

ASAM OpenCRG

List of Features and Requirements

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1 Purpose

The purpose of this document is to capture features and requirements for the further development of OpenCRG. The input for this document originates from a series of meetings with industry-experts on the subject matter. Their statements from presentations and discussions has been compiled into concise and non-overlapping feature- and requirements descriptions. They are the foundation for further project planning and project proposals at ASAM.

A "feature" in the context of this document is tool functionality, which is perceivable by a user of a standard-compliant tool, with which he can interact, and which is clearly separated from other functions of the tool.

A "requirement" in the context of this document is a description of a necessity that shall be met by the standard or the standard-compliant tool, respectively. Requirements can also be used for describing details of a feature.

The list of features for OpenCRG shall be as complete as possible in this document. Features typically describe major parts of a standard. One feature can correspond to one chapter in the later standard document. The specification effort for features is typically very high. This must be known prior to project start, so that the necessary resources for the project can be allocated.

The list of requirements does not have to be complete prior to project start. Requirements typically have a lesser impact on the efforts to create a standard. This document shall only include those requirements, which are deemed as important and require acceptance by the ASAM community prior to project start. All further requirements for standard development can be defined after the project start.

The chapter "Other Topics" includes those expert contributions, which can neither be classified as a feature nor as requirement, or which will certainly not be part of an OpenCRG standardization project. Most of the topics would potentially be realized in a software implementation project, which would produce source code or tools that support the application of OpenCRG.

2 Features

ID	F001	Priority	Normal
Title	Georeferencing		
Description	The data model of OpenCRG shall be extended with georeferencing parameters in order to transform internal coordinates (u,y) to geographic coordinates. The chosen georeferencing shall be independently usable with other standards.		
Rational	The current data model of OpenCRG has an internal coordinate system (u,y), which works well in conjunction with OpenDRIVE. This allows to precisely map the surface grid data of OpenCRG on road networks described by OpenDRIVE. However, this CRG-internal coordinate system does not easily work with other standards that use geocoordinates such as longitude and latitude. Parameters for precisely transforming the internal coordinates to a public geocoordinate system shall be added to the data model. This would make OpenCRG usable with other standards for road network description.		

ID	F002	Priority	Normal
Title	Multiple Data Layers		
Description	OpenCRG shall support multiple datasets per reference line, i.e. $z(u,v)$ effectively results in a vector. The elements of the vector includes values of different physical properties of the surface, e.g. <ul style="list-style-type: none"> • elevation • friction (μ) • luminance/gray values (L_v) 		
Rational	OpenCRG currently supports just one dataset per reference line, i.e. $z(u,v)$ returns a scalar. The scalar typically represents the surface elevation. Other physical properties such as friction (for vehicle dynamics simulation) and gray values (for testing optical sensors) are needed for specific simulation use-cases.		

ID	F003	Priority	Normal
Title	Special Areas		
Description	Allow holes in CRG grid by filling it with NaN or special key-values for indicating non-drivable areas in the CRG data.		
Rational	CRG does not allow holes, i.e. parts with missing heights within the grid data. Allowing this may be useful for skipping parts which are not passable like traffic islands. This is especially useful when		

	combining openCRG with openDRIVE where these objects are explicitly modelled and have thus no road surface.
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3 Requirements

ID	R001	Priority	Normal
Title	Harmonize the reference line definition with OpenDRIVE		
Description	Adaption of the openCRG axis representation to allow integration in openDRIVE without inconsistencies in axis length.		
Rational	openCRG and openDrive follow different road axis (reference line) representations. Especially for axes with high curvatures and with larger grid size (i.e. axis increment) this leads to inconsistencies in the axis length and consequently to errors in the resulting heights for a query on a certain axis position. This is especially relevant, when the mode "attached" is used where the reference line of the CRG data is replaced with the OpenDRIVE road's reference line.		

ID	R002	Priority	Normal
Title	Allow wide roads with high curvature.		
Description	Allow wide roads with high curvature. Minimum requirement would be to allow the center of the maximum reference line curvature to be in the NaN area, for example by checking with local CRG width during the curvature check.		
Rational	Curvature check for a CRG is performed based on the maximum width of the CRG. It is checked if the center of maximum reference line curvature is inside road limits. That means for example that you cannot combine a wide road part followed by a narrow part with high curvature, even when the curvature constraints within the narrow part are not violated.		

ID	R003	Priority	Normal
Title	Show reference line on maps from multiple map-providers.		
Description	The current MATLAB API allows the reference line to be shown on Google-Maps. The API shall be extended to plot the reference line on other free mapping services, such as OpenStreetmap, and commercial services such as Bing, Apple or Here.		
Rational	The license terms & conditions of Google-Maps have changed. This function is not freely available any longer. An API-key is required to use this function.		

4 Other Topics

4.1 Further Development of the API Source Code

Source code is available for OpenCRG and shall become part of the standard delivery. The source code is written in the programming languages ANSI C and MATLAB, and provides the following functions:

- ANSI C: import and evaluate data,
- MATLAB: import, manipulate, evaluate, display and export data.

The MATLAB code shall be executable in MATLAB from MathWorks and in the open-source tool Octave.

The source code shall be further developed in parallel with changes to the standard and to remain functional with future releases of the ANSI C standard and the MATLAB tool (two product releases per year). In addition to that, the functional scope of the source code may be extended. The latter may be done via a collaborative source code development project.