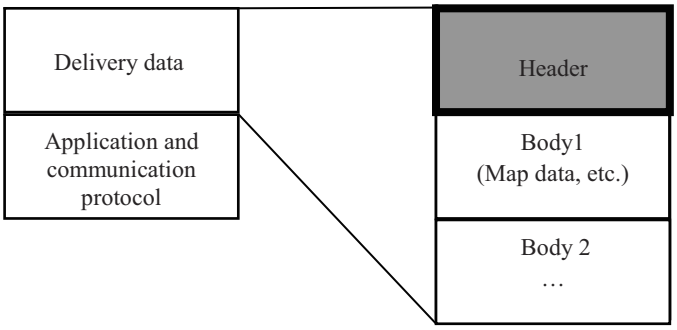

Figure 3 — Basic structure of delivery data

7.2 Framework concept

7.2.1 Varieties of updates

Varieties of updates are defined as triple of initiatives, types and data categories.

Classifications of data categories initiatives and types can be found in Clause 6 and Annex C.

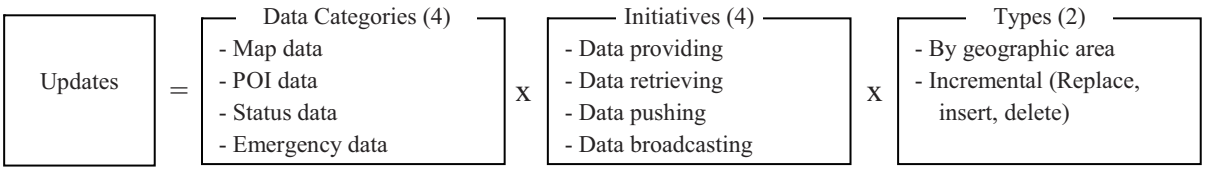

Figure 4 — Varieties of updates

7.2.2 Case of update by geographic area

7.2.2.1 Introduction

When an update is done by geographic area, all the data of the geographic area is sent, which means the data set also includes unchanged information.

There are two methods of updates: Mode1, execute post-compilation at the In-vehicle System, Mode2, execute some kind of pre-compilation at the Service Centre (i.e. generating necessary layers, etc.) in order to reduce the process at the In-vehicle System.

Most of the actual systems are hybrids of Mode1 and Mode2.

A full update is a specific case of an update by geographic area. A full update is done to replace the whole In-vehicle System dataset.

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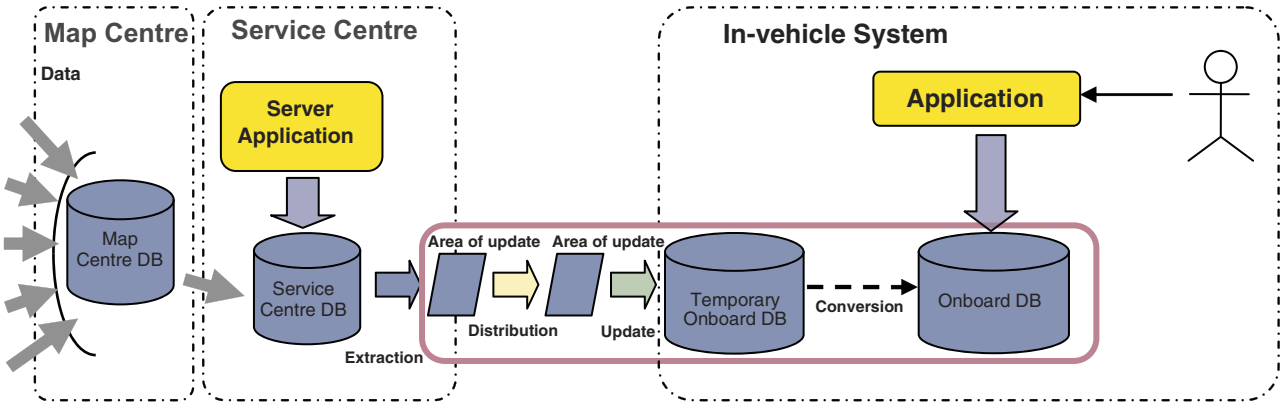
7.2.2.2 Case of Post-compilation (Mode1)



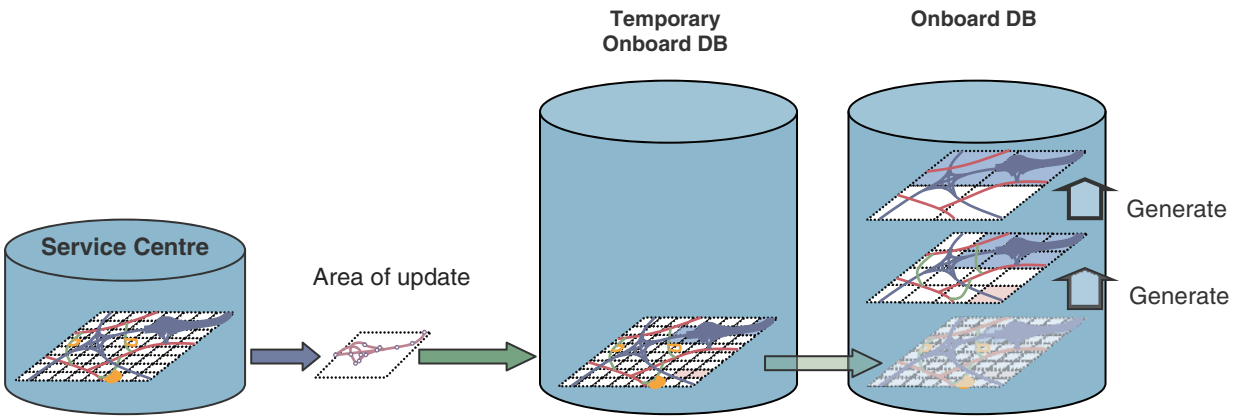


Figure 5 — Case of Post-compilation (Mode1)

An In-vehicle System receives an area of update data from a Service Centre through the communication. Compilation and layer generations are done in the In-vehicle System.

NOTE Generally, a Post-compilation Mode tends to have a lower volume of transmitted data.

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7.2.2.3 Case of Pre-compilation (Mode2)

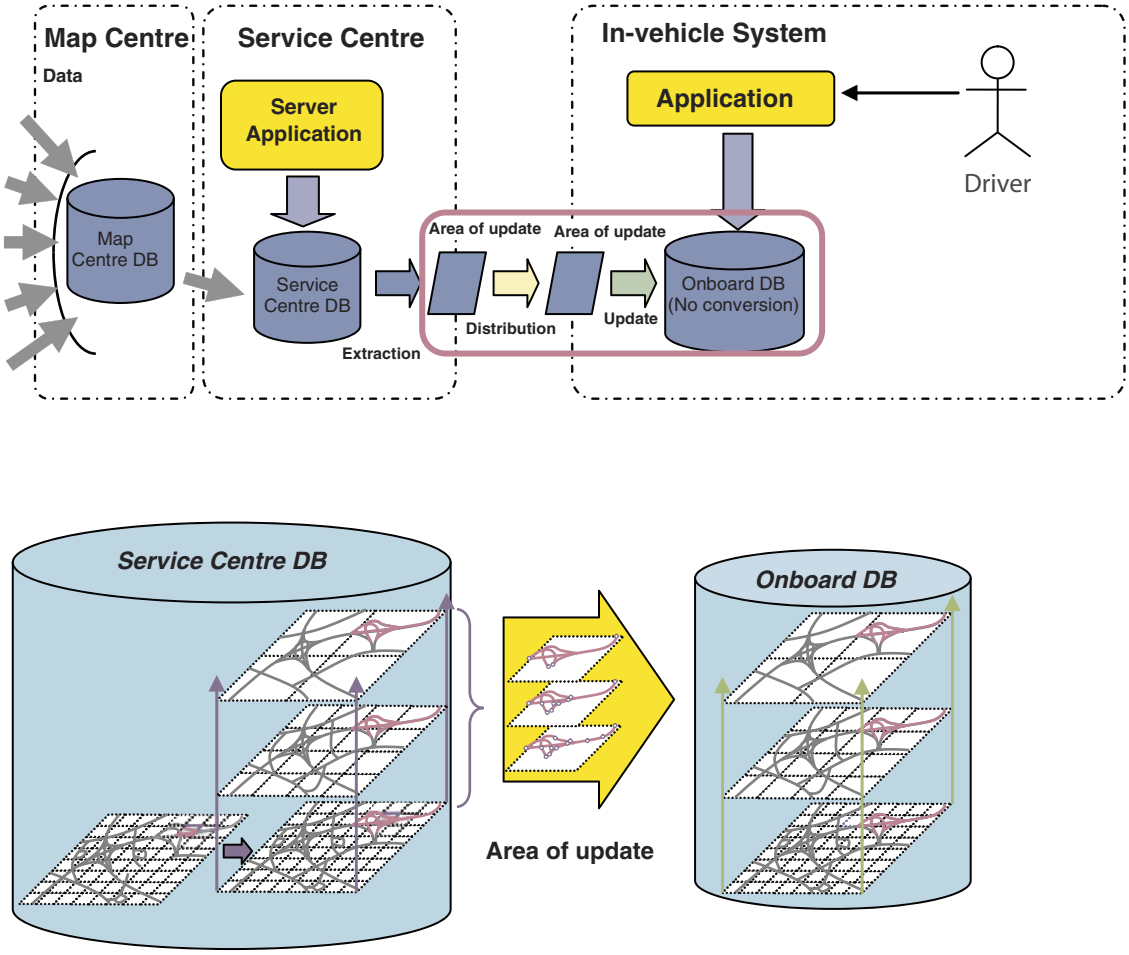

Figure 6 — Case of Pre-compilation (Mode2)

An In-vehicle System receives an area of update data from a Service Centre through the communication. Updating data of all layers is made at a Service Centre, including the relationships of each layer.

NOTE Generally, the compilation in the In-vehicle System is minimized. Integrating the data to the onboard database (DB) is basically the only process needed in an In-vehicle System. The central processing unit (CPU) load is likely to be lighter than in a Post-compilation system (Mode1), though the volume of update data is likely to increase.

7.2.3 Case of incremental update

When update is done incrementally, only the different parts are sent.

As seen in the update by geographic area, there are also two modes of incremental updates: Mode1, to compile the data at an In-vehicle System (Post-compilation), and Mode2, to compile the data at a Service Centre and provide required layers (Pre-compilation).

Most of the actual systems are hybrids of Mode1 and Mode2.

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Mode1 Post-compilation

An In-vehicle System receives the minimum amount of update data (i.e. only changes) from a Service Centre through the communication mean. Each In-vehicle System compiles and generates the subset of data.

NOTE 1 Generally, a Post-compilation method (Mode1) tends to have a lower volume of data transmitted.

Mode2 Pre-compilation

An In-vehicle System receives update data from a Service Centre through the communication. The compilation of data is executed in a service centre. Update data is sent out to an In-vehicle System and incorporated without on-board compilation.

NOTE 2 Generally, the compilation in the In-vehicle System is minimized. Integrating the data to the onboard DB is basically the only process needed in an In-vehicle System. The CPU load is likely to be lighter than in a Post-compilation system (Mode1), though the volume of update data is likely to increase.

7.2.4 Descriptions of the exchange process of updating data

When updating a map, a Service Centre and an In-vehicle System shall check the status before and after the update. For more details, see Annex E.

The process is divided into three steps:

1) Preprocessing: prepare the data to be updated and confirm the user's intention.

2) Delivering of update data: data sending and receiving.

3) Post-processing: verification of the termination and other related tasks.

An entire update process is shown in Figure 7. The data flows in the shaded area in Figure 8 are defined in this International Standard.

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