ADASIS White Paper

Advanced Driver Assistance Systems Interface Specifications

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Executive summary

ADASIS (Advanced Driver Assistance Systems Interface Specification) is an industry de-facto standard enabling and advancing map-enhanced driver assistance systems leading to Automated Driving (AD).

ADASIS was created in 2002 by an open group of major organisations from the global vehicle industry who joined forces, driven by the common vision and belief that defining the ADAS Interface will:

- enable ADAS and Automated Driving applications to be provided with data from map database systems or other data sources
- enable these applications to build predictive and vehicle environment data based on map, position, and other georeferenced data which will improve the performances of such applications
- provide to the industry a de-facto and adequate standard to be used worldwide, being independent from different map formats and suppliers
- contribute as one enabling technology to the development and deployment of all Automated Driving levels
- drive global growth in this field
- contribute to improve road safety, lower emissions, and provide enhanced driving comfort

ADASIS is based on the ADAS Horizon concept. As a predictive sensor, digital maps enable drivers to anticipate the road ahead, effectively extending their horizon beyond what is immediately visible and thereby contributing to safer, smarter, and cleaner mobility. It also provides redundant information in addition to perception sensors, redundancy being necessary to achieve the robustness needed for high level of automation. ADASIS defines an appropriate interface for exchanging georeferenced information between the Digital Map (of any kind) and Driver Assistance systems.

The ADASIS Non-Profit International Association decided to share with all potential users a White Paper:

- to **build awareness**, general information about ADASIS and its purpose
- to **better communicate** about ADASIS and in particular ADASISv3 and future developments
- to **position ADASIS in the automotive eco-system totally independent from map providers**
- to **explain how ADASIS supports current and future challenges** in the development of automotive systems
- to **federate members** around common goals and future developments
- **as a tool to discuss with other initiatives related to ADS**, in particular TISA, SENSORIS, NDS, Car2Car CC, 5GAA, CCAM Association, 2Zero Association (EGVIAfor2Zero).

This White Paper briefly presents the relevant automotive context, such as:

- **Automotive trends**: ADAS evolution, Software Defined Vehicles
- **Automated driving**: positioning and role of the map as a sensor
- **Future vehicle architecture**: central distributed and cloud-based software architecture, in-vehicle and cloud networking: from CAN-based to IP-based

Finally, **ADASISv3 supporting Future Vehicles** is presented with:

- **Use cases** benefiting from a detailed ADAS Horizon providing lane-level information, enabling Precise Localisation, supporting Sensor Fusion, and supporting Automated Driving.
- **Key messages**:
  - ADASISv3 as a **Standard for Transmitting Map Data**
  - ADASISv3 as **One Horizon from Multiple Data Sources**
  - ADASISv3 **representing Dynamic Geo-Reference Data**
  - ADASISv3 as a **Communication Protocol for Efficient Deployment**

In summary:

What makes ADASISv3 Unique in its ADAS and ADS Support?

- Making accurate map data and positioning available
- Efficient transport of information
- Open worldwide standard

Acronyms and definitions

2Zero	Towards zero emission road transport: Co-programmed partnership between the European Commission and EGVIAfor2Zero (association representing the private sector)
ACC	Adaptive Cruise Control
AD	Automated Driving
ADAS	Advanced Driver Assistance System
ADASIS	ADAS Interface Specification
ADASISv2	ADASIS Version 2 protocol (CAN-based)
ADASISv3	ADASIS Version 3 protocol (IP-based)
ADS	Automated Driving System
AHP	ADASIS Horizon Provider
AHR	ADASIS Horizon Reconstructor
AI	Artificial Intelligence
AV	Automated Vehicle
CAN	Controller Area Network
CCAM	Connected, Cooperative and Automated Mobility
ECU	Electronic Control Unit
E/E	Electrical and/or Electronic (E/E) automotive architectures
GNSS	Global Navigation Satellite System
HD map	High Definition map, e.g., lane level digitised
HPC	High Performance Computing
IMU	Inertial Measurement Unit
ISO	International Organization for Standardization
OADF	Open Auto Drive Forum
ODD	Operational Design Domain
OSI	Open Systems Interconnection
PAS	Publicly Available Specification
PPC	Predictive Powertrain Control
PSF	Physical Storage Formats
QoS	Quality of Service
SAE Levels	SAE's six levels of driving automation range from Level 0 (no driving automation) to Level 5 (full driving automation)
SD map	Standard Definition map, e.g., centre line digitised
SDV	Software Defined Vehicle
V2X	Vehicle-to-everything

Table 1: Acronyms and definitions

1. Introduction

ADASIS (Advanced Driver Assistance Systems Interface Specification) is an industry de-facto standard enabling and advancing map-enhanced driver assistance systems leading to Automated Driving (AD).

ADASIS was created by an open group of major organisations from the global vehicle industry who joined forces, driven by the common vision and belief that defining the ADAS Interface will:

- enable ADAS and Automated Driving applications to be provided with data from map database systems or other data sources
- enable these applications to build predictive and vehicle environment data based on map, position, and other georeferenced data, which will improve the performances of such applications
- provide to industry a de-facto and adequate standard to be used worldwide, being independent from different map formats and suppliers
- contribute as one enabling technology to the development and deployment of all Automated Driving levels
- drive global growth in this field
- contribute to improve road safety, reduce emissions, and provide enhanced driving comfort, relieving the driver from the driving task according to the level of automation.

1.1 Purpose of the ADASIS White Paper

Why should organisations consider ADASIS for ADAS and ADS?
The purpose of this White Paper is:

- to build awareness, general information about ADASIS and its purpose
- to better communicate about ADASIS and in particular v3.x and future developments
- to position ADASIS in the automotive eco-system totally independent from map providers
- to explain how ADASIS supports current and future challenges in automotive system development
- to federate members around common goals and future developments
- as a tool to discuss with other initiatives related to ADS, in particular TISA, SENSORIS, NDS, Car2Car CC, 5GAA, CCAM Association, 2Zero Association

This White Paper targets decision makers and real users of ADASIS in their products/systems, other standardisation organisations, as well as non-expert.

1.2 Why ADASIS? The ADAS Horizon concept

In 2002, navigation map data were stored on CD and then on DVD in the vehicle, using proprietary Physical Storage Formats (PSF) and therefore not interoperable. The attempt of the International Standardisation Organisation (ISO TC204 WG3.2) to standardise the PSF failed. On the other hand the potential of using map data to predict the up-coming road ahead of the current vehicle position led the automotive industry, under the umbrella of ERTICO-ITS Europe, to develop a standardised interface for Advanced Driver Assistance Systems to access efficiently map data independently of the in-vehicle map PSF.
This development is based on the ADAS Horizon concept (Figure 1):

Figure 1 ADAS Horizon concept

As a predictive sensor, digital maps enable drivers to anticipate the road ahead, effectively extending their horizon beyond what is immediately visible and thereby contributing to safer, smarter, and cleaner mobility. ADASIS defines an appropriate interface for exchanging information.

The ADAS Horizon concept includes the following elements:

- The ADAS Horizon Provider, building and maintaining the ADAS Horizon;
- The ADAS interface, using the ADASIS Protocol that defines how the ADAS Horizon will be sent from the ADAS Horizon Provider to the ADAS Applications;
- The ADAS Applications, the client applications that receive the ADASIS Protocol messages and reconstruct the ADAS Horizon.

The ADAS Reconstructor is a common component of ADAS Applications that is built in accordance with this general architecture and concept. The task of the ADAS Reconstructor is to receive, dissect, and interpret ADASIS Protocol messages, and, in effect, reconstruct a copy of the ADAS Horizon on the client side to be then used by the application(s).

1.3 ADASIS Current State

This section briefly presents the different ADASIS versions which are in use or under development.

1.3.1 ADASISv2

The ADASISv2 protocol has been a mature specification for more than 10 years. It is used in various control units to support, e.g., Powertrain Functions or Driver Assistance Systems. With only a limited number of messages it can describe the whole area around the current vehicle position and defined kilometres ahead. It is a very efficient and lean data exchange protocol that targets CAN-bus based systems. Successful applications include among others curve warning, predictive adaptive cruise control, Predictive Powertrain control, and the control for efficient use of electric vehicles.

ADASISv2 has some limitations which makes the protocol not useable for complex applications like Automated Driving. These typically require access to High Definition (HD) map data.

ADASISv2 is a broadcast communication protocol which does not allow for reliable communication between provider and reconstructor as it cannot detect if messages are not being received/transmitted.

1.3.2 ADASISv3

The evolution of the map is related to its end user. First, navigation maps were used by humans (guidance, display), now ADAS and High Definition (HD) maps are used directly by ADAS or ADS functions as they are more accurate and provide complex attributes for the purpose of the functions.

ADASISv3 was introduced in 2018, providing the ADAS Horizon from HD maps. The current version v2.x is already used by some OEMs to support and enable SAE Level 3 functions, e.g.:

- Mercedes-Benz S-Class, with the use of ADASISv3 for the access of the digital HD map (https://media.mercedes-benz.com/article/ac10efc4-c477-4345-b0d9-55c72a277502),
- Geely use ADASISv3 since 2023 in series vehicle (https://global.geely.com/)
- 3rd manufacturer known but cannot be disclosed
- and many others to come.

1.4 Outline

The Executive Summary presented a summary of the whole document and provided an outlook for further development foreseen by the ADASIS members.

Following this short introduction, the ADASIS White Paper is organised as follows:

- Section 2: Automotive Trends
- Section 3: Automated Driving
- Section 4: Future Vehicle System Architecture
- Section 5: ADASISv3 Supports Future Vehicles

2. Automotive Trends

2.1 From ADAS to Automated Driving

Vehicles controlled by an Automated Driving System (ADS) require systems and components with increased robustness and should contain multiple, possibly redundant, computing nodes and multiple sensors. One of these sensors is a digital map. The main challenges for automated vehicles are:

- The integration and coordination of all the ADAS needed to control the automated vehicle on the road network;
- Building the decision-making system based on e.g., Artificial Intelligence models to pilot the vehicle on the road network and its complex environment (other vehicles, traffic, weather conditions, etc.).

2.2 Software-defined Vehicles

Next to electrification and Automated Driving, Software-Defined Vehicles (SDV) are considered one of the key disruptors in the automotive industry. At present, cars are mainly defined by their hardware: type and size of the combustion engine, transmission, brakes, suspension, etc. Software is slowly taking more and more control of the vehicle. Currently, software that defines engine mapping and camera-based system are already mainstream. With electrification and Automated Driving, the influence of software will increase exponentially.

2.2.1 SDV Advantages and Implications

So, when do we consider a vehicle to be a software-defined vehicle? According to Aptiv[1], it is a vehicle whose features and functions are primarily enabled through software. So why would this be a benefit? The biggest advantage of software is that it is much cheaper and more flexible to produce than hardware; it does not require any changes in machine setup or the use of additional raw materials. Once the software has been designed, the production of the software module is a simple copying process that is done at the touch of a button.

For car owners the advantage is that new or improved features can be made available after the vehicle has been produced, so that the vehicle remains up to date even after purchase. This is something that customers expect, as they also experience this with their other devices (smartphone, TV, etc). For car manufacturers the advantage is that they can monetise the software by offering new features for cars already in use. Also, more insight into the vehicle can substantially reduce warranty cost.

There is one prerequisite for this to succeed: vehicles need to be connected to cloud services. Without "over-the-air" update capabilities, it will be cumbersome to add these new features to a vehicle. The advent of connected vehicles is therefore an important enabler for the development of the SDV.

3. Automated Driving

3.1 Introduction

If there is one trend in the automotive industry that has garnered a lot of interest from both the public and the industry, it is self-driving vehicles. Although it is a much-hyped feature, research into Automated Driving has influenced the development of vehicles. The number of ADAS features has therefore increased. This section discusses the impact of Automated Driving on vehicle systems, in particular the use of digital maps as a sensor for trajectory planning.

A *Path* is the road, i.e., the sequence of road section to be driven. The *trajectory* indicates on which lane, a part of a *path*, a vehicle is driving. Traditionally, a digital map is used for navigation purposes to guide drivers to their destination. This functionality is also needed for an automated vehicle. In addition to route planning, i.e., the strategic use of the map, it also plays a key role on a tactical/operational level: The map needs to be accurate enough and combined with proper precise localisation to provide guidance for dealing with traffic situations, i.e., how to choose the right lane and how to manoeuvre through an intersection.

An accurate map is required to determine the exact width of all lanes so that a vehicle changing lanes can move into the designated lane. The map needs to be up to date as well: If there are roadworks that affect the number of lanes, it will be much easier and safer to cross these sections if these lane changes were on the map. The vehicle can then combine this information with information from external sensors (e.g., cameras). Such an accurate map contains the road geometry, and all relevant georeferenced objects/attributes (path, offset, lane) that are needed to support Automated Driving.

3.2 Accurate Positioning

Without accurate positioning, it is impossible to control a car automatically. The required accuracy (less than 30 cm) cannot be achieved with conventional positioning technology based on GNSS and vehicle sensors (speed, gyro, IMU). To achieve the required accuracy, information from other sensors must be used: cameras, for example, can provide information on objects (e.g., traffic signs, landmarks) around the vehicle; this can be matched with relevant information from an accurate map. Such a map provides accurate information (position, size) on these objects (traffic signs, lights, landmarks). Triangulating this map information with information from cameras and other sensors improves positioning accuracy.

3.3 Architectural Impact

In an Automated Vehicle (AV), the human intelligence needed to drive a car is replaced by computer intelligence. This has a major impact on a vehicle's software and hardware systems:

- Powerful computing systems (High Performance Computing, HPC) are essential, as is:
- Fast communication between these systems (e.g., with automotive Ethernet), and
- A software architecture that combines everything.

3.3.1 Powerful Computing Systems

An AV requires a huge amount information to be processed. It also needs to be processed in real-time. To make this possible, AD-capable vehicles need to be equipped with more powerful computing systems (e.g. HPCs) than current vehicles.

Information processing also affects the safety of an AV. Therefore, the computing systems need to consider safety aspects such as reliability, security, and other safety-related requirements, as these systems cannot rely on the humans as a fallback mechanism. It is highly likely that redundant systems will be needed to meet these safety requirements.

3.3.2 Fast Communication

Not only does computing needs to become faster and handle large amounts of data, but this also applies to the communication network between the computing systems. Large amounts of data need to be exchanged in real time between multiple cameras, lidar and radar systems. This requires not only high-bandwidth networks, but also networks with a low latency and a guaranteed Quality of Service (QoS). Automotive Ethernet is the most popular solution for this task.

3.3.3 Software Architecture

In an AV, more decisions need to be taken by computers than in a human-driven vehicle; they need to make the decisions that used to be taken by humans. For key tasks like object detection, machine learning and other decision support, algorithms are needed. For these algorithms to be effective, they need to be updated regularly with new information: The neural networks used for Artificial Intelligence (AI) tasks need to be trained regularly and new algorithms must be implemented so that they can cope better with old and new situations (e.g., introduction of a new traffic sign, extension of the Operational Design Domain, ODD). To do this, an AV requires a fast and reliable cloud connection.

The software system that supports machine leaning and data fusion, as well as controls the vehicle must be resilient to errors. Hence, its architecture must be functionally safe. As maps are an important asset for AVs, these maps need to be very accurate (dm level) and also up-to-date: changes to the road network need to be known as soon as possible. Consequently, such a system not only requires more storage space, but also cloud connectivity. This emphasises the importance of a cloud as an integral part of the architecture of AVs.

Due to their complexity, AVs require more software than conventional vehicles. Moreover, the quality of the software also needs to be higher to meet the stringent safety & security requirements. The software will constantly take decisions that could have life or death consequences. As safety is of the utmost importance, the software needs to comply to the right safety levels as defined in ISO 26262/21448 and, by extension, in the relevant standards for AI algorithms (PAS 8800). Cybersecurity also needs to be guaranteed: an insecure system cannot be trusted, as the software can be manipulated.

4. Vehicle System Architecture

4.1 System Architecture Evolution

AVs generate gigantic volumes of data and are highly complex. The increasing system complexity and functional growth are pushing today's distributed domain architectures to their limits. Server/Zone architectures help to clean up the existing distributed domain system architecture in the vehicle. ADASIS intends to support all current and future Electrical and/or Electronic (E/E) architectures, presented below:

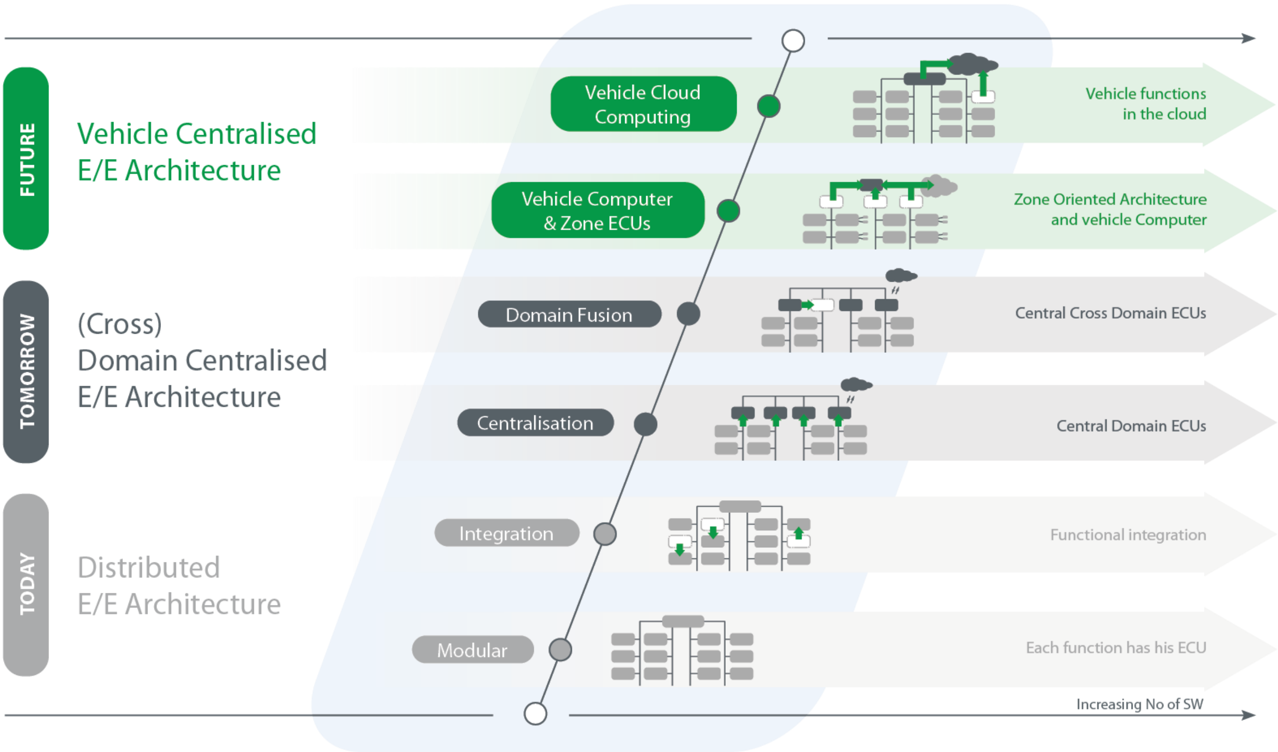

Figure 2 Possible evolution of E/E vehicle architecture (from [2])

In a **Distributed Domain Architecture**, individual functions, such as airbag, air conditioning, or mobile network connection, require their own Electronic Control Unit (ECU). As a result, a modern vehicle can have more than 100 ECUs on board.

A **Centralised Domain Architecture** is an intermediate step from distributed domain architecture to server/zone architecture. Intelligent HPCs replacing traditional distributed control units, act as the central "electronic brain" for data management in the vehicle. In addition, HPCs control wireless updates of the software and firmware over the entire service life of the vehicle. The vehicle is always up-to-date and new functions and applications can be installed at any time. HPCs form the basis for the shift towards **service orientation** in vehicles, safely and conveniently.

A **Server/Zonal Architecture** consists of, e.g., two to five scalable HPCs that implement the functions of different domains. It is expected that many manufacturers will adopt such an architecture by around 2030. Then, the next major integration step will be the vehicle computer for all applications in a **standardised server architecture**.

4.2 Central, Distributed, and Cloud-based Software Architecture

With mobile technologies such as 5G or 6G, bandwidth and latency times are significantly better than previous communication technologies, which enable both OTA software updates and the use of cloud software from the vehicle. Cloud-native software architectures enable the transparent execution of software functions both in the cloud and in the vehicle. This means that technologies from the cloud and data centres such as hypervisors, virtual machines, or containers based on, e.g., Docker will find their way into the vehicle, at least on HPCs.

4.3 In-Vehicle and Cloud Networking: from CAN-based to IP-based

The realisation of map-based functions in a distributed-domain architecture often required the implementation of software on a larger number of ECUs with relatively low computing power. The need for a highly cost-effective interconnection has led to the dominance of CAN in such architectures.

The shift to a more centralized vehicle architecture with a smaller number of ECUs makes it possible to connect these ECUs with much more powerful communication networks, such as Automotive Ethernet. Bandwidth restrictions, which had a major impact, no longer apply or only apply to a much lesser extent. IP-based communication is very common and established outside the classic automotive world, which can be leveraged with ADASISv3. For example, by communicating map data within a vehicle via Automotive Ethernet, we are very close to communicating map data to any other device, be it a smartphone, a third-party device, or the cloud. This enables architectures that were previously unthinkable (e.g. horizon over cloud, apps that work consistently with vehicle behaviour).

5. ADASISv3 Supports Future Vehicles

5.1 ADASIS Introduction

Modern vehicles provide advanced functions through the use of sensor information of the environment. These sensors, such as cameras, radar or LIDAR, have a limited availability and a limited field of view, resulting in limited performance and function availability. This impairs vehicle safety. To increase safety, performance, and availability, maps can be used to extend their field of view and also increase the redundancy of the information, as supplied by the sensors. Therefore, maps should be an integral part of modern vehicle architectures and are a prerequisite for higher-level ADAS and AD functions. The role of maps in an ADAS system is discussed in more details in Chapter 3.4 which refers to a *map as a sensor*.

ADASIS specifies a transmission interface for map data between a component providing map data, and a component consuming map data. Therefore, ADASIS can be used:

- between ECUs,
- inside an ECU or
- between a cloud service and an ECU to *transmit* map data.

ADASIS makes it possible to flexibly add, combine, and exchange map provider and/or map consumer components from different sources and companies without the need to change the overall system.

The ADASISv2 standard implements the ADASIS Horizon for the transmission of semantical information from navigation maps via the CAN bus. It uses a limited amount of data to describe the road network, traffic signs, and road properties, such as curvatures and slopes. ADASISv2 is still used for basic ADAS functions such as Predictive Powertrain Control (PPC), Predictive Cruise Control (PCC) [1], overspeed warning, intelligent speed limit assist, overtaking assist, and predictive ACC (e.g., acceleration/deceleration at speed limits, curves, and slopes).

Higher-level ADAS and AD functions need precise maps to increase the positioning accuracy of the vehicle, improve the environment awareness by fusing map and environment sensor data, increase safety by providing redundancy to sensors. These HD maps contain not only semantic information, but also highly accurate topographic information such as the cm accurate coordinates of lanes, lane markers, poles, localisation objects, and many more traffic-related objects with up to cm accuracy.

ADASISv3 was developed to support ADAS and AD systems by delivering HD map information. It supports a higher level of data detail (e.g., 1cm vs. 1m resolution, lane-level information, etc.) and can transfer a much larger amount of HD-map data than ADASISv2 for the SD-maps mentioned above. Other data sources providing fixed and dynamic georeferenced data can be included.

[1] PCC was the first application on the market.

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5.2 ADASISv3 Basic Concepts

ADASIS uses a Provider-Reconstructor approach: An ADASISv3 Horizon Provider (AHP) extracts relevant information from a map and makes it available to other components on the same or other ECUs. These components implement an ADAS Horizon Reconstructor (AHR) to use this information. This approach makes it possible to keep *the amount of information* sent to a minimum and to adapt the use of map information to the capabilities of the respective ECUs.

In addition to the Provider-Reconstructor concept, the *Path* is also an essential construct in ADASIS: The AHP translates map information into one or more paths and their attributes as illustrated in Figure 3. These paths and attributes are then sent to the AHRs including *localisation.* As a benefit, the client application will receive its current position on the Path(s) along with path(s) description(s) around the vehicle.

Figure 3 ADASIS path concept definition

The ADASIS Horizon Provider (AHP) calculates one or more possible paths through the road network. These paths form the “ADAS horizon”. The AHP transmits these paths and their attributes using the ADASIS protocol for a specified range ahead of the vehicle. This horizon can reach out far beyond the range of sensors (e.g., camera) and might be based on routing information or on heuristics. The ADAS Horizon concept reduces drastically the amount of data to be transmitted, in comparison to the complete map information around the vehicle. In addition, the AHP is also responsible to map-match the vehicle’s position to the transmitted path tree, and to provide the position on the path to the ADASIS reconstructors.

The path tree contains only basic information about the road topology. Further information can be attached to each path by so called “ADASIS profiles”. These ADASIS profiles contains additional information as speed limits, road furniture, localisation objects, and many more. The types of profiles can be configured for each ECU to match their demands and capabilities. So, one ECU with low processing power might only consume curvatures and speed limits while another ECU with higher processing power might consume also detailed lane level information and lane markers with WGS84 coordinates.

5.3 Use cases

ADASIS has classically been used for the efficient distribution of a subset of map information to other ECUs that are not capable of handling large map data or other type data. The idea is to provide a horizon on the road beyond what is "visible" with sensors (e.g., camera, radar). This section will describe how ADASISv3 is able to support advanced automated vehicle functions among others.

5.3.1 Provide Lane-level Information

Having a detailed lane level picture of the road is essential for AD. ADASISv3's path definition consists of an accurate description of lanes with their geometry, lane markers, types and connectivity. Also, legal restrictions such as minimum and maximum speed limits, traffic lights, and overtaking restrictions are available on lane level. In addition, the AHP will transmit the vehicle position including lane information as basis for the localisation (see next chapter).

5.3.2 Enable Precise Localisation

Knowing the exact position of the vehicle on the map is another key requirement for AD. With the help of the detailed lane level description of the road including lane markers, road furniture and other localisation objects as delivered by ADASISv3 this is made possible. Thanks to the use of additional sensors such as camera and LIDAR can enable the vehicle to determine its exact position on the map, with much greater accuracy than a GNNS combined with an IMU.

5.3.3 Support Sensor Fusion

AD requires extremely accurate information, both in space and in time. This requirement is very hard to satisfy with map information only. Therefore, AD vehicles rely on information from a multitude of sensors: e.g., cameras, radar, lidar. ADASISv3 can improve the information from sensors by supplying accurate map data on road furniture (e.g., road signs). Fusing this information with other sensors will lead to greater accuracy, as well as more redundancy in determining a vehicle's position.

The ADASISv3 feature of supporting Auxiliary ADASIS Horizon Providers makes it possible to enhance the map-based information with additional sensor information: an Auxiliary AHP can distribute map data enhanced with sensor information using the ADASISv3 protocol.

5.3.4 Support Automated Driving

One of the main drivers behind the development of ADASISv3 is to support the increased level of automation in vehicles. As already mentioned, these systems require very accurate map information, both spatially through HD maps, as well as in a timely fashion, both by distributing this efficiently, as well as being able to dynamically transmit changes related to the map (e.g., accident information, traffic light phases).

This HD accuracy is not just restricted to the accurate position of the vehicle, but also extends to an accurate lane-level description of the road, including road furniture (e.g., traffic signs). One of the key functions of supplying road furniture information is that it can be used to enhance the position accuracy.

As the map information needs to be accurate, ADASISv3 also makes it possible to augment static map information with dynamic information from external sources (e.g., traffic information, V2X)

5.4 ADASISv3 as a Standard for Transmitting Map Data

ADASIS' main goal is to provide the most efficient distribution method of map data within the vehicle. It does so in a standardised way and is able to handle any georeferenced data received from other sources.
Currently, the ADASISv3 protocol is specified on OSI layer 7 (application layer). This will be extended to OSI layer 6 (presentation layer, serialization) soon. This will make it possible to deploy ADASISv3 components in a plug-and-play fashion. Further specifications for lower OSI layers are planned, but will not be mandatory, as they are often defined by the OEM and common for the complete vehicle.

ADASISv3 makes it possible to exchange map data, independent from a map supplier. Moreover, a combination of map suppliers depending on regions and/or map features is possible without changes to the interface. This makes a flexible system, that can be optimised based on different criteria: performance or cost efficiency.

The ADASISv3 standard can be used for different architectures and applications. It can be used for intra-ECU communication. If different suppliers each deliver software components for one HPC (see § …), the software components can distribute map data and fused sensor data, internally by using the ADASISv3 protocol (e.g., on top of Adaptive AUTOSAR, or automotive Linux).

If different ECUs have a demand for map data, the ADASISv3 protocol can be used for the inter-ECU distribution of map data. An example for this would be the classical system architecture today (see §…): a dedicated navigation ECU, and multiple ECUs consuming map data. This can be based on Automotive Ethernet and the operation of ECUs.

In future, map and navigation data can also be distributed from the Cloud to the vehicle with the help of the ADASISv3 protocol. Existing, and well-proven Internet protocols such as Websockets or AMQP would be a good candidate to support this. It would make it possible to replace the map component by a cloud component. As future vehicles are connected this will save cost. Moreover, it will make it easier to provide vehicles with the latest map information.

5.5 ADASISv3 as One Horizon from Multiple Data Sources

ADASISv3 supports multiple horizon providers (see Figure 4). The primary ADASIS horizon provider sends out the basic road and lane network and is responsible for providing the position of the vehicle on the horizon. Other horizon providers, so-called auxiliary ADASIS providers, can enrich this horizon with additional information referring to locations on the Horizon. This information can come from vehicle sensors, e.g., radar, camera, or LIDAR, or by external information sources (e.g., traffic information). The next chapter provides more detail on these external sources. The Auxiliary horizon provider feature makes a more flexible and scalable solution for data fusion possible. Through this feature all reconstructors consuming this data can directly benefit from fused data.

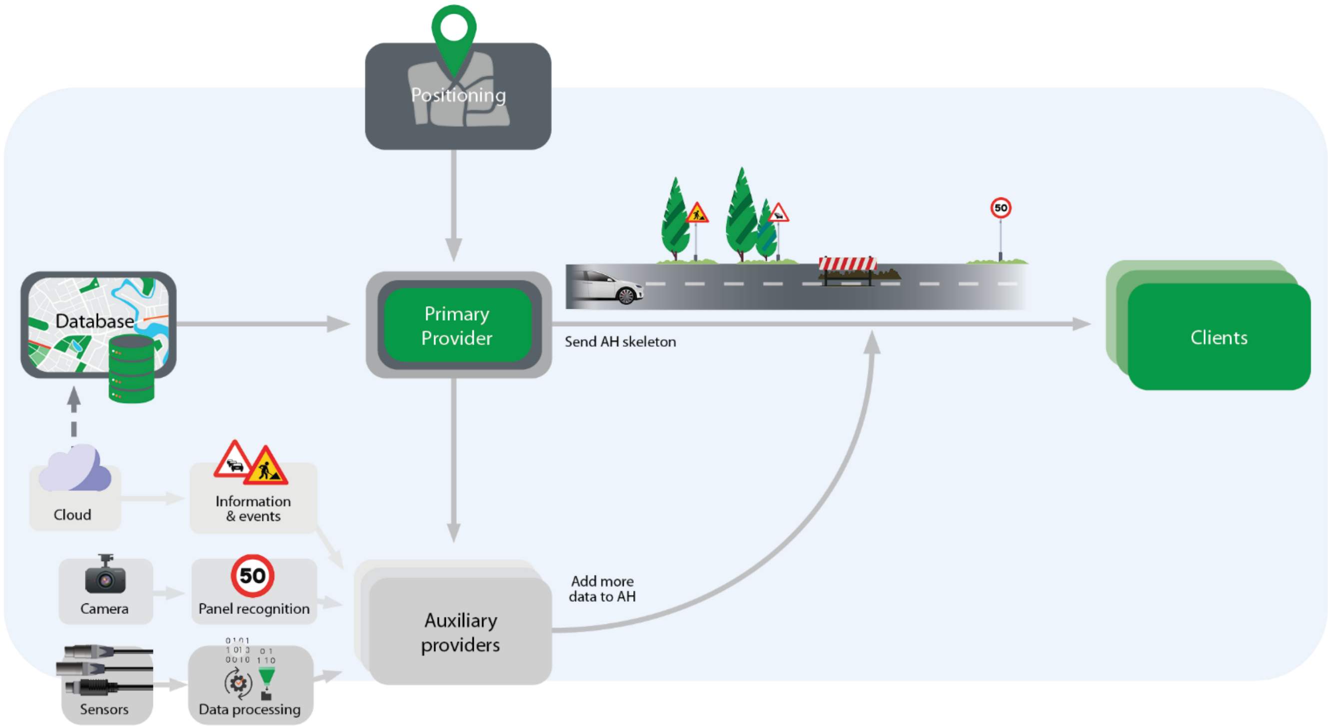

Figure 4 ADASISv3 as one Horizon from multiple data sources

5.6 ADASISv3 for representing Dynamic Geo-referenced Data

As already mentioned, ADASISv3 enables support of dynamically changing information coming from other sensors. Next to internal sensors, this also includes data *from outside the vehicle* (e.g., V2X, TPEG, cloud services). While the concept of Auxiliary Horizon Providers allows the delegation and enrichment of information from a primary provider, it also makes it possible to host a horizon provider in the cloud. This concept can also be used to host other horizon providers in the vehicle (e.g., for redundancy).

With the help of the additional information, ADASISv3 facilitates the update of map data and route information: dynamic traffic changes including:

- prediction of traffic light phase change,
- electronic speed limit signs,
- traffic (jam) and hazard information,
- weather information,
- current average speed.

5.7 ADASISv3 as a Communication for Efficient Deployment

5.7.1 Deployment Aspects

ADASISv3 can be deployed in a wide range of vehicle architectures described in sections 4.2 and 4.3.

- ADASISv3 can be used independent from Operating System or Middleware. So, it can be used with AUTOSAR CLASSIC and AUTOSAR ADAPTIVE as well as on a proprietary middleware.
- ADASISv3 can be used on top of a variety of transport layers and session layer protocols such as SOME IP in the vehicle, or by REST API or on top of Secured Web Sockets (WSS) directly from the cloud.
- The ADASISv3 protocol minimises the necessary transmission bandwidth needed to transmit map data to ADAS/AD functions. The bandwidth depends on the number of supported ADASISv3 profile types sent by the ADASIS provider. It requires only a low bandwidth ranging from less than 1 kB/s average for basic map support and short horizon lengths and can increase to 10 kB/s or more for longer horizons and a higher amount of ADASIS profile types (which might be necessary for higher level ADAS and AD features).
- Even ADASISv3 does not deal with cyber security by itself it can be integrated into existing cyber security solutions in the vehicle.

5.8 What Makes ADASISv3 Unique in its ADAS/ADS Support?

ADASISv3's goal is to support advanced ADAS and Automated Driving system through efficient distribution of high-definition map information:

5.8.1 Making Accurate Map Data and Positioning Available

ADASISv3 makes it possible for ECUs that do not have access to a map and current vehicle position, or lack the capability to access map data and positioning, to benefit from this information, in particular:

- Provide lane level information about the most preferred path ahead of the vehicle as well as alternative paths
- Support for wide range of road and lane properties as well as road furniture's (e.g. lane types, lane marker WGS84 coordinates, road boundaries, …)
- Scalable from Low Power ECUs to HPCs due the "ADASIS profile" concept
- Use of map information for prediction purposes (e.g., lane level speed limits, curvatures, slopes, road boundaries, …)
- Provide high accuracy map attributes for ego vehicle localisation.
- Support sensor fusion through the enrichment of map data with sensor information, by using the Auxiliary AHP concept
- Enrich static map data with dynamically changing data for cloud sources or V2X: e.g., road hazards, traffic light phasing.

5.8.2 Efficient Transport of Information

ADASISv3 is based on a flexible and scalable standardised communication strategy. It aims at supporting both low-end ECUs, as well as powerful HPC nodes. *This is achieved by the combination of the Horizon concept together with the flexibility of the ADASIS profiles.* The Horizon concept transmits only map information that has relevance for the paths the vehicle is traversing. By doing this the amount of information from an HD map will be substantially reduced. In addition the ADASIS profiles allows an ECU to consume only the needed information further reducing the amount of map data to be processed.

5.8.3 Open World-wide Standard

ADASISv3 is unique in that it is map agnostic. It can support maps in any format from any region of the world. Moreover, its specification is open and can be used by any organisation free of charge.

6. Conclusion

This White Paper presented the ADASIS concept of the ADAS Horizon with its evolution since its foundation in 2002. It enables all vehicle systems to access digital map and georeferenced data relative to the vehicle position to build prediction and optimisation strategies. since 2012, ADASISv2 is used in vehicle series of many brands across the world with high impact for example on energy use (fuel consumption) by supporting predictive powertrain functions. ADASISv3 released in 2020, is already used by OEMs and is suited to access High-Definition maps, extending the main ADAS Horizon with Auxiliary Horizon built with other georeferenced data, typically from sensors or external dynamic data (e.g. traffic, emergency, X2V, etc.)

In conclusion the ADASIS Non-Profit International Association promotes with this White Paper the latest version of its specification: **ADASISv3 is able to support Future Vehicles** including advanced automated vehicle functions among others by:

- providing lane-level information,
- enabling Precise Localisation,
- supporting Sensor Fusion,
- and supporting Automated Driving.

ADASISv3 Key messages:

- a **Standard for Transmitting Map Data**
- as **One Horizon from Multiple Data Sources**
- as a mean for **representing Dynamic Geo-Reference Data**
- as a **Communication Protocol for Efficient Deployment**

In summary:

What makes ADASISv3 Unique in its ADAS and ADS Support?

- Making accurate map data and positioning available
- Efficient transport of information
- Open world-wide standard

7. Annex and References

7.1 Annex - History: ADASIS development steps

Why a standard for the horizon?

Late 80s, the Introduction of vehicle navigation was the ground for the automotive industry to develop vehicle functions and Advanced Driver Assistance Systems using vehicle position and map data. It was the motivation to build the ADAS horizon supporting prediction and optimisation of vehicle functions.

At the early stage of navigation map data were physically stored in proprietary format on CDs and then DVDs. Navigation map were therefore NOT interoperable, which made the access to map data for ADAS very complicate and expensive.

This issue was addressed by the ISO TC204 WG3 in a dedicated sub-group to define a standard for the "Physical Storage Format" of navigation map format. Unfortunately, no agreement could be reached in the late 1990s, which was for the automotive industry a major drawback and was the basis to standardise the ADAS Horizon as a map agnostic standard to be accessible by all ADAS in the vehicle.

The ADASIS standard development

As a summary, the main steps in the development of the ADASIS (ADAS Interface Specification) de-facto standard specification are:

- ADASIS was initiated by Navtech (today HERE Technologies), constituted as a Forum **in 2002** by ERTICO industrial partners
- ADASISv1 released **in 2005**, was tested & validated in EU project MAPS&ADAS until 2007
- ADASISv2 released **in 2010** enabled the first predictive applications on the road **in 2012** for trucks with Predictive Powertrain Control reducing fuel consumption by 5 to 8%
- Since May 2018, ADASIS is a Non-Profit International Association under Belgian law (AISBL: Association Internationale Sans But Lucratif)
- **11/2018 ADASISv3 version 1** is released internally to enable Automated Driving (public release 10/2020)
- **09/2021**: ADASISv3.2 released internally (public release 12/2022)
- **03/2022 ADASISv3 version 2** was implemented by Mitsubishi Electric and demonstrated on the SIP-adus pilot in Japan
- **Since mid 2022 ADASISv3** is used in Level 3 **-** series vehicles as indicated in section 1.3.2
- In **2023**: ADASISv3.3 & ADASISv3.4 was released internally
- **Q2/2024** Publication of the ADASIS White Paper
- ADASIS developed also a Reference Implementation for v2 and v3.2, for members only

7.2 References

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