ASAM

Project Proposal Summary Sheet

Project Number	ProjectNumber
Domain	Simulation
Relevant Standard	OpenDRIVE, CityGML
Project Name	Transportation Area Concept
Project Type	☐ Major ☐ Minor ☐ Revision ☒ Concept ☐ Implementation ☐ Study
Start Date	
End Date	
ASAM Funds	
Proposer	

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1 Executive Summary

For testing and validation of advanced driver assistant systems and automated driving simulation is used. The complex systems under test not only need precise and detailed modeling of the road but also a growing amount of information about the environment, too.
Currently ASAM OpenDRIVE is fulfilling the task for the road description quite well, thus it became de-facto standard in automotive domain. The newest version 1.7 was published in August 2021. Nevertheless, disadvantages and issues arose, including the following:

- Simulation settings and road settings became more and more complex
- More real-world data were introduced.
- The databases were linked with various other databases for sensor simulation.

The standard CityGML issued by the international Geospatial Consortium (OGC) is the most commonly used format for storing, modelling and exchanging such semantic 3D city models. Highly accurate geo-referenced, geometric and topological information as well as semantic capabilities are key strengths of CityGML. Different thematic modules are available to cover diverse use cases, including simulations and analyses. The newest version 3.0 of CityGML was published in September 2021 and contains revised and extended concepts for modelling the street space. Compared to OpenDRIVE, CityGML follows a completely different geometric modelling approach based on discrete areas. As general exchange standard for 3d city models CityGML does not cover all requirements for a specific application, which results in some drawbacks regarding the automotive domain. City management applications often require a fragmented view of the traffic area, which does not match a simulation view

- Semantic concepts differ with respect to their approach on segmenting the street space in individual objects as well as modelling the road (e.g. linear referencing, parametric geometries)
- Only including OpenDRIVE into CityGML does not solve the OpenDRIVE issues.

CityGML contains a built-in mechanism for extending the data model of the standard with concepts not originally within its scope called Application Domain Extensions (ADE). This could help in order to bridge the gap between the two standard.

The proposal for this concept project is to re-think the road modeling approach incorporating requirements of automotive domain using the Area Concept of the OpenDRIVE concept project to tackle the challenges of the realistic representations of real-world data on a larger scale. The project should come up with a proposal how to combine precise road description of large real world road networks, road infrastructure and furniture together with their complex environment. The concept project will bring together the expertise of both, automotive and city modeling domain to propose an easy and modular solution that is easy to use and extendable by further relevant stakeholders (e.g. traffic or energy management).

2 Overview / Goals

2.1 Motivation

2.1.1 Current OpenDRIVE

Upcoming applications in the automotive domain aim at enabling realistic representations of real-world data on a larger scale. Regarding this, the following issues with the current OpenDRIVE emerge:

- Modeling is based on reference lines with relative lane definitions. These are usually virtual constructs, based on clear rules. However, roads in complex urban scenarios are often not built according to these road construction guidelines.
- Due to the modeling approach, auxiliary constructions are often necessary, which leads to even more complexity, ambiguities or gaps. It is therefore very difficult to update or patch parts of a complex road model.
- The hierarchical XML specification can lead to multiple definitions of the same elements, such as road marks. The strict hierarchy leads to costly and time-consuming update procedures of subordinate elements in one OpenDRIVE file.
- Real-world data cannot be transformed into OpenDRIVE syntax directly. This is due to OpenDRIVE being a virtual construct. This means, its modeling procedures are not common among other domains, such as road operators or public authorities.
- Scalability and data exchange are very limited, due to a large XML structure that do not have abbreviations, such as namespaces. It is therefore necessary to facilitate huge databases of urban or long motorway settings.

2.1.2 Already proposed innovation for road modeling

In the OpenDRIVE concept project the Area Concept already worked these issues. To do this, the way of modeling a road network is changed in order to bridge the gap between current simulation use cases and the upcoming challenges of introducing more real-world settings into the simulation as well as data with a higher level of detail. The key motivations are:

- Model roads as they are, without creating gaps.
- Simplify the modeling of complex urban situations.
- Make the usage of existing real-world data easier by integrating data of public authorities faster.
- Use shared geometries to ensure the integrity of topological data and avoid unintended gaps.
- Do not use artificial modeling constructs or helping constructions, such as reference lines, junction containers or hard-coded lane structures, in order to model real-world data.
- Avoid using relative coordinate referencing at any time that is referencing along imaginary reference lines. Instead use absolute coordinates wherever possible.
- Simplify the linkage to other databases in order to easily provide supplementary information.
- Store separate content in layers for flexible access and extension. Layers may be arbitrarily user-defined.
- Improve the maintainability of a database by making it easier to update individual parts or elements.
- Avoid large XML files and enable spatial indexes and queries by using geographic information system (GIS) technology to quickly access and process large databases.

- Improve scalability, since the current OpenDRIVE is not scalable at all.

A detailed lineup of differences between the proposed Area Concept and OpenDRIVE 1.x is provided in documentation of the OpenDRIVE concept project work package WP05 description in Section 1.3.1.

The area concept facilitates stand-alone polygons for the description of the usable area, for example for transport modes or traffic participant types. All polygons belonging to one traffic mode are grouped into a layer. This results in having different independent layers for different traffic modes, which simplifies the modeling of complex urban scenarios. The elements can be combined in a variety of ways:

- Polygons (areas) within the same layer are linked to each other implicitly using shared geometries, which superimpose topology constraints. These topology constraints ensure data integrity and are easy to handle on a database level. The necessary tool support is already available in the GIS domain and partly standardized.
- Explicit linking of elements within one layer or between layers can be achieved on a flat attribute level. Such an approach offers great flexibility and easy extensibility.
- Additional "logical linking layers", for example using reference lines, lane center lines or movement paths, can be included into the layer tree at any time.

The current OpenDRIVE works well for automated test case generation with a limited scope. The Area Concept enables the extensive use of real-world representations, which is very restricted in OpenDRIVE. Test case creation of smaller settings is also possible with appropriate tool support due to the different modeling approach.

Therefore, the Area Concept can replace the current OpenDRIVE. Once the complexity of test cases increases and test cases incorporate more real-world data, the Area Concept will play out its advantages. Due to the completely different nature of road element modeling, at the current design state the Area Concept will most certainly not be directly compatible with the current OpenDRIVE implementation. This results in a new standard definition. Discussions in the WP05 working group lead to the common understanding that "there won’t be any compatibility to OpenDRIVE 1.x" and that "the tooling has to be re-invented". Still, a common interpretation of datasets is intended to enable the transfer of OpenDRIVE 1.x datasets to the Area Concept model without loss of information. This is achieved, for example, by re-using function reference implementations from OpenDRIVE 1.x and supplying a base converter to translate OpenDRIVE 1.x datasets into the Area Concept data model.

2.1.3 Current CityGML

CityGML recently introduced in their version 3.0 a rework of the transportation module. The core idea of defining traffic areas (and on top of it traffic space and on top of this traffic clearance as volumes) was extended in a more elaborated way: The traffic area segmented based on their functional usage. This leads to a collection of various areas and their combination will result in the overall traffic area. But for complex intersections this will get very expensive to calculate the lane of interest. Additionally the vehicle type individual centerline calculation could get complicated, too which often is necessary for automotive applications. Already a straightforward roads with e.g. bicycle lanes and pedestrian crossing lead to a larger amount of traffic areas that have to be combined to calculate the lane of interest. The traffic module itself also does not solve the issue of comprehensive semantic modeling of the road’s appearance (e.g. road markings and surface). For road infrastructure and furniture additional modules have to be used. Nevertheless their depth of (semantic) modeling is rather limited compared to OpenDRIVE and the need of modeling more ITS infrastructure such as traffic cameras, induction loops, roadside sensors and communication equipment becomes more urgent.

Thus CityGML is providing a good approach how to model comprehensive environments. The required level of detail is not covered for automotive domain, yet. The required information is distributed interspersed throughout different modules with different development cycles. The idea of the concept project is to propose a solution that incorporates all necessary modeling in one module, using a modeling approach that is suitable for both domains, automotive and city modeling as basis for a digital twin that can be used by additional stakeholders.

2.2 Use-Cases

The concept proposal shall cover the at least the domains of automotive development, test and verification as well as city modeling. General speaking all their use cases could be stated here. They are the intrinsic driver of comprehensive environment modeling but more stakeholders can benefit from an overall digital twin. Also within the two mayor domains the use cases can vary. Therefore the following use cases should give an idea of the versatility of the proposed concept but is not limited to the mentioned

Table 1 Generation of High-Definition Road Networks

ID	
Description	Traffic simulation, vehicle dynamics simulation, sensor simulation as well as virtual development, test and validation require geo-referenced, high-definition maps of road networks. Such kind of maps are created by surveying companies or derived from areal images and ordered by public authorities, car manufacturers, simulation tool vendors, urban planners etc. The road networks should be interchangeable among stakeholders.
Actors	• Surveying companies and map makers • Public authorities • Vehicle manufacturers and their suppliers • Simulation tool vendors • Urban planners

Table 2 Traffic Simulation

ID	
Description	Macroscopic simulation of traffic on road networks. Traffic simulation may incorporate large numbers of various traffic participants, e.g. pedestrians, cyclists, road and rail vehicles etc. Traffic simulation is used to simulate surrounding traffic of a vehicle under test, traffic volume in specific areas, accident probabilities, traffic management strategies, impacts of changes in the road network etc. Traffic simulation requires a logical description of corresponding road networks for varying kinds of traffic participants.
Actors	• Public authorities • Mobility (as a Service) operators

	• Road operators • Vehicle manufacturers and their suppliers • Simulation tool vendors • Urban planners

Table 3 Sensor Simulation

ID	
Description	Simulation of sensors as a device, module or subsystem of a vehicle or infrastructure is indispensable for the selection of individual sensors as wells as for the compilation of sensor sets and the development of sensors and sensor-based functionalities in the automotive and traffic management context. Sensor simulation provides the foundation for development and test of driving assistance functions, for automated and autonomous driving functions as well as for intelligent traffic management. The environment has a strong influence on sensor's behavior.
Actors	• Vehicle manufacturers and their suppliers • Simulation tool vendors • Road operators • Urban planners

Table 4 Virtual Development, Test and Validation

ID	
Description	Development, testing, validation and verification of automated and autonomous driving functions are increasingly carried out virtually. Also the final approval will base heavily on virtual testing and verification. The reproduction of countless, realistic journeys over millions of kilometers requires complex road networks and an extensive amount of scenarios as input files. Major requirements on corresponding file formats is standardization and exchangeability.
Actors	• Vehicle manufacturers and their suppliers • Simulation tool vendors • Public Authorities • Testing organizations

Table 5 City Planning

ID	
Description	The overall planning of urban areas have to include various aspects such as change of mobility, livability (regarding supply and emission reduction), ecological as well as economical impact, solar potential calculation, heat distribution, air and emission flow simulation, citizen needs, etc. A lot of these aspects are influencing each other. Therefore a detailed modeling of Environment, supply infrastructure

	including traffic networks is crucial especially if different simulation tools are used. Using the same data source ensures that everybody is simulation on the same basis.
Actors	• Simulation tool vendors • Public Authorities

Table 6 City Management and Operation

ID	
Description	The management of urban areas covers not only the road operation but also energy management, green-space management, etc. Road operations should manager its infrastructure assets in a way that e.g. traffic simulation can use this knowledge base to calculate impacts of changed traffic flows, constructions sides temporary measures. For that a detailed modeling of the road and roadside infrastructure as well as environment is necessary.
Actors	• Simulation tool vendors • Public Authorities • Mobility (as a Service) operators • Road operators

2.3 User stories / Requirements

Note: This chapter is not required for Study Projects!

This can be a list of user stories, features, requirements, issues.

The standard shall include the following features / requirements.

Table 7 Feature / Requirement overview

Feature / Requirement	Type
	Choose an item.
	Choose an item.

2.4 Relations to Other Standards, Projects or Organizations

2.4.1 Standard and Standardization activities (ASAM, ISO, AUTOSAR, Other)

The project will come up with a new proposal of modelling taking existing solutions into account. Most relevant standards will be:

- OGC CityGML
- ASAM OpenDRIVE

2.4.2 Backward Compatibility to earlier releases

The project will come up with a new proposal, therefore no backward compatibility has to be considered.

2.5 Goals

The two standards ASAM OpenDRIVE and OGC CityGML were developed from completely different starting points and stakeholders and also with different objectives. Both have strength and weaknesses with respect to different applications.

This project's objective is to evaluate the requirements of different stakeholders and applications requiring a detailed traffic space and environment model and how these requirements can best be met.

There are various possibilities and therefor different possible outcomes of this project. As for now the following options could be explored:

- Connecting ASAM OpenDRIVE 1.x and OGC CityGML
  This approach could use the strengths of both worlds, but it must be evaluated, whether and how this can be achieved in a reasonable way. Both standards are conceptually completely different, which cause problems when trying to link both.
- Connecting ASAM OpenDRIVE 2.x and OGC CityGML
  It might be necessary to adapt OpenDRIVE in a non-backward compatible way to link both worlds. This approach might also offer opportunities to get rid of known OpenDRIVE issues and constantly evolved structures leading to a lean, focused, and easier to understand standard.
- Extending OGC CityGML with concepts from the Area Concept
  The CityGML Transportation modul was revised with the publishing of version 3.0. Still, it does not meet all requirements of applications from the automotive domain. As an exchange format for semantic city models it's not that focused on specific applications as OpenDRIVE is for simulation applications. But CityGML offers the concept of Application Domain Extension (ADE). To not reinvent the wheel using the base concepts of CityGML and extending them by concepts of the Area Concept could be a promising solution.
- Follow-up of the Area Concept in a distinct ASAM Standard
  If the found requirements cannot be met by any existing standard or solved by extending or revising an existing standard, the best option could be to launch a new standard. This approach offers the greatest freedom of ideas, drawback is that no developments exist on which to build on.

It is also feasible that different branches are pursued at the same time within the project. Results of this project can flow back into other projects, for example the ongoing ASAM OpenDRIVE 1.8 development project.

3 Technical Content

<Text>

4 Review Steps

Note: This chapter is not required for Study Projects!

4.1 Mandatory reviews based according to the project type

Table 8 Mandatory Reviews

Project Type	Internal review	External Review
Revision	Yes	
Minor	Yes	
Major	Yes	Yes
Concept	Yes	
Implementation	Yes	

4.2 Additional review types

The following additional review types shall be carried out by the project:

Table 9 Review Types

Check	QA-Measure	Responsible
☐	Example implementation	Choose an item.
☐	<other QA measure>	Choose an item.

5 Deliverables

Note: This chapter is not required for Study Projects!

At the end of the project, the project group will hand over the following deliverables to ASAM:

Table 10 Deliverables

Item No.	Description
1	
2	
3	
4	
5	
6	
7	
8	
9	

6 Project Plan

6.1 Work Packages

Note: This chapter is necessary only for Study Projects which require a budget!

The project consists of the following work packages:

Table 11 Work packages

WP-No.	**Title / Description** • (Intermediate) Deliverable
1	Mutual Understanding: Giving an introduction in CityGML transportation module (and transportation related modules) concept and OpenDRIVE Area Concept
	• Presentation of CityGML's transportation module • Presentation of Area Concept • Recap of current OpenDRIVE
2	Summarizing Requirements: Collecting of requirements to a proper road, road infrastructure and environment description format from relevant stakeholders (at least automotive and city modeling domain). Evaluate them in the sense to check if existing standards are already meeting the requirement in a feasible way, which can be borrowed or linked to. Derive work items from prioritized requirement list.
	• Requirement list • Solution list • Work item list
3	Work item concepts: Create concepts for each selected work item.
	• Concept proposal for each work item
4	Concept compilation: Combine all work item concepts in one overall proposal document.
	• Concept proposal document

6.2 Time Schedule

Note: This chapter is not required for Study Projects!

The work packages shall be carried out as per the following time schedule:

Table 12 Time schedule

	Title / Description	**<Year>**

WP-No.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

7 References

[1] <Document Title>, <Document Author>

[2]

Appendix: A. Filling Instructions

Table 13 Project overview

Project Number	**The project number is provided and filled in by ASAM.**
Relevant Standard	For the further development of an existing standard (major, minor or revision), enter the ASAM standard name in this field. Also, in case of implementation and concept projects the related standard shall be named here.
Project Name	Create a short but descriptive name for the project. In case of a new standard this should be the future standard name.
Project Type	Chose a project type from the given list.
Start Date	Enter the planned start date (Month / Year) of the project.
End Date	Enter the planned end date (Month / Year) of the project.
ASAM Funds	Enter the amount of budget requested from ASAM.
Proposer	Issue submitter Name and Company

A.1. Executive Summary

Provide a summary of the contents of chapters Overview, Technical Content, and Project Plan. Start with a purpose statement. Shall consist of two paragraphs or half page at most. Briefly describe the potential impact that shall be achieved. The text may be used by ASAM for publishing the project, e.g. in newsletter articles or the web page.

In case of a Study project: Start with a purpose statement. Summarize goals and the content of the work group.

A.2. Overview

A.2.1. Motivation

Provide a general explanation for the motivation of the project proposal. This may include the description of the history that led to the proposal, general problems with current industry practices or existing standards, identified areas for improvement or economic constraints that require the solutions proposed for this project.

In case of a Study project: Briefly describe the goals of the work group, which shall be achieved by the end of the project. Focus on a few goals, which are specific, realistic and can be achieved in the given time.

A.2.2. Use-Cases

Use-cases in the context of ASAM standards describe the external behavior of the standardized system, i.e. the interaction of the system with a user or with another system. The description of use-cases is particularly useful for explaining the motivation for new standards, major version development projects or the addition of new features in minor version development projects.

ASAM subdivides use-cases into three tiers, where each lower level is a refinement of its immediate higher level.

- Business Use-Case: Describes an economic advantage, company need, process, method or element of a larger tool chain that involves many people of a company or multiple companies in a customer-supplier relationship. Example: ECU calibration and measurement.
- End-User Use-Case: Describes a need, process, method or element of a tool chain that is handled by one person while he carries out specific tasks within a company use-case.
  Example: Start measuring data on an ECU.
- Technical Use-Case: Describes a technical necessity, that is required for the operation and interoperability of technical systems, such as tools, ECUs, test systems or application software, to support the tasks of end-user use-cases. Example: XCP protocol commands for DAQ start.

If the use-case method is used for describing the motivation of the project proposal, then the minimum requirements for content are:

- All relevant Business Use-Cases for this project must be listed.
- List must contain at least one Business Use-Case.
- Describe multiple End-User Use-Case for each Business Use-Case.
- The list of End-User Use-Cases can be incomplete but shall contain the most important End-User Use-Cases.

If the list of End-User Use-Cases is not complete, then it shall be completed during the project's development phase.

The description of Technical Use-Cases is optional.

Use cases should adhere to the following format:

Table 14 Use case description

ID	**Assign a unique ID to this use-case. Is used for mapping.**
Description	Write a brief description for the use-case.
Actors	Provide list of specific actors (i.e. company departments, end-users, tools, ECUs, etc.)

A.2.3. User stories / Requirements

In the context of ASAM standards this describes user stories, requirements, features or issues that the output of the project should satisfy.

Features in the context of ASAM standards describe functionality of the standardized system, which is available to the user. The description of features is particularly useful for existing standards, that shall be extended with new features. The list shall also contain those features, which exist but shall be revised or extended in functionality.

If standards exist but have known issues that shall be fixed, then the description of those issues is particularly useful for explaining the motivation of the project. Issues can be missing minor features, specification gaps, unclear or ambiguous descriptions, inconsistencies and errors.

A.2.4. Relations to other Standards, Projects or Organizations

A.2.4.1. Standard and Standardization activities (ASAM, ISO, AUTOSAR, Other)

List any standards, projects or organizations, that have an influence on this project. Describe how they shall be considered during this project.

- Standards: Other standards may need to be referenced, be kept compliant with, synchronized or otherwise considered for this project.
- Projects: The work of other projects, which are ongoing in parallel of the development phase of this project, may need to be coordinated.
- Organizations: Other standardization organizations may need to be contacted and shall influence or contribute to this project, e.g. to release specific IP or provide specific files to be used for this project.

A.2.4.2. Backward Compatibility to earlier releases

Standards for minor and revision releases shall be backward-compatible!

A.3. Technical Content

Provide a detailed description, how the identified use-cases, features or issues (as per preceding chapter) shall be solved or implemented through the proposed project. Descriptions shall include, if applicable:

- Components of a system, which shall be standardized
- Features or functionality of the standardized components
- Method of standardization
- Top-level requirements to be considered for developing the standard
- Improvements & benefits of the changes as compared to earlier releases of the standard
- Assumptions

The technical content description shall be understandable for readers with an engineering background, but with no specific domain-expertise. Consequently, a brief technical introduction may be needed.

In case of a Study project: Start the content description with a motivation or reason, why this work group is being proposed. This may include the description of problems or use-cases. Continue with describing, how the goals shall be achieved, which technical topics shall be covered and which standards (ASAM and non-ASAM) are involved. Describe expected documentation, prototypes or other work products that may be produced by the work group, if any.

A.4. Review Steps

A.4.1. Mandatory reviews based according to the project type

For each standard development project (major, minor, revision) enough time for an internal review, carried out by the project group, should be scheduled.

Immediate quality criteria are:

- Standard is free of specification gaps, unclear or ambiguous descriptions, inconsistencies and errors

- Standard is professionally written, understandable, logical, consistent, uses well established terminology and is well formatted
- Standard is feature-complete, i.e. it does not leave gaps within the intended scope of standardization
- Base standard is independent from specific implementation technologies

Indirect quality criteria are:

- Standard meets market needs
- Standard can be implemented
- Standard allows inexpensive implementations
- Standard allows an implementation with state-of-the-art and future-proof implementation technologies

A.4.2. Additional review types

In this chapter, describe the measures that additional will undertake to ensure the quality of the standard. Such quality measures could be but are not limited to:

- Reference implementation: Develop a reference implementation in parallel to standard development. Distribute the sources together with the standard.
- Implementation project: Carry out a project for implementing the standard in parallel to standard development. Distribute the project result as an ASAM product.

A.5. Deliverables

Provide a list of deliverables, which are handed over to ASAM at the end of the project. Deliverables must be material items, e.g. documents, code or executables. They are delivered in an electronic format, e.g. as files.

Please note that the sources for generating or compiling the deliverables, including tool-related files that are needed for the generation or compilation process, must be delivered to ASAM, too. Those sources and files need not to be listed in this chapter.

A.6. Project Plan

A.6.1. Work Packages

The plan is a decomposition of the project into individual work packages with the goal to develop the deliverables.

Table 15 Work packages

WP-No.	Title / Description
	• Deliverable
Sequential number, starting with "1".	Provide a brief description of the work package or give a descriptive title.
	• List of deliverables, including intermediate results of this work package.
2	
	•

3	
	•

A.6.2. Time schedule

This Gantt chart gives an overview of the distribution of the work packages over the project years, as well as their mutual interaction and the sequence of processing of the individual work packages.

A.7. References

Provide a list of documents and their authors that are referenced in earlier chapters. Use the sequential number in squared brackets for referencing them in earlier chapters.

Association for Standardization of
Automation and Measuring Systems

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