ASAM	**P20019-02** **OSC Concept Project**

Project			
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Standard Name/ Project Name	OpenSCENARIO (OSC) Concept Project (OSC 2.0)		
Current Version	N/A	Next Version	
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Submitter			
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Change History

Date	Author	Chapter + Description
13.02.2019	Gil Amid	First Revision
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Contents

Project 1
Submitter 1
Change History 1
Section 1: Project Proposal 3
1 Executive Summary 3
2 Motivation 5
2.1 General Description 5
2.2 Features 5
2.3 Requirements Descriptions 6
3 Technical Content 8
3.1 ASAM OSC 2.0 Workgroup 9
3.2 Driver and Traffic Model Workgroup (WG) 10
3.3 Weather, Environment Models and Localization/Geographies WG 10
3.4 Vehicle Dynamics Model WG 10
3.5 Parameters and Constraints Handling WG 10
3.6 Measurements, Grading and Success criteria WG 11
3.7 Scenario Creations Methods and Reuse WG 11
3.8 Overall Outcome 11
4 Quality Assurance 13
5 Deliverables 14
6 Project Plan 15
6.1 Resources 15
6.2 Work Efforts 16
6.3 Time Schedule 17
6.4 Budget 18
6.5 Resource Checks 19
7 Relations to Other Standards, Projects or Organizations 21
8 References 22

Section 1: Project Proposal

1 Executive Summary

OpenSCENARIO is an open file format for the description of dynamic contents in driving simulation applications. The ownership of this format is being transferred to ASAM. The transfer is covered in a different project proposal.

This concept project proposal addresses the evolution of OpenSCENARIO to the next level in order to establish OpenSCENARIO as the mechanism to define tests and scenarios for the full development process of autonomous vehicles, and the full complexity of real-world scenarios, including complex inner-city traffic.

It is assumed that during the development process of autonomous vehicles, the development evolves from pure software-based simulation, through SIL, HIL, VIL hybrid testing models, up to test tracks and street driving.

OpenSCENARIO 2.0 should serve as the format and mechanism to supply dynamic content and functional behavior to all these testing and execution platforms, for all driving scenarios ranging from simple motor-way interactions to long-running, complex inner-city traffic scenarios. Given the large scope of proposed features and requirements, as captured in the proposal workshop, as well as the large number of initially interested participants (in the region of 70 or more participating entities), partitioning of development work, while retaining a unified view of the core concepts of OpenSCENARIO 2.0 will be crucial.

This initial concept project is intended to provide this unified view of the different concepts that are required for the features and requirements intended for OpenSCENARIO 2.0, while accomplishing the initial concept work on the individual feature concepts in sub-working groups inside this project.

Once clarity on the scope of the feature concepts and their interplay with the core conceptual framework is established, it is expected that proposals for separate concept development projects, and/or standard development projects will be created, where the needed work to complete the concept development warrants this.

Additionally this initial concept will have to ensure coordination with the evolution of OpenSCENARIO 1.0, both by dispatching sub-features that are ripe for integration into 1.x to the appropriate standardization projects, as well as providing a migration path or backward compatibility solution from OpenSCENARIO 1.0 to OpenSCENARIO 2.0.

The task attempted here has a very wide scope, the problem domain spans over different technical domains and interactions, and thus may require different thinking, different modes of work, and perhaps recruiting international collaboration.

The proposed internal structure of the project consists of a top-level workgroup, forking a few sub-working groups and overseeing their progress. The proposal is trying to set a very aggressive schedule of an outline within 6-9 months (end of concept project) ,followed by other projects of initial implementations within a 12-15 months, and completion of the full standard project by the end of 2020.

The outcome will be the definition of concepts for the features F001 to F011, as described in the following chapters, or concept project proposals to spawn separate concept projects for them, if the project group determines this as necessary. It is assumed that the concept will demonstrate a high level block diagram architecture, demonstrating the encapsulation of the features.

Concepts may include prototype implementations, example code or demonstrators to show feasibility of the concept and how an implementation in accordance with the concept could look like.

The proposal is aiming at OpenSCENARIO 2.0 – where the vision is that this is a standard with all the required feature to enable testing and validation of ADAS systems and autonomous vehicles. It is expected that certain sub-features will likely lead to standardization-ready concepts for evolution of OpenSCENARIO 1.x as well.

2 Motivation

2.1 General Description

With the evolution of autonomous vehicles, the need for more sophisticated testing and validation of ADAS and autonomous driving system is increasing exponentially. It is predicted that simulation-based testing will replace the unachievable goal of test driving billions of kilometers for validation purposes. It has been already published that different companies run tens of thousands of simulation-based tests for their autonomous systems.

OpenSCENARIO is already quite advanced and usable (but not feature-complete) in describing complex maneuver scenarios, involving multiple cars. One of the top-priorities for the concept project is to further develop the detailed maneuver model and add highly needed features, see F001.

OpenSCENARIO is a low-level and concrete specification format, primarily designed to be read by simulation tools. Users, who create maneuver descriptions and tests, need a higher level of abstraction and potentially different ways to express this than in the current detailed XML-format of OSC. There are multiple ideas how to express maneuver descriptions on a higher level of abstraction, with interfaces to general-purpose languages or the development of a domain-specific language being among the expressed ideas. This is a top-priority for the expert community and shall be further investigated with a concept for standardization as an outcome of this project, see F008.

Some features in OpenSCENARIO are implemented in the current OSC data model in a very basic way, e.g. the Weather Model and Driver Model. Those features are still far away from being complete. Tool vendors and users alike have expressed their need to significantly extend those models. For some of them, the concept project group may come to the conclusion that a separate standard is required.

The concept group is expected to propose a concept and direction, which will enable OpenSCENARIO to supply a step-function in its ability to describe a full, complex simulation and/or tests, addressing all the required elements, and utilizing existing building blocks (like OpenDRIVE or OpenCRG).

The proposed scenario definition mechanism is expected to enable massive testing and verification of new, complex hardware and software systems, and their interaction with the complex environment of driving.

2.2 Features

The concept project shall include the following new or revised features. This set of features was analyzed, revised and prioritized in the proposal workshop that took place on Jan-2019. The list here is in priority order, as was voted in said workshop. Detailed descriptions of the individual features can be found in the document titled “ASAM OpenSCENARIO List of Features and Requirements”. The key outcome of the proposal work shop was that there were two outstanding features in the prioritization voting (both at more or less the same level of priority):

- F001 Maneuver model
  (Enhancements to the set of maneuvers that can be described)

- F008 High level maneuver descriptions
  (More abstract, expressive and efficient ways of describing maneuvers)

It is obvious that the two are interrelated to a certain degree and should be well coordinated. Most of the other features discussed, specifically the different models, ideally can be plugged in to the core standard conceptually.

A few of the other features, like F007 (Parameter stochastics) and F010 (Automatic parameter calculation) will likely have more tight interactions with the core standard on a conceptual level

TABLE: FEATURES

Feature	Type
F001: Maneuver model	Change
F008: High level maneuver descriptions	New
F003: Traffic Model	New
F007: Parameter stochastics	New
F002: Driver Model	New
F004: Environmental Condition Model	New
F009: Replay of Recorded Scenarios	New
F010: Automatic parameter calculation	New
F005: Infrastructure Event Model	New
F006: Vehicle dynamics model	Change
F011: Additional metadata for parameters	New
F012: Language Constructs for Localization	New

2.3 Requirements Descriptions

The proposed concept shall address the following requirements. These requirements were captured in the document titled “ASAM OpenSCENARIO List of Features and Requirements” and the detailed description can be found there. They were revised in the proposal workshop, and the revisions can be found in the workshop summary – set of slides.

TABLE: ISSUE DESCRIPTIONS

ID	Title/Description
R001	Avoid Different Ways to Model
R002	Define Elements as 'Mandatory' Only When Absolutely Needed
R003	Maintain Independence and Open Linking Between Standards.
R004	Define Three Levels of Control for Ego Vehicles.
R005	Allow Tool-Vendor Specific Extensions.
R006	Allow Definition of Feature Subsets
R007	Define Semantics to Enable Reproducibility and Single Interpretation. (Workshop phrasing was: Well Defined Semantics Requirement)
R008	Allow both Open-loop and Closed-loop Simulation by the Same Maneuver Descriptions. (Workshop phrasing: Maneuver Description Shall be Suitable for Open-loop and Closed-loop Simulation)
R009	Define Parameter Boundaries
R010	Synchronize Maneuvers and Events
R011a	Allow Definition of Success Criteria for Individual Maneuvers, and for Full Scenarios and Tests – DUT criteria
R011b	Allow Definition of Success Criteria for Individual Maneuvers, and for Full Scenarios and Tests – non-DUT criteria
R012	Allow Textual Editing of the Format. (Workshop phrasing was: Suitability for textual editing)

3 Technical Content

During the proposal workshop, it was pointed out by Dr. Siddartha Khastgir that if you look at the needs from OpenSCENARIO with respect to simulation/testing control and analysis - your view will be vastly different if you are the user of scenarios and simulation, or if you are developing the simulator. The first will care mostly on how to define the environment and the essence of the interactions within the scenario, the latter will focus on how all the interfaces, the different models behave and interact among themselves, and how do you construct all these model to play together.

OpenSCENARIO 2.0 should adhere to the needs of both. On one hand it is expected to supply the tool provider with the information they need to operate their model, and to combine their models together, on the other hand it should supply the end user who is interested in testing and simulation – a productive and easy way to construct tests and simulation using scenarios and configurations data.

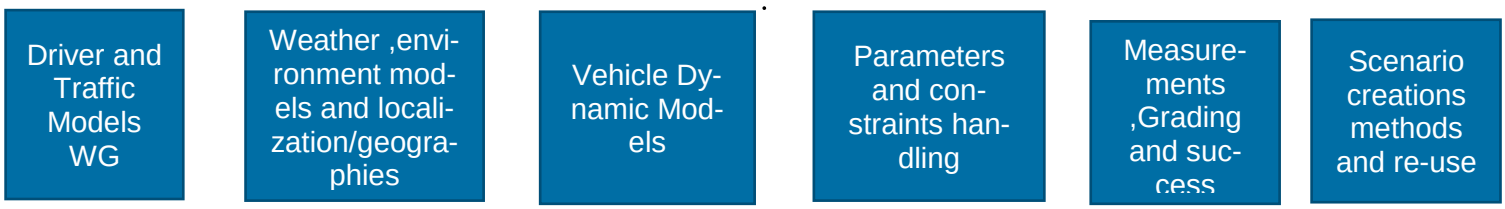
Additionally, the needs of users comprise the overall handling of scenarios during the validation and verification workflow: This comprises the revision control of scenarios, traceability of scenarios to requirements, quality assurance of scenarios, including manual reviews and automatic checking of scenarios against requirements and quality metrics and rules.

Given the different needs and different perspectives, it is proposed to start the concept project with a primary work group – ASAM OpenSCENARIO 2.0 Workgroup. Given the scope of the project it is assumed that the primary work group will find the need to extend the concept project and launch additional, more focused concept project(s) work groups, building it in a hierarchical model. In this hierarchical mode, the top level work group oversees the work and merges the output from the subgroups. The top level work group will create and outline and block diagram of the proposed systems and models, and will launch sub work groups to define the internals.

It is expected that the initial concept project will focus on the coherent view of OpenSCENARIO 2.0, and the initial concept work for the individual features, while keeping more detailed work to new projects (sub work groups) that are to be spawned from that. The core reason for this is to keep the project manageable in terms of duration and resources needed (i.e. as well-defined as we can given the uncertainties involved). Concepts for features that need quite a bit of work should be split out to new projects as soon as possible, allowing additional budget and resources to be brought to bear.

This structure is articulated here, such that it will be clear that while this concept project proposal is focusing on setting the concept for the top level architecture and interfaces, the overall scope of OSC 2.0 is much wider. It is expected that the top level work group will develop concepts for the features defined in the next chapters, or project proposal for spawned projects.

Here is a proposal of a potential structure, followed by roles and responsibilities for each group



3.1 ASAM OSC 2.0 Workgroup

This is the top-level workgroup. Members include

- A project leader
- Key technical experts in the relevant domains, (these are the experts who will probably serve as leaders of subgroups)
- Technical experts.

The group will start with a 2 months focused effort defining the high-level framework of OSC 2.0. It will set directions as:

1. What level of backward compatibility to OSC 1.0 is required?
2. Is OSC 2.0 based on a domain-specific language, an API for general purpose languages, a high-level data model, or a combination of those, or is it just an evolution of OSC 1.0?
3. Most important: What are the interface mechanisms and backbone between the different models included in the proposed standard and the core standard.

Once the overall framework for OpenSCENARIO 2.0 is set, the group will assign and launch any sub-workgroups. Based on availability of resources, this may imply quickly supplying a set of concept or project proposals – each targeting a specific, sub block/sub module of “the standard to be”. It is expected that these sub groups, once launched, will deliver their output for integration by the top-level group.

It is expected that a number of participants of the top-level work group will move their participation to the sub-groups, once they are established. It is necessary to retain enough technical expertise at the top-level working group level to ensure that integration work of sub-group results remains possible. It will remain the responsibility of the project leader to retain a sufficient level of expertise at that level.

Once this whole structure is set in place, the top-level group will continue by partitioning the work on the proposal to the different work groups, and resolving any interface issues. top-level group will be responsible for setting the overall schedule of sub-working groups, including milestones, reviews, and necessary electronic and face-to-face meetings with the top-level group. Sub workgroups will be responsible, through their sub-workgroup leader, for scheduling of internal discussions, electronic and face-to-face meetings, etc.

It is expected that the top-level work group will work in an agile like approach, where quick release of evolving drafts of the proposal will be published. It is up to the consumers to decide when they would like to rely on a draft to start implementation.

Deliverables:

- Full Concept document containing:
  - High level description of the full system
  - Block diagram of the models and their interactions
  - Description /Definition of a suite of tools (optional) that may be required for a complete solution (Architecture diagram)
  - Suite of Examples
  - Migration and/or backward compatibility concept description

3.2 Driver and Traffic Model Workgroup (WG)

A driver model is a behavioral model that predicts and emulates the behaviors of different drivers. It describes various aspects of the driver's behavior in traffic situations. A Traffic model is the ability to define the movement of traffic participants as an aggregate.

This WG is expected to deliver a concept proposal describing the roles of these models, and their primary interface to the overall system. Of special concern is the interface to vehicle dynamics models, since driver behavior can be affected by the limitations of the vehicle dynamics to a certain degree.

3.3 Weather, Environment Models and Localization/Geographies WG

These models deal with elements for describing the weather, such as precipitation, fog, wind, lighting and other phenomena. It also supplies information on local or geography specific restrictions and behavior, as well as different environmental events.

This WG is expected to deliver a concept proposal describing the roles of these models, and their primary interface to the overall system.

3.4 Vehicle Dynamics Model WG

ADAS and autonomous driving cars can be simulated without considering vehicle dynamics effects. However, simulation results are then limited to test and verify the pure drive logics such as trajectory calculation, etc. It cannot be simulated, when calculated drive maneuvers produce unplanned movements of the ego vehicle, e.g. excessive positive or negative wheel slip, oversteering, under steering, skidding and others. Simulation-based testing would be incomplete and would have to be complemented by vehicle testing. If the scope of vehicle dynamics is included in simulations, then this would significantly increase the simulation fidelity and value of simulation.

This WG is expected to deliver a concept proposal describing the roles of these models, and their primary interface to the overall system.

3.5 Parameters and Constraints Handling WG

OpenSCENARIO is expected to allow methods for describing parameter distributions and variations:
(a) Intervals (e.g. min, max)
(b) Stochastic distributions (e.g. linear- or gauss-distribution)
(c) Discretely defined distributions (e.g. histograms)
It is also expected to enable parameter passing, and assigning constraints and boundaries.

This WG is expected to deliver a concept proposal describing how parameters and constrained are handled in the full system, and their interfaces to the different sub-modules.

3.6 Measurements, Grading and Success criteria WG

In order to grade a simulation as pass/fails – one needs to measure various parameters in the simulation, as it performs. These parameters can be used in different formulas to set a success/fail criterion. The consistency of these measurements and their definitions is critical for the grading process.

This WG is expected to deliver a concept proposal describing an approach and requirements in order to enable measurements and calculating and deciding on success criteria for different use cases.

The exact scope of this workgroup will depend on the overall scope of OpenSCENARIO as defined in the top-level workgroup, especially regarding the inclusion of test specifications in OpenSCENARIO or as separate documents outside of OpenSCENARIO.

3.7 Scenario Creations Methods and Reuse WG

Scenarios can be created in different ways from different sources. It can be either direct text input, GUI input, extraction from different data sources (e.g. recorded real-world scenarios, accident databases, other databases of pre-existing scenarios or partial scenarios), composition from other sub-scenarios and more.

This WG is expected to deliver a concept proposal that demonstrates the methods required to support the different ways of creating and reusing scenarios, and resulting requirements for the OpenSCENARIO format. The idea is not to standardize individual workflows or methods, but rather demonstrate that use of OpenSCENARIO is possible in different workflows, and all necessary requirements can be met by OpenSCENARIO. The group will look at GUI based methods, textual methods and automation methods.

3.8 Overall Outcome

The overall expected outcome of the project (and its potential sub projects) is a wide set of concept documents. It is expected that the content of these document will be close to a draft proposal for a standard, and as such will enable quick implementation of the full standard once the standard development projects are launched:

- Full/Primary Concept document containing:
  - High level description of the full system
  - Block diagram of the models and their interactions
  - Description /Definition of a suite of tools (optional) that may be required for a complete solution (Architecture diagram)
  - Suite of Examples
  - Migration and/or backward compatibility concept description
  - Optional: Proposals for possible starting points and sources of IP – e.g. a number of participating companies might be interested in contributing existing in-house developments in terms of lanuages or frameworks to the standard.
- Driver and Traffic model concept document.

- Weather, Environment models and Localization/Geographies concept document.
- Vehicle Dynamics Model concept document.
- Parameters and constraints handling concept document.
- Measurements, Grading and Success criteria concept document.
- Scenario creations methods and reuse concept document.

4 Quality Assurance

The following quality assurance measures shall be carried out by the project:

TABLE: QA-MEASURES

Check	QA-Measure	Responsible
☒	Peer reviews – by technical members (in and out of the project) .	Project Team
☐	Editorial review – By technical experts	Choose an item.
☐	Public review – By technical Audience	Choose an item.
☐	Reference implementation - See below implementatioj project.	Choose an item.
☐	Implementation project - A reference implementation can be provided as open source or for testing.	Choose an item.
☐	Validator project	Choose an item.
☒	Proof-of-concept implementations - Create a prototype implementation or write example code to demonstrate feasibility of the concept.	Project Team Member

5 Deliverables

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

TABLE: DELIVERABLES

Item No.	Description
D001	OpenSCENARIO 2.0 Concept papers: • Concept proposal/papers for the different features. • High level architecture and interfaces between models (see section 3.8 for details) • Example of use cases, Examples of Scenarios at different complexity levels and different usage modes • Proposal for a suite of tools: enabling syntax checks of scenarios, and static analysis of scenarios. Potentially also a GUI entry tool for Scenario • Proposed Tools or methodology to migrate or utilize OpenSCENARIO 1.0 Scenarios.
D002	Project proposal(s) for spawned projects – for the different features.

6 Project Plan

6.1 Resources

Member companies contribute resource for the project as per the following table.

The table currently lists the expected rolls and members of the top level work group, without identifying specific names.

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TABLE: RESOURCES - WORK AND FUNDS

Company (Name, Location)	Committed Work (Man-days)	Committed Funds (Euros)	Project member's name, phone, email
Foretellix Ltd.	60		• Gil Amid, +972-58-434-7475 , gil.amid@foretellix.com
			•
			•
			•
			•
			•
			•
			•
Total:			

The following intellectual property will be transferred from member companies to ASAM:

TABLE: RESOURCES - INTELLECTUAL PROPERTY

Company (Name, Location)	Intellectual Property Description	Value (Euros)
	Total:	

6.2 Work Efforts

The project consist of the following work packages:

TABLE: WORK PACKAGES

WP-No.	Title / Description • Deliverable	Effort (Man-days)
1	Top Level OSC 2.0 Concept Work group	
	• Concept Exploration • Technical Content for Project Proposal(s)	120 10
2	Driver and Traffic Model	
	• Concept exploration • Technical Content for Project proposal	60 5
3	Weather, Environment models and localization/geographies	
	• Concept exploration • Technical Content for Project proposal	60 5
4	Vehicle Dynamics Model	
	• Concept exploration • Technical Content for Project proposal	60 5
5	Parameters and Constraints Handling	
	• Concept exploration • Technical Content for Project proposal	60 5
6	Measurements, Grading and Success Criteria	
	• Concept exploration • Technical Content for Project proposal	60 5
7	Scenario creations methods and reuse	
	• Concept exploration • Technical Content for Project proposal	60 5
	Total Effort of Work Group:	520

Projects may use optional service providers, which have the following tasks:

TABLE: SERVICE PROVIDER TASKS

Task No.	Title / Description • Deliverable	Effort (Man-days)
T1	Top Level Concept Document	
	• Concept Paper	20
T2	Driver and Traffic Model	

	• Concept Paper	20
T3	Weather, Environment models and localization/geographies	
	• Concept Paper	15
T4	Vehicle Dynamics Model	
	• Concept Paper	10
T5	Parameters and Constraints Handling	
	• Concept Paper	15
T6	Measurements, Grading and Success Criteria	
	• Concept Paper	10
T7	Scenario creation methods and reuse	
	• Concept Paper	10
	Total Effort of Service Providers:	100

The total work effort for the project is:

TABLE: TOTAL WORK EFFORT

	Formula	Amount (Man Days)
Total Effort of Work Group		520
Total Effort of Service Providers	+	100
Total Work Effort		620

6.3 Time Schedule

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

TABLE: TIME SCHEDULE

WP-No.	Title / Description	2019											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Top level concept Development	☐	☐	☒	☒	☒	☒	☒	☒	☒	☒	☒	☐
2	Driver and Traffic model	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☐	☐

3	Weather, Environment models and localization/geographies	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☐	☐
4	Vehicle Dynamics Model	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☐	☐
5	Parameters and Constraints Handling	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☐	☐
6	Measurements, Grading and Success Criteria	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☐	☐
7	Scenario creation methods and reuse	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☐	☐

TABLE: DESIRED OVERALL SCHEDULE AND MILESTONES

WP-No.	Title / Description	2019											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Approve and launch project	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐
2	Launch Sub Workgroups	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐
3	Project outline published, Key decisions and block diagrams	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐
	First, Partial Full concept draft published	☐	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐
	F2F meeting dates	☐	☐	☐	☒	☐	☒	☐	☒	☐	☒	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6.4 Budget

The service budget to pay the service providers and the share of funds provided by ASAM are:

TABLE: SERVICE BUDGET

	Total Effort of Service Providers (Man-days)	Formula	Amount (Euros)
Service Budget	100	× €700 =	70,000
Total Committed Funds		-	
ASAM Funds			70,000

A budget for video conferencing can be requested, if the project group members originate from locations that would require long-distance (i.e. intercontinental) business trips to regularly participate at project meetings and if means for carrying out video conferencing are not available through the members themselves:

[It is expected that this concept project will require a lot of video conferencing, hence this budget estimate]

TABLE: VIDEO CONFERENCING BUDGET

	Number of Meetings (Days)		Cost per Meetings (Euros)		Amount (Euros)
Video Conferencing Budget	15	×	2000	=	30,000

Note: this is an “upper bound” estimate for video conferencing. It is expected that many o

6.5 Resource Checks

Funds provided by ASAM are subject to spending limits. The next table allows the requester to check, whether the ASAM Funds, as calculated in the preceding chapter, are within these limits. Please note that projects of type "Implementation Project" have no given spending limits, so the below check does not apply for this project type.

TABLE: ASAM FUNDS LIMIT CHECK

	Effort (Man-Days)	Formula	Amount (Euros)
Total Work Effort	620	× €700 =	434,000
Total Committed Funds		+	
Total Transferred IP		+	
Subtotal			434,000
Upper Limit for ASAM Funds		0.75× Factor =	325,500
	Project Type	Factor	

	New, major, minor or revision standard development project	0.25	
	Study project	0.25	
	Concept project	0.75	
Check	ASAM Funds ≤ Upper Limit for ASAM Funds		☒

The total work effort required from the project group members shall be equal or less than the total committed work from member companies:

TABLE: WORK RESSOURCES CHECK

	Formula	Amount (Man-days)
Total Effort of Work Group		520
Total Committed Work		
Check	Total Effort of Group ≤ Total Committed Work	☐

7 Relations to Other Standards, Projects or Organizations

OpenSCENARIO is tightly related to all OpenDRIVE projects, OpenCRG, and especially to OpenSCENRAIO 1.0 transfer project (P2019-01)

Additionally, it is expected that this project may relate to modeling standards like UML, Maps and topology standards like SHAPE high definition mapping.

Different simulators interface standards like: OSI, ProtoBuf.

Given the high interest in autonomous driving and simulation standards for autonomous driving, it is recommended that organization like SAE may get exposed to this work.

ISO/TC 22/SC 33/WG 9 (Test scenario of autonomous driving vehicle) is working on international aspects of the application of scenarios for testing of autonomous driving vehicles, so that a close working relationship with this working group should be established.

8 References

[1] “ASAM OpenSCENARIO List of Features and Requirements”, Thomas Thomsen

[2] “Concept Project for OpenSCNEARIO”, power point deck, Pierre R. Mai