FEEDMAP – INCREMENTAL UPDATING MEETS MAP-BASED PROBES

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ABSTRACT

This paper presents the first results of the FeedMAP project, which is co-funded by the European Commission. FeedMAP started in March 2006 and is building a cooperative map feedback and updating framework improving the cooperation between map data providers and map users. This concept will contribute to an improved transport efficiency and increased road safety by creating a sustainable source of map updates for future navigation and in-vehicle applications.

KEY WORDS

Incremental map updating, map feedback loops, road transport technology, transport telematics, multi sensor technology, multi-sensing, map-based probe data

INTRODUCTION

For the past years, the demand for accurate and up-to-date map information has increased dramatically. The use of digital maps is now being expanded to many existing new application areas such as in-vehicle Advanced Driver Assistance Systems (ADAS).

More comfort, more performance, more safety. In short these are the demands that ADAS systems need to consistently meet and fulfil at all times – even where the general conditions for mobility are not always perfect. Growing traffic density and the consequences thereof such as traffic congestion and longer travelling times, as well as the greater complexity of many traffic situations, are making driver assistance systems increasingly attractive and useful. These systems give the driver helpful information, make it easier for him to take the necessary decisions, and support him in handling both difficult and complex traffic situations. Fresh and reliable digital maps are seen as a new type of sensors for vehicles providing important source of information for look-ahead capability for ADAS applications enhancing the environment perception.

The EC-funded ActMAP project, which was completed in November 2004, developed a solution for one part of the problem. This successful project contributed to a standardised solution for the distribution of map updates from the map providers and road administrations to the in-vehicle clients. The most significant benefit of the ActMAP framework is the dramatic reduction of the time needed for distribution of map updates (around 6 months today). However, the time between a physical change on the road network and its availability in the map providers' database still depends on the frequency of surveys of the map providers and/or road administration, which could take up to two years.

The FeedMAP concept is using the results, knowledge and standards developed in the ActMAP project to improve the identification and creation of these updates including a quality assessment. The key players are confronted with an increasing cost for acquisition and collection of data and its maintenance. Indeed, the number of attributes on the maps and their accuracy has increased dramatically in order to answer the needs of new ADAS and navigation applications (e.g., number of lanes, sign posts, speed limits). This increases the importance of finding novel and cost-effective ways to aggregate map data and update acquisition, to which FeedMAP is contributing.

Together, the ActMAP and FeedMAP concepts focus on a cooperative environment between road users and map providers collecting, analysing and distributing in-vehicle digital map incremental updates. Using this combination, the road users enhance the map updates process for all the other road users using intelligently the communication infrastructure and the in-vehicle map database and sensors available.

OBJECTIVES

The objective of the FeedMAP project is to assess the technical and economic feasibility of map data improvement by providing a map data feedback loop applied to a map data updating framework using the ActMAP mechanisms.

The cooperative environment is based on the collection of deviations between data from in-vehicle sensors and the map database. Simple algorithms allow the detection of map data discrepancy with the driven road and send deviation reports to a FeedMAP service centre (FMSC). The statistical analysis of aggregated deviations received from many users will produce potential map updates along with quality parameters such as consistency, correctness and accuracy. They will then be sent to the relevant map data owners for cross checking with their own information. Finally, qualified map updates are distributed through the ActMAP framework to in-vehicle database and relevant bodies.

This solution allows merging road user experiences with the map data information held by the map providers and the road administrations. Such cooperative environment enables reducing the time between the actual changes on the road network and its publication in the road databases of map vendors and public administrations. It is expected that even with a low penetration rate of equipped vehicles, physical road modifications and other features that are not on the map database can be quickly detected, qualified and redistributed.

ACTMAP FEEDMAP FRAMEWORK

In order to achieve this overall objective, the FeedMAP project will develop and validate a cooperative framework as illustrated in Figure 1.

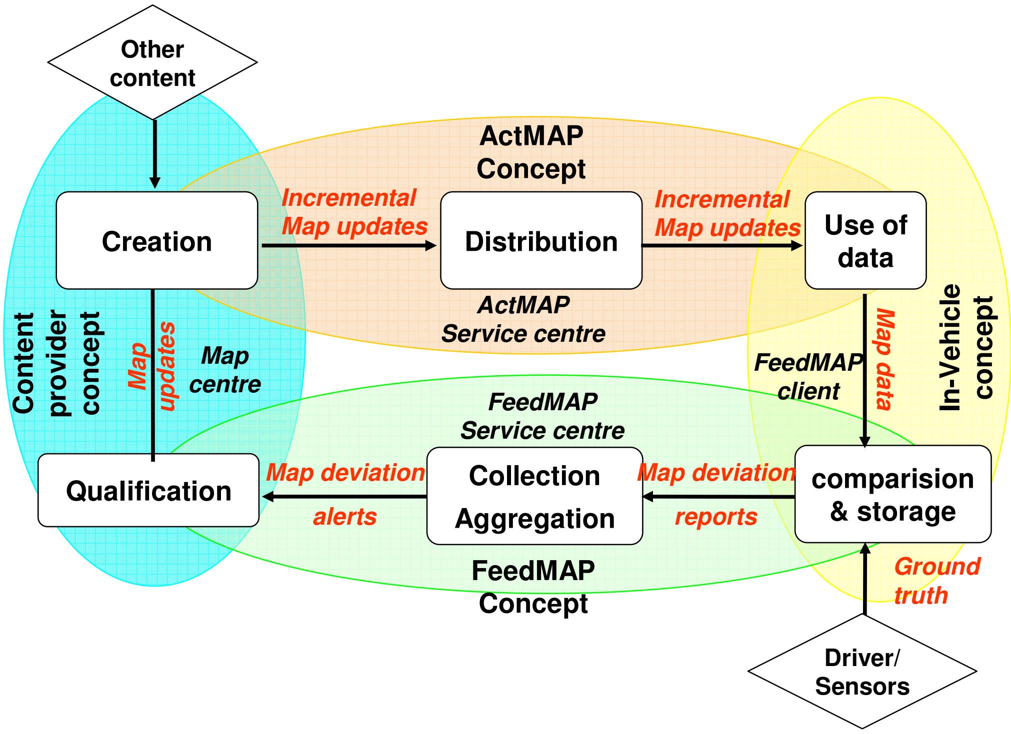

Figure 1: ActMAP FeedMAP framework

This framework is based on four complementary concepts, which are traditionally driven by different key players:

1. *The in-vehicle concept* – detecting potential map deviations by comparing up-to-date maps to environment sensor information (driven by car industry and equipment providers),
2. *The FeedMAP concept* – aggregating map deviation reports in a statistical manner from multiple in-vehicle FeedMAP clients and issuing of map deviation alerts with reliability measures (driven by FeedMAP service providers),

3. *The content provider concept* – qualifying deviation alerts, integrating with map production work flow and generating map updates (driven by map providers, road authorities and other content providers),
4. *The ActMAP concept* – distributing map updates through the ActMAP service centres consolidated with the FeedMAP specifications (driven by service providers).

The ActMAP/FeedMAP framework represents the interconnection between the different functions creating a sustainable loop of incremental map deviation and update information. In this loop, the road users contribute to the update of map providers' database and vice-versa. Coming out of the loop, the map providers, equipment providers, car industry and road authorities will benefit of a new source of map survey while the user will always keep an updated map for its ADAS and navigation applications.

USE CASES

Deviation detection

This use case includes all functions from the FeedMAP Client (FMC) detecting a map deviation and issuing a map deviation report towards the FMSC, processing the deviation by FMSC and issuing a deviation alert to the Map Centre (MC) (see Figure 2).

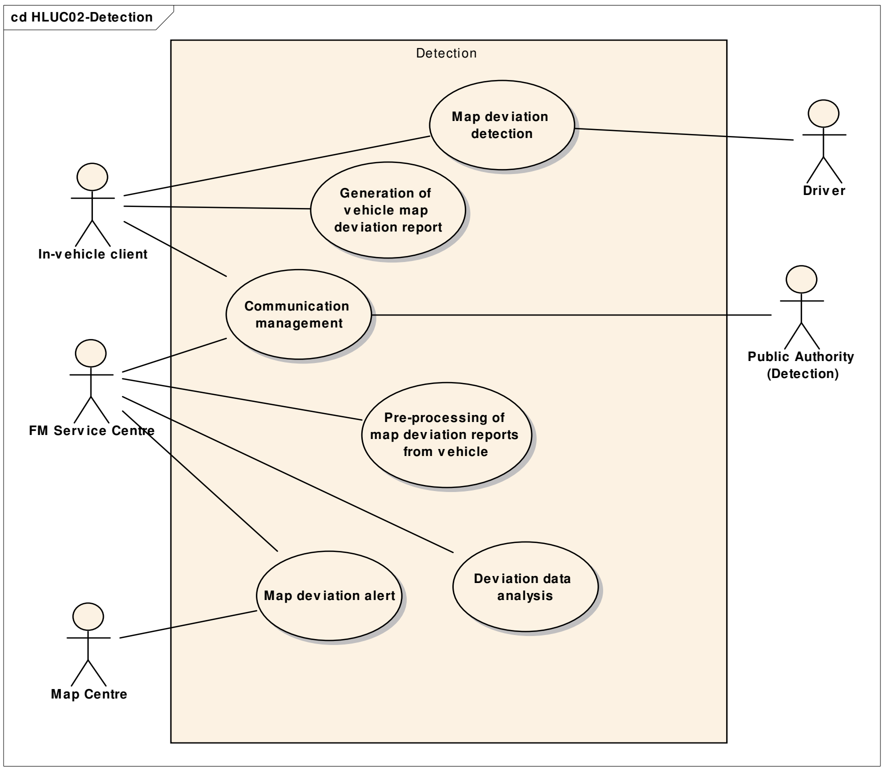

Figure 2: Use case - detection

A deviation can be detected in different ways:

- detection by in-vehicle client (autonomous, driver-in-the-loop)

- detection by driver (manual, conscious)
- detection by public authority (special type of detection by driver)
- joint detection: autonomous detection by in-vehicle client; confirmation by driver (e.g., via button or speech interface)

The use case diagram is the same for all these scenarios. Differences can only be seen in the sequence diagrams. The scenario ‘Detection by vehicle in-client’ is described more in detail by the sequence diagram illustrated in Figure 3.

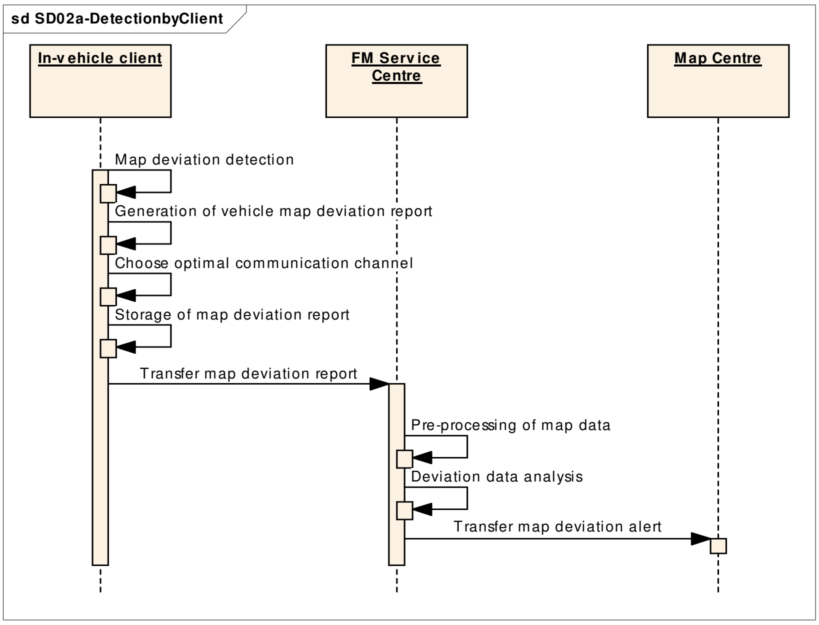

Figure 3: Sequence diagram - detection by in-vehicle client

A FeedMAP client may detect a mismatch of the in-vehicle map with data retrieved from sensor, e.g., the navigation system positions itself ‘off-road’, i.e. away from the gemotry in the map database. It will compile all necessary information into a deviation message (e.g., map version, position, time, and sensor data) and choose for the optimal channel for sending it to a FeedMAP service centre at an appropriate moment in time, maybe together with previously recorded deviations. This can, e.g., be a WLAN connection at a garage or petrol station. The FMSC will process the deviation report, to statistically validate it with other deviation reports. Once a certain confidence is given, the FMSC will issue a map deviation alert towards the map centre, to which the map deviation applies.

Map data processing

The map data processing high level use case as illustrated in Figure 4 includes all functions from the FMSC generating a map deviation alert to the issuing of a map update towards the ActMAP Service Centre (AMSC).

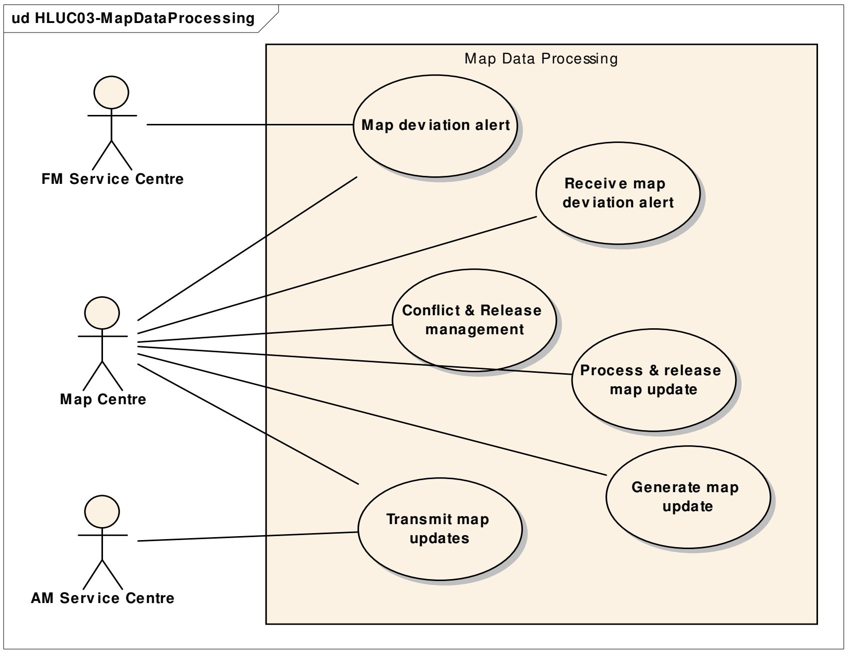

Figure 4: Use case - map data processing

The sequence diagram as shown in Figure 5 describes the steps performed by the map centre. Upon receiving a map deviation alert, the map centre will qualify it again and, upon accepting it, will integrate it into the map production process. The map production process is considering many other sources such as field survey, mobile mapping, and customer feedback. As a result, a map update may be performed, if the deviation has not already been recorded and processed otherwise. The map update is sent to the ActMAP service centre.

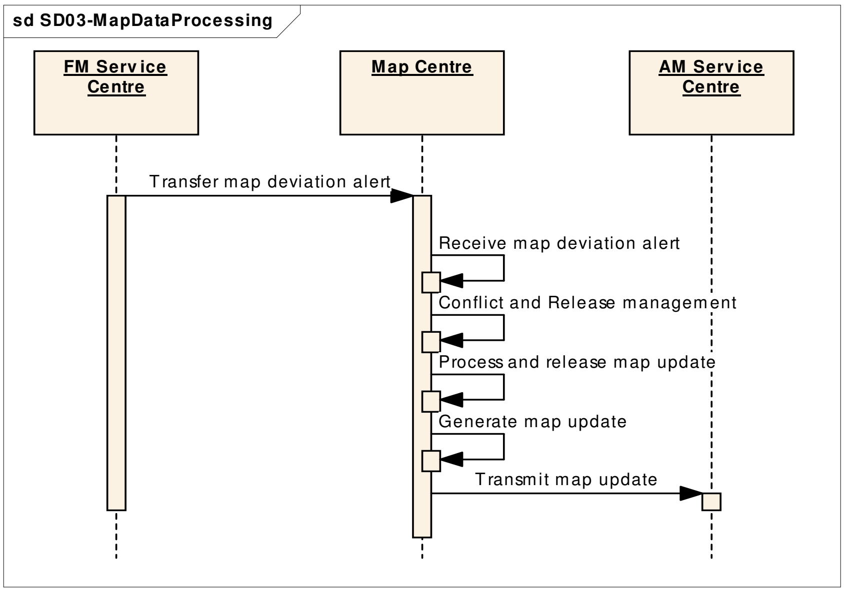

Figure 5: Sequence diagram - map data processing

Map update

The map update use case as shown in Figure 6 includes all functions from delivery of map updates by the map centre to processing by in-vehicle clients or other map users, e.g., public authorities.

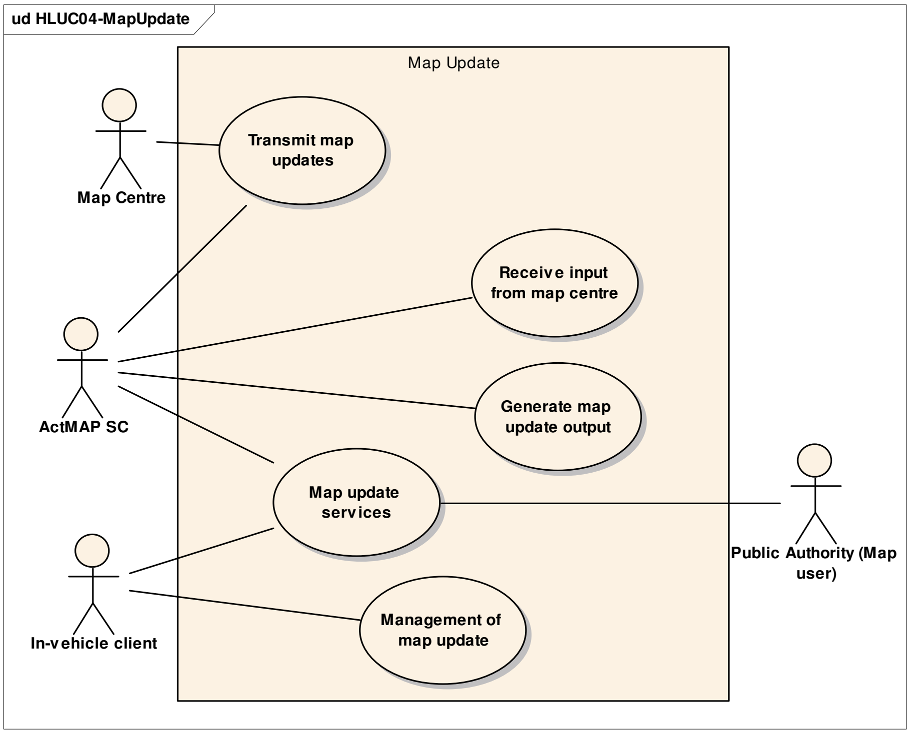

Figure 6: Use case - map update

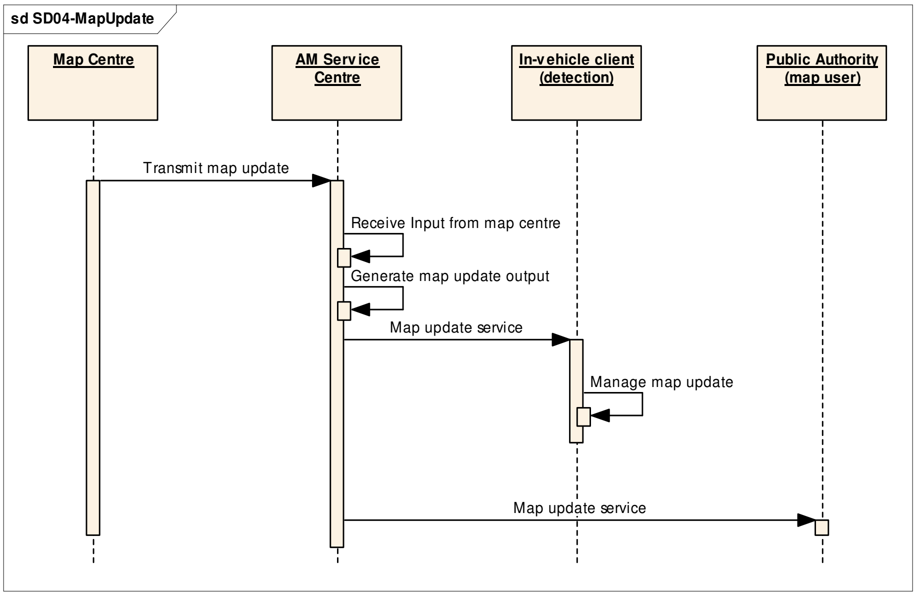

Figure 7: Sequence diagram - map update

Upon reception of one or more map updates, the AMSC will decide on the best strategy to further process and deliver the update, based on the needs of the target in-vehicle client it is serving. In many cases this may include a pre-processing of the map updates to transform them into a format to update a particular proprietary physical storage format used for the in-vehicle database. The in-vehicle client needs to have a running ActMAP update client, which will receive the updates and include them into the in-vehicle map database (see Figure 7).

FEEDMAP DEVIATION TYPES

The following list describes the set of deviations being investigated by the FeedMAP concept. The majority of deviations are related to map database content, but some are also related to the behaviour of in-vehicle applications.

- Wrong or missing Road Geometry (2D)
- Road altitude (missing, wrong or inaccurate)
- Slope (missing, wrong or inaccurate)
- Point of interest (new, wrong position)
- Traffic sign (new, wrong position)
- Gaps between road elements
- Direction of traffic flow (wrong or missing)
- Prohibited/restricted manoeuvre (wrong or missing turn restriction)
- Speed limits (current speed vs. map)
- Travel time (min, max, average)
- Scenic routes (subjective scenic value)
- Road lane information (lane markings, number of lanes, lane width, lane type)
- Traffic jams, road works
- Hazard detection (e.g., weather conditions)
- Wrong route guidance Missing route guidance
- Subjective choice of route
- Incorrect map display
- ADAS incorrect warning or action

OUTLOOK

The FeedMAP consortium has defined the FeedMAP framework based on the identified requirements. The deliverable on requirements for map data feedback is available. The detailed technical specifications will be published in April 2007. Upon completion, the consortium will perform a substantial validation of the concept by means of a prototype implementation. Five test sites will be realised, focussing on different aspects of the overall framework. The project will be completed by August 2008. Parties that would like to get more actively involved are invited to join the ActMAP/FeedMAP forum.

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