

ASAM OpenSCENARIO®: Supplementary notes

Introduction

This text was provided by ASAM to accompany the release of ASAM OpenSCENARIO (OSC) V2.0.0. It aims to provide some clarity on the position of OSC as well some insight into the direction the standard is headed over the coming years.

OSC defines the dynamic content of the world, for example, behavior of traffic participants and how these are expected to interact with each other and the environment. OSC occupies a unique position among the ASAM OpenX standards in that ASAM's membership currently actively develops two major versions of it in parallel. For the sake of readability in this document the terms OSC 1.x and OSC 2.x represent the latest version of each. Due to the different foundations between the versions, ASAM took measures throughout the development of these parallel activities to ensure that convergence and compatibility between OSC 1.x and OSC 2.x is possible. These measures were formulated as requirements to all OSC development projects:

1. OSC 2.x shall be a full superset of the features of OSC 1.x.
2. Migration of an OSC 1.x scenario to an OSC 2.x scenario shall be possible.
3. Conversion of a subset of OSC 2.x that maps to the feature set of OSC 1.x shall be possible.
4. All future OSC releases shall be accompanied by an up-to-date ruleset for a migration path from OSC 1.x to OSC 2.x.
5. The run time behavior of any scenario converted/migrated from the latest OSC 1.x to OSC 2.x shall be the same. This requirement can be influenced by implementation-specific factors, which are not addressed here. In other words, whatever you can express in OSC 1.x you will be able to express in OSC 2.x in order to get the same runtime behavior.



These requirements still apply but are not yet satisfied with OSC V1.2.0 and OSC V2.0.0 (see [Section 10.8, "Elements from 1.2.0 not yet covered"](#)). The gap will be closed in the upcoming OpenSCENARIO project and further releases of OSC.

Relation between OSC 1.x & OSC 2.x

OSC 1.x is based on an XML format, the most recent version is V1.2.0. OSC 2.x is based on a domain specific programming language and includes an extendable domain model, the extension mechanism is described in [Section 9.3, "Extending the domain model"](#). The domain model represents the central concepts of the on-road driving domain, see [Section 8.1, "Domain model introduction"](#). The first version for OSC 2.x is being released to accompany this statement, OSC V2.0.0. OSC 2.x is not backwards compatible with OSC 1.x, although it may be possible to convert certain scenarios using a subset that is directly supported by OSC 1.x. OSC 2.x is intended as a superset to OSC 1.x. In other words, what you can do in OSC 1.x you can do in OSC 2.x, and more. An improvement with OSC V2.0.0 is the support for abstract scenarios ^[1].

Concrete and logical scenarios can be expressed in both versions, however OSC 2.x offers additional features that enrich the scenario description. As OSC 1.x does not support abstract descriptions, it has no direct equivalent to OSC 2.x.

Version	Concrete	Logical	Abstract	Functional
V1.1.1	✓	✗	✗	✗
V1.2.0	✓	✓	✗	✗
V2.0.0	✓	✓	✓	✗

Table 1. The levels of scenario abstraction as supported by different versions of ASAM OSC.

Neither version of OSC guarantees exact reproducibility across different tools due to the high amount of implementation-specific factors that may influence the simulation results. The focus of OSC is on enabling exchange and re-use of scenario descriptions. This does not change across the versions – given the right conversion mechanism.

All parameters in an OSC V1.2.0 scenario file must have a default value assigned, which means that by itself an OSC V1.2.0 scenario file is always concrete. Such a scenario file may be accompanied by an additional parameter distribution file, and if used together with the scenario file in an implementation that supports it then the combination is considered a logical scenario. In such a case the default values are overridden.

It is important to note, that the more abstract a scenario, the more possible valid solutions there may be and the lower the guarantee of another user replicating an exact scenario or set of scenarios during concretization. This is due to the nature of abstraction levels, the reader is referred to additional literature for further information, see e.g. Neurohr et al., 2021^[1].

In addition to supporting more levels of scenario abstraction, OSC 2.x also provides the following new features:

- A programming language, an object-oriented DSL
- Consistent scenario description over concrete, logical and abstract scenario levels
- Increased support for binding to external code/functions/methods (e.g. distribution functions, statistics)
- Built in constraints
- Built in KPI and coverage measurements
- Increased support for reuse (e.g. of scenarios, libraries or modifiers)
- Extendible language and domain entities
- Designed to support additional non-simulation based use cases such as X-in-the-loop or proving grounds
- Abstract road network description independent and complimentary to specific map formats ([Section 8.5, "Abstract road network"](#))

It should be noted that many of these new features are not a mandatory part of a scenario description. For a full overview of the new features and increased scope, refer to [Section 1, "Scope"](#). As this is the first release of the DSL with the many new features, we expect there to be a need for additional functionality that is not yet a part of the standard. The language supports self-extension as well as the ability to bind to external software methods defined in other languages or mechanisms. The domain model can also be extended with further entities, actors, or actions that it does not yet define, see [Section 9.3, "Extending the domain model"](#). It is expected that future projects will investigate the integration of relevant user-defined extensions into future versions of the standard.

Migration

Due to the more descriptive nature of the DSL and the difference in its semantics to OSC 1.x there are often multiple options to migrate from OSC 1.x to OSC 2.x. Often elements in OSC 1.x, such as behaviors or actions do not have a one-to-one mapping, but the behavior can be replicated through combinations of language constructs in OSC 2.x. Options to do this are documented in the standard. Other times, there are

elements that have no direct mapping, such as controllers, these are not domain elements and rather data model constructs specific to OSC 1.x that do not have an equivalent in OSC 2.x.

Section 10, "Migrating from ASAM OpenSCENARIO V1.2.0" provides significant detail on how users of OSC 1.x can migrate their scenarios to OSC V2.0.0. This is currently non-normative and does not yet cover all elements of OSC 1.x. Section 10.8, "Elements from V1.2.0 not yet covered" shows where coverage is not yet complete. See the roadmap for what we plan to do to improve this. OSC V2.0.0 does not yet include a normative ruleset enabling direct or automated conversion from OSC 1.x scenarios. ASAM aims to include this in future releases.

Roadmap

Throughout the last years, ASAM has consistently communicated a convergence roadmap. ASAM expects (and encourages) both parallel versions of OSC to converge to a unified version.

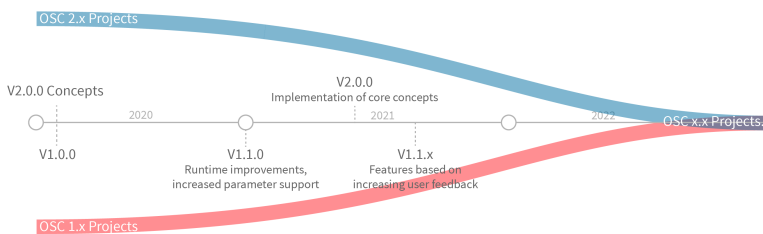


Figure 1. ASAM's initial roadmap (published 18.03.2020)

Given the current release, this roadmap has been updated.

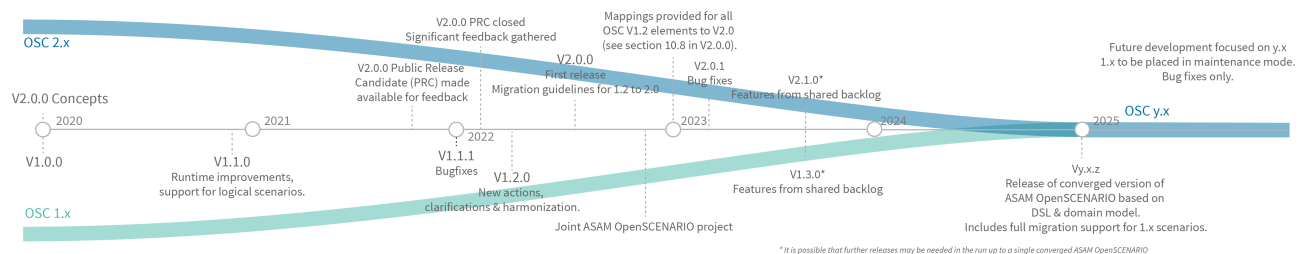


Figure 2. Updated roadmap for OSC.

ASAM aims for convergence of both parallel versions of OSC to a single version by the end of 2024.

To ensure co-development ASAM will setup a joint project. The joint project will aim to develop one converged version of OSC that is based on the DSL defined in OSC V2.0.0. This will likely be a new major version (Y.X).

A converged version will have full coverage of the domain features in OSC 1.x as well as OSC 2.x. It will be a full superset. A converged version will have at least one clear mapping for domain features of previous versions. It is still open to which extent this will be automatable.

On the way to a converged version the project may release additional versions of OSC 1.x and OSC 2.x based on a shared backlog. At the least we expect there to be an OSC V1.3.0, an OSC V2.0.1 and an OSC V2.1.0. There may be more, dependent on the backlog.

A joint project may define new features during the convergence period but these must be reflected in both OSC 1.x and OSC 2.x.

Once a converged version of OSC is released then OSC 1.x will move into maintenance mode and no new features will be added to OSC 1.x. From then on new features will only be available in the converged

version of OSC. The converged version will be based on the DSL and the domain model. As of now, the XML format will not be supported by the converged version.

Closing Words

We would like to thank the many ASAM members who invested their time and efforts over the past years to make this release happen.

Stay tuned on ASAM's communication channels for more news on ASAM OpenSCENARIO and upcoming projects.

We hope you enjoy reading, using and applying this groundbreaking new ASAM release!

[1] C. Neurohr et al., [Criticality Analysis for the Verification and Validation of Automated Vehicles](#), IEEE Access, 2021, IEEE, 9, 18035