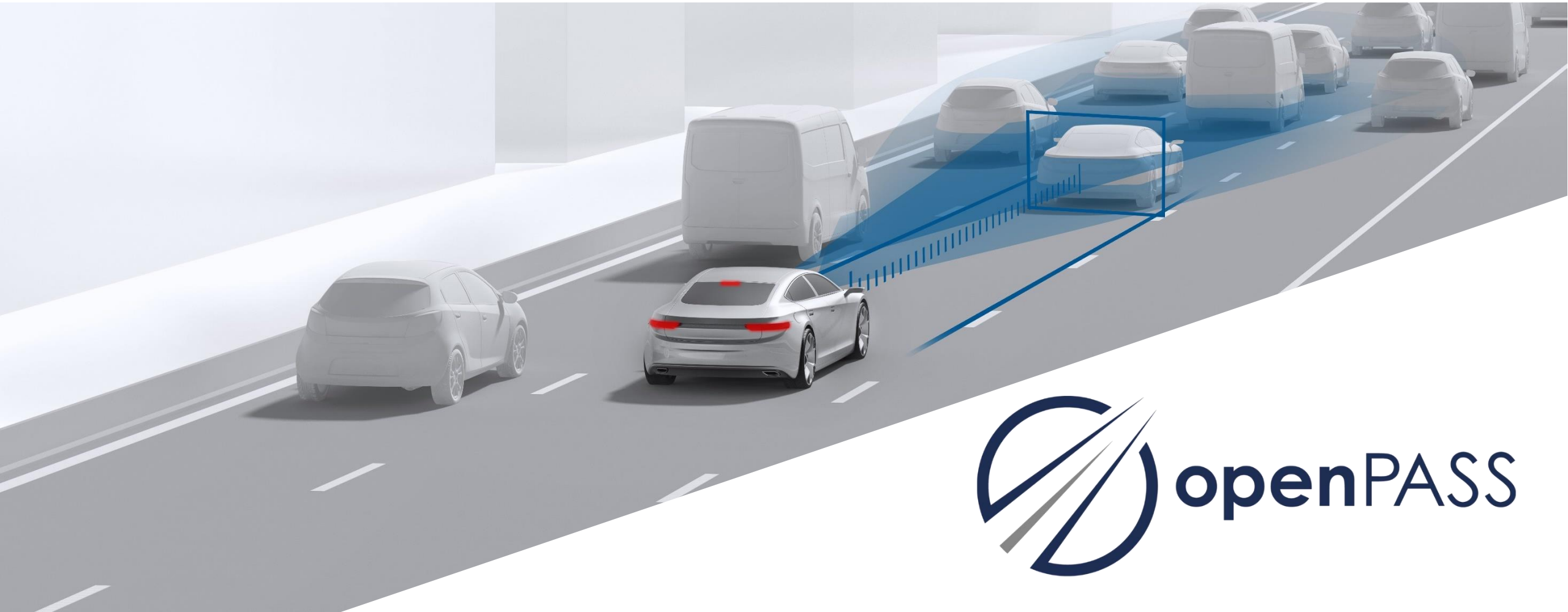
OPENPASS PCM WORKSHOP

JANUARY 14, 2022



openPASS

OPENPASS PCM WORKSHOP

Topics:

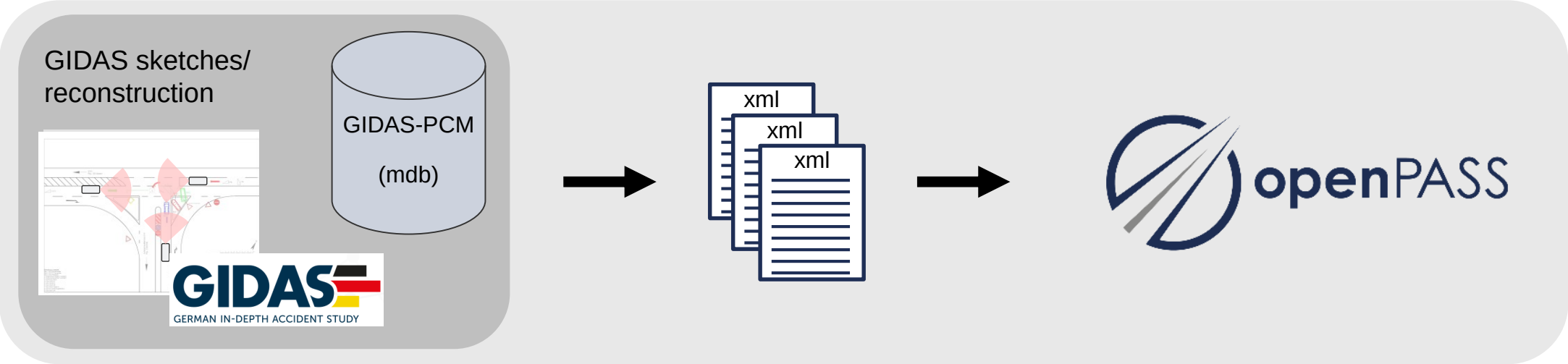
- **Use case “PCM simulation”**
- **openPASS overview & history (PCM in v0.5 etc.)**
- openPASS v0.8 configs with PCM data
- Examples for PCM simulation
  - Agent without system ➔ collision
  - Agent with AEB and view obstruction by object
- Discussion – how to proceed with PCM data in OpenDrive, OpenSceanrio..

USE CASE
CRASH RE-SIMULATION

Features:

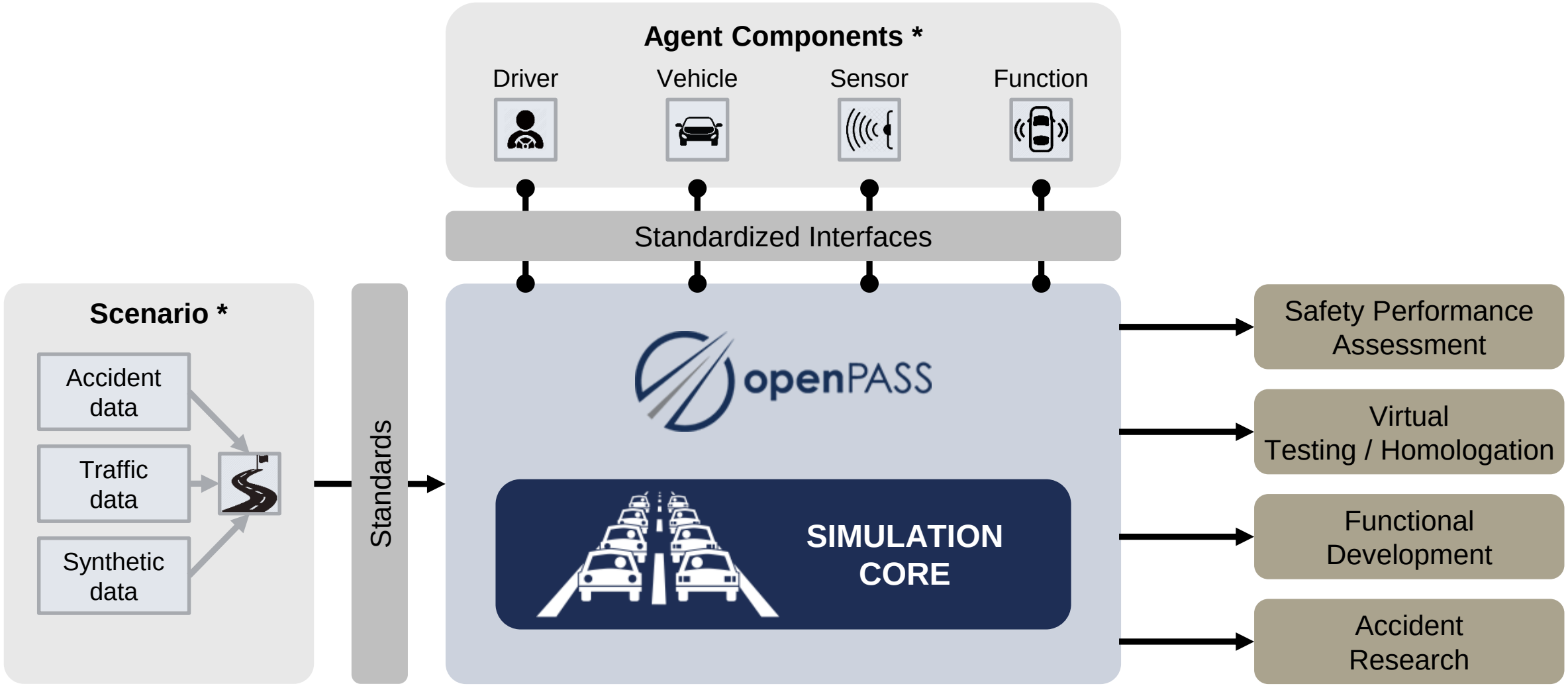
- Create configuration files from GIDAS-PCM accident scenario database
- Stochastic variation of the scenarios (positions, velocities)
- Basis components for re-simulation: sensor, trajectory follower, two track vehicle model, impact calculation
- Store results in csv files in case folders

Example question: How many selected cases could be avoided by a AEB function?



In 2020/2021: Re-factoring PCM use case to integrate it into common platform based on v0.6 / OSI

PLATFORM IDEA

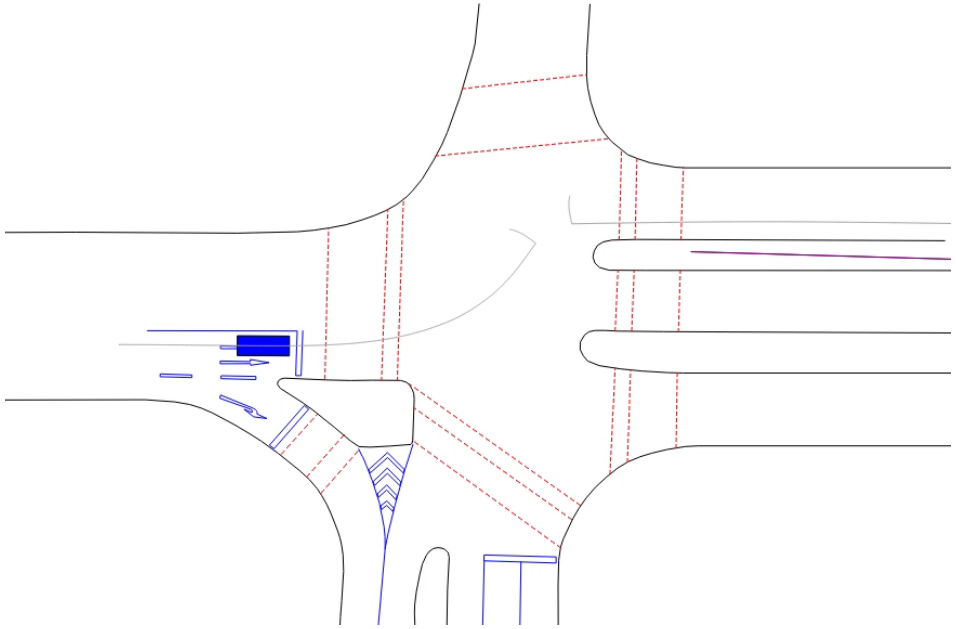


* Simple examples are provided

EXEMPLARY SIMULATION RESULTS

Crash re-simulation from GIDAS-PCM case

Oncoming collision at intersection (LTAP – “left turn across path”) with post-crash behaviour



Traffic-scenario Simulation

AEB intervention triggered by passive cut-in manoeuvre

VISION

openPASS
(open **P**latform for **A**ssessment of **S**afety **S**ystems)

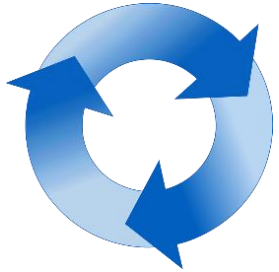
High level of transparency and acceptance through publicly available open source platform

Traffic simulation of highway, rural and urban scenarios

Stochastic variation of scenarios

Standardized interfaces for model integration

Reproducibility through deterministic simulation



Harmonized and flexible platform for effectiveness assessment of advanced driver assistance systems and automated driving

WORKING GROUP

openPASS Working Group

Driver members:

User member:

Service provider:

Eclipse Automotive Working Groups

TIMELINE

Eclipse Working Group **openPASS** (idea for openPASS generated within P.E.A.R.S. in 2014)

08/2016
Foundation of
openPASS

01/2018
New
driver
member

06/2018
New
user
member

11/2018
New
driver
member

Vision:
Harmonized
simulation
platform

2016 2017 2018 2019 2020 2021

03/2017
Initial
commit

09/2017
PCM
mod.

02/2018
V0.5
PCM

02/2020
V0.6
OSI

10/2020
V0.7
Urban

11/2021
V0.8
Docu/CI

Eclipse Project **sim@openPASS**

OPENPASS PCM WORKSHOP

Topics:

– Use case “PCM simulation”

– openPASS overview & history (PCM in v0.5 etc.)

– **openPASS v0.8 configs with PCM data**

– Examples for PCM simulation

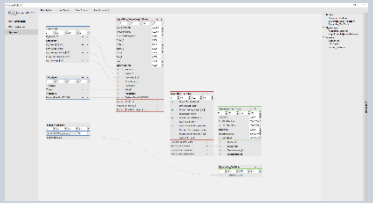
  – Agent without system ➔ collision

  – Agent with AEB and view obstruction by object

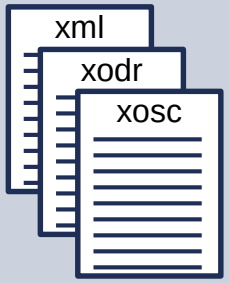
– Discussion – how to proceed with PCM data in OpenDrive, OpenSceanrio..

SIMULATION PROCESS
USER PERSPECTIVE

Simulation Process

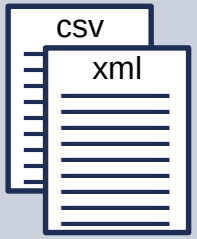


Configuration in GUI:

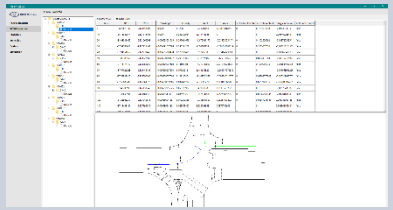


➔ Configuration files

Simulation execution

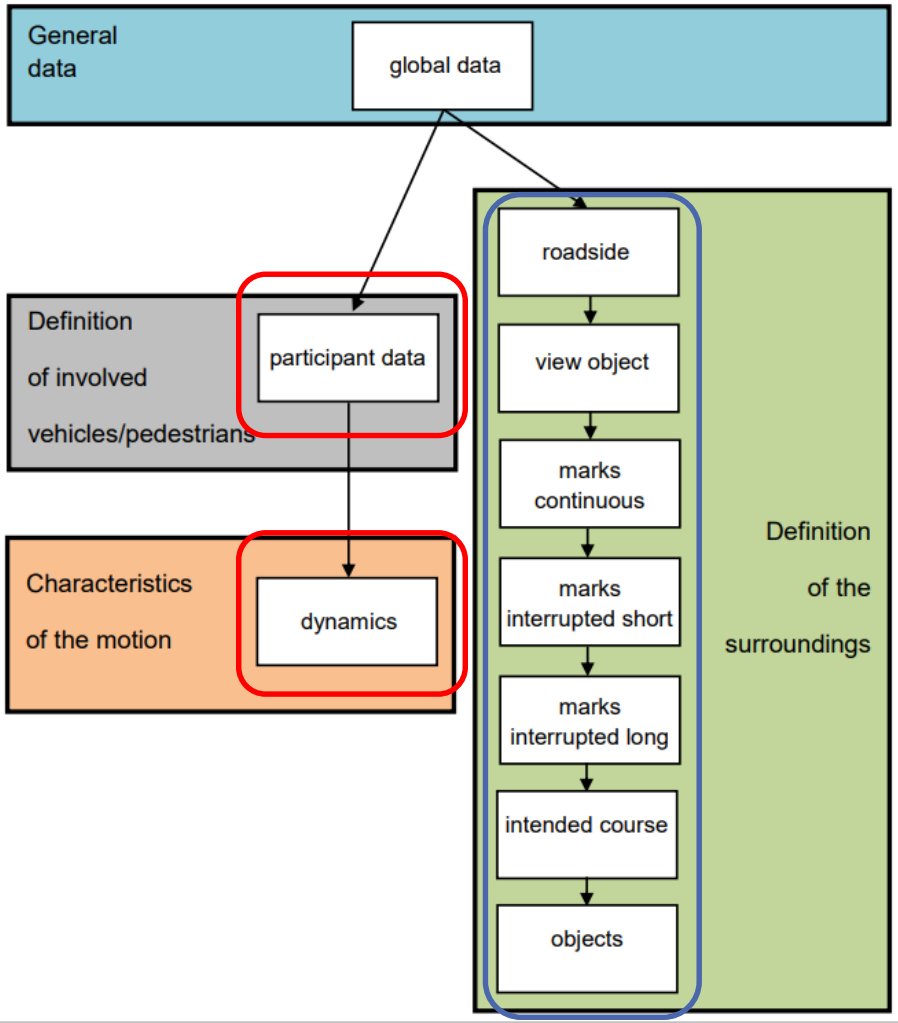


Output files



Evaluation in GUI

OPENPASS V0.8 CONFIGS WITH PCM DATA



PCM data tables used for simulation

- Participant data ➔ define vehicle properties
- Dynamics ➔ define trajectories

PCM data tables used for visualization

- Roadside, marks, view objects ➔

no XODR logic = no import into simulation core

OPENPASS CONFIGS (PCM EXAMPLE)

master simopenpass / sim / contrib / examples / PCM_Re-Simulation / result_pcm / 1000232 / 0-0-0 / Default / configs

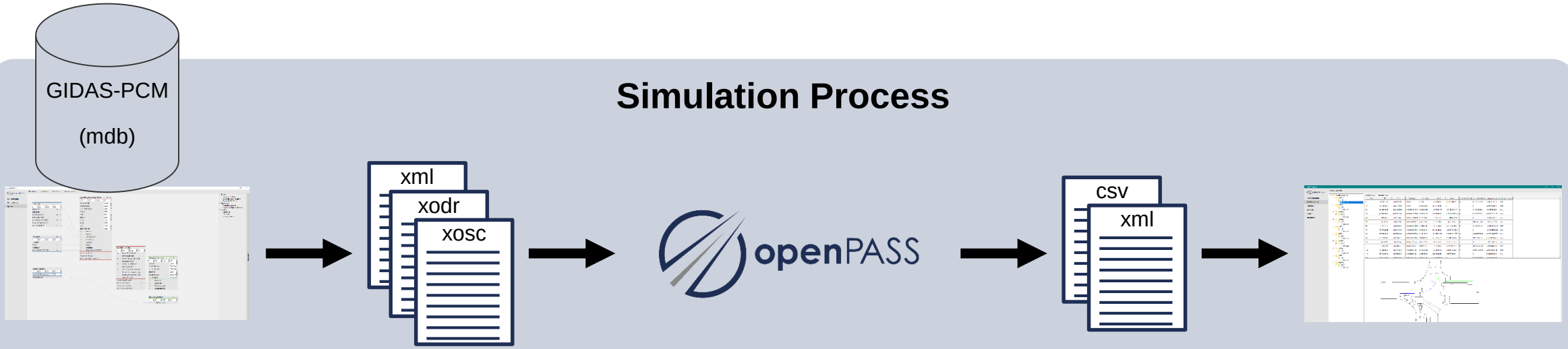
History Find file Clone

correct the CSV logger in PCM example
Dmitri Fix authored 1 month ago

17ffdfb5

Name	Last commit	Last update
..		
ProfilesCatalog.xml	Update PCM ReSim example	3 months ago
Scenario.xosc	Rename examples PCM Folder to PCM_Re-Simulation and update ...	6 months ago
SceneryConfiguration.xodr	Rename examples PCM Folder to PCM_Re-Simulation and update ...	6 months ago
SystemConfig.xml	Rename examples PCM Folder to PCM_Re-Simulation and update ...	6 months ago
VehicleModelsCatalog.xosc	Update PCM ReSim example	3 months ago
sceneryConfiguration.xml	Rename examples PCM Folder to PCM_Re-Simulation and update ...	6 months ago
simulationConfig.xml	correct the CSV logger in PCM example	1 month ago

SIMULATION PROCESS
USER PERSPECTIVE ➔ PCM-SIMULATION



Simulation Process

Configuration in GUI:
“PCM-Simulation”
a) Select PCM cases
b) Select folder with existing results
- Define variations
- Select AgentConfig
- Select Result folder
- Press “Start”

Configuration files
➔ PCM specific Output:
VehicleModelCatalog.xosc
Scenario.xosc

Default configs:
Scenery.xodr
ProfileCatalog.xml
simulationConfig.xml

Simulation execution

Output files

Evaluation in GUI

TO DO: link to system config

PCM PARTICIPANT DATA ➔ VEHICLE MODEL CATALOG

participant_data

FALL	BETI	TYPI	WIDTH	LENGTH	DISTCGFA	WEIGHT	WIDTHRATI	DISTHF	HEIGHTCG	WHEELBASE	IXX	IYY	IZZ	MUE	TRACKWIDT	HEIGHT	CGFRONT
1000232	1	0	1,83	4,82	1,4	1920	0,6	99999	0,59	2,8	988	3292	3292	0,76	1,55	1,45	2,41
1000232	2	0	1,64	3,91	1,09	1200	0,6	99999	0,52	2,27	406	1353	1353	0,76	1,41	1,26	1,91

VehicleModelsCatalog.xosc 3.53 KB

```
<?xml version="1.0" encoding="UTF-8"?>
<OpenSCENARIO>
    <FileHeader revMajor="1" revMinor="0" date="2020-01-01T00:00:00" description="openPASS vehicle models" author="openPASS"/>
    <Catalog name="VehicleCatalog">
        <Vehicle name="Agent_0" vehicleCategory="car">
            <Properties>
                <Property name="AirDragCoefficient" value="0.3"/>
                <Property name="AxleRatio" value="1.0"/>
                <Property name="DecelerationFromPowertrainDrag" value="0.5"/>
                <Property name="FrictionCoefficient" value="0.76"/>
                <Property name="FrontSurface" value="1.0"/>
                <Property name="GearRatio1" value="1.0"/>
                <Property name="Mass" value="1920"/>
                <Property name="MaximumEngineSpeed" value="10000.0"/>
                <Property name="MaximumEngineTorque" value="500.0"/>
                <Property name="MinimumEngineSpeed" value="1.0"/>
                <Property name="MinimumEngineTorque" value="-500.0"/>
                <Property name="MomentInertiaPitch" value="3292"/>
                <Property name="MomentInertiaRoll" value="988"/>
                <Property name="MomentInertiaYaw" value="3292"/>
                <Property name="NumberOfGears" value="1"/>
                <Property name="SteeringRatio" value="1.0"/>
            </Properties>
            <BoundingBox>
                <Center x="2.41" y="0" z="0.59"/>
                <Dimensions width="1.83" length="4.82" height="1.18"/>
            </BoundingBox>
            <Performance maxSpeed="100" maxAcceleration="10" maxDeceleration="10"/>
            <Axles>
                <FrontAxle maxSteering="1" wheelDiameter="0.6" trackWidth="1.55" positionX="2.8" positionZ="0.3"/>
                <RearAxle maxSteering="0" wheelDiameter="0.6" trackWidth="1.55" positionX="0" positionZ="0.3"/>
            </Axles>
        </Vehicle>
```

DYNAMICS DATA ➔ SCENARIO.XOSC

dynamics

FALL	BETNR	STEP	XPOS	YPOS	VX	VY	AX	AY	PSI	BRAKING	RECON	TTC
1000232	1	0	-38,33	-9,12	8,33							
1000232	1	0,01	-38,25	-9,12	8,33							
1000232	1	0,02	-38,17	-9,12	8,33							
1000232	1	0,03	-38,08	-9,12	8,33							
1000232	1	0,04	-38	-9,12	8,33							
1000232	1	0,05	-37,92	-9,12	8,32							
1000232	1	0,06	-37,83	-9,12	8,32							
1000232	1	0,07	-37,75	-9,12	8,32							
1000232	1	0,08	-37,67	-9,12	8,32							
1000232	1	0,09	-37,58	-9,12	8,32							
1000232	1	0,1	-37,5	-9,12	8,32							
1000232	1	0,11	-37,42	-9,12	8,32							
1000232	1	0,12	-37,33	-9,13	8,32							
1000232	1	0,13	-37,25	-9,13	8,32							
1000232	1	0,14	-37,17	-9,13	8,32							
1000232	1	0,15	-37,08	-9,13	8,32							
1000232	1	0,16	-37	-9,13	8,32							
1000232	1	0,17	-36,92	-9,13	8,32							
1000232	1	0,18	-36,83	-9,13	8,32							
1000232	1	0,19	-36,75	-9,13	8,31	-0,0023	-0,06	-0,01	-0,0069	0	0	4,84
1000232	1	0,2	-36,67	-9,13	8,31	-0,0022	-0,06	-0,01	-0,0069	0	0	4,83
1000232	1	0,21	-36,59	-9,13	8,31	-0,0021	-0,06	-0,01	-0,0069	0	0	4,82
1000232	1	0,22	-36,5	-9,13	8,31	-0,002	-0,06	-0,01	-0,007	0	0	4,81

```
<Storyboard>
    <Init>
        <Actions>
            <Private entityRef="Agent_0">
                <PrivateAction>
                    <TeleportAction>
                        <Position>
                            <WorldPosition x="-39.72996858" y="-9.11062007" z="0" h="-0.0067" p="0" r="0"/>
                        </Position>
                    </TeleportAction>
                </PrivateAction>
                <PrivateAction>
                    <LongitudinalAction>
                        <SpeedAction>
                            <SpeedActionDynamics dynamicsShape="linear" value="0.0" dynamicsDimension="rate"/>
                            <SpeedActionTarget>
                                <AbsoluteTargetSpeed value="8.33"/>
                            </SpeedActionTarget>
                        </SpeedAction>
                    </LongitudinalAction>
                </PrivateAction>
            </Private>
        <Story name="TrajectoryStory">
            <Act name="Act_0">
                <ManeuverGroup maximumExecutionCount="1" name="TrajectorySequence">
                    <Actors selectTriggeringEntities="false">
                        <EntityRef entityRef="Agent_0"/>
                    </Actors>
                    <Maneuver name="TrajectoryManeuver">
                        <Event name="TrajectoryEvent" priority="overwrite">
                            <Action name="Trajectory">
```

ROADSIDE, MARKS, OBJECTS ➔ SCENERY.XML

roadside | marks_continuous

FALL	LINENO	POINTNO	X	Y	Z
1000232	6	8	-25,82	-15,79	0
1000232	6	9	-26,71	-15,1	0
1000232	6	10	-26	-15,39	0
1000232	6	11	-25,94	-15,3	0
1000232	6	12	-25,99	-15,16	0
1000232	6	13	-26,11	-15,09	0
1000232	6	14	-28,95	-14,08	0
1000232	6	15	-28,89	-13,78	0
1000232	7	1	-28,92	-10,89	0
1000232	7	2	-26,12	-10,88	0
1000232	7	3	-26,11	-11,03	0
1000232	7	4	-24,39	-10,79	0
1000232	7	5	-26,13	-10,5	0
1000232	7	6	-26,11	-10,69	0
1000232	7	7	-28,91	-10,64	0
1000232	7	8	-28,92	-10,89	0
1000232	8	1	-28,88	-9,5	0
1000232	8	2	-25,79	-9,51	0
1000232	8	3	-25,5	-9,5	0
1000232	8	4	-25,34	-9,44	0
1000232	8	5	-25,24	-9,34	0
1000232	8	6	-25,22	-9,23	0
1000232	8	7	-25,23	-9,16	0
1000232	8	8	-24,27	-9,15	0
1000232	8	9	-25,42	-8,76	0
1000232	8	10	-26,54	-9,06	0
1000232	8	11	-25,76	-9,12	0
1000232	8	12	-25,88	-9,23	0

sceneryConfiguration.xml 48.5 KB

```xml
<?xml version="1.0" encoding="UTF-8"?>
<PCM>
    <global_data>
        <OffsetX>8.68708056e-315</OffsetX>
        <OffsetY>4.604586682e-316</OffsetY>
        <Participants>93203504</Participants>
        <SimulationVersion>0</SimulationVersion>
    </global_data>
    <Marks>
        <marks_continuous>
            <line id="1">
                <point id="1">
                    <x>-14.79</x>
                    <y>-21.78</y>
                    <z>0</z>
                </point>
                <point id="2">
                    <x>-14.79</x>
                    <y>-21.77</y>
                    <z>0</z>
                </point>
                <point id="3">
                    <x>-13.48</x>
                    <y>-20.52</y>
                    <z>0</z>
                </point>
```

OPENPASS PCM WORKSHOP

Topics:

– Use case “PCM simulation”

– openPASS overview & history (PCM in v0.5 etc.)

– openPASS v0.8 configs with PCM data

– **Examples for PCM simulation**

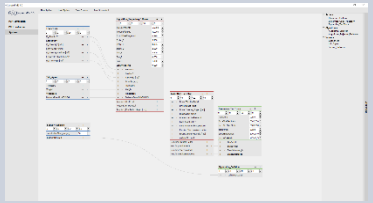
  – **Agent without system ➔ collision**

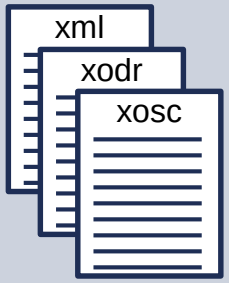
  – (Agent with AEB and view obstruction by object)

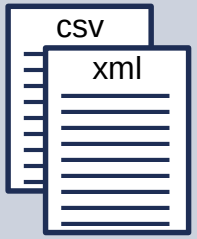
– Discussion – how to proceed with PCM data in OpenDrive, OpenScenario..

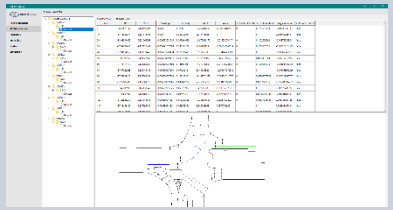
SIMULATION PROCESS
USER PERSPECTIVE ➔ SYSTEM EDITOR (NO PCM DATA)

Simulation Process









Configuration in GUI:
- Select agent components
- Connect with signals
- Define parameters

Configuration files
➔ Output: static systemConfig.xml

Simulation execution

Output files

Evaluation in GUI

OPENPASS ➔ OUTPUT FILES

```
<Observations>
    <Observation>
        <Library>Observation_LogAgent</Library>
        <Parameters>
            <String Key="OutputFilename" Value="simulationOutput.xml"/>
            <Bool Key="LoggingCyclicsToCsv" Value="true"/>
            <StringVector Key="LoggingGroup_Trace" Value="XPosition,YPosition,YawAngle"
```

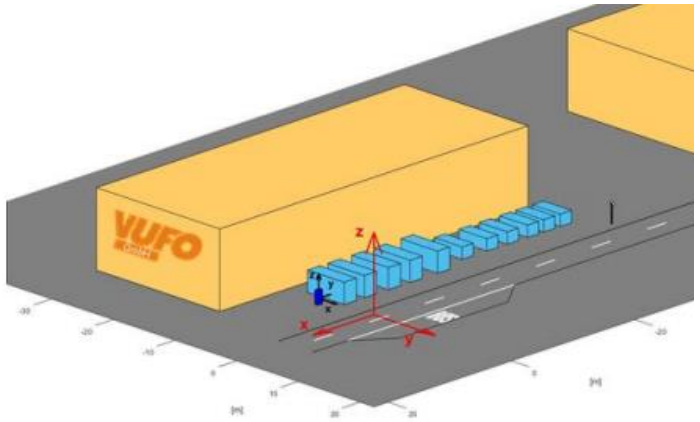
result_pcm › 1000232 › 0-0-0 › Default › results

Name	Änderungsdatum	Typ	Größe
Cyclics_Run_000.csv	12.01.2022 12:58	Microsoft Excel-C...	109 KB
simulationOutput.xml	12.01.2022 12:58	XML-Dokument	5 KB

	A	B	C	D	E	F	G
1	Timestep	AgentId	AccelerationEgo	VelocityEgo	XPosition	YPosition	YawAngle
2	0	0	0	8.330.000	-39.729.969	-9.110.620	-0.0067
3	0	1	0	19.440.000	101.699.921	1.826.321	3.130.000
4	10	0	-7.048.988	8.330.000	-39.646.670	-9.111.178	-0.0067
5	10	1	-5.472.872	19.440.000	101.505.534	1.828.575	3.130.000
6	20	0	3.771.385	8.259.510	-39.563.372	-9.111.736	-0.0067
7	20	1	4.253.503	19.385.271	101.311.147	1.830.828	3.130.000
8	30	0	-6.681.416	8.297.224	-39.480.779	-9.112.288	-0.006698
9	30	1	-5.838.008	19.427.806	101.117.307	1.833.073	3.130.003
10	40	0	-5.805.927	8.230.410	-39.397.809	-9.112.834	-0.006691
11	40	1	4.268.140	19.369.427	100.923.042	1.835.312	3.130.016
12	50	0	3.612.756	8.172.351	-39.315.506	-9.113.377	-0.006683
13	50	1	-5.978.165	19.412.109	100.729.360	1.837.498	3.130.075
14	60	0	-6.328.442	8.208.478	-39.233.785	-9.113.916	-0.006676
15	60	1	4.274.774	19.352.329	100.535.251	1.839.678	3.130.147
16	70	0	-4.780.439	8.145.194	-39.151.702	-9.114.461	-0.006672
17	70	1	-5.693.229	19.395.077	100.341.740	1.841.804	3.130.265
18	80	0	3.481.802	8.097.389	-39.070.252	-9.115.012	-0.006672

```
<Event Time="4960" Source="OpenPASS" Name="ExtendedCollisionInformation">
    <TriggeringEntities>
        <Entity Id="0"/>
        <Entity Id="1"/>
    </TriggeringEntities>
    <AffectedEntities/>
    <Parameters>
        <Parameter Key="OCPA" Value="135.137787"/>
        <Parameter Key="HCPAo" Value="44.355654"/>
        <Parameter Key="OCPAo" Value="157.343132"/>
        <Parameter Key="OYA" Value="131.071508"/>
        <Parameter Key="OpponentCollisionVelocity" Value="19.291254"/>
        <Parameter Key="OpponentPointOfContactLocalY" Value="0.502757"/>
        <Parameter Key="OpponentPointOfContactLocalX" Value="-1.678529"/>
        <Parameter Key="OpponentVelocityDirection" Value="3.086993"/>
        <Parameter Key="OpponentVelocityChange" Value="13.616278"/>
        <Parameter Key="OpponentVelocity" Value="5.708374"/>
        <Parameter Key="HCPA" Value="68.778560"/>
        <Parameter Key="OpponentSliding" Value="1"/>
        <Parameter Key="OpponentYawVelocity" Value="5.146419"/>
        <Parameter Key="Sliding" Value="1"/>
        <Parameter Key="CollisionVelocity" Value="8.185805"/>
        <Parameter Key="PointOfContactLocalX" Value="1.229333"/>
        <Parameter Key="YawVelocity" Value="5.299997"/>
        <Parameter Key="VelocityDirection" Value="2.097976"/>
        <Parameter Key="VelocityChange" Value="8.510174"/>
        <Parameter Key="PointOfContactLocalY" Value="0.706571"/>
        <Parameter Key="Velocity" Value="6.630590"/>
        <Parameter Key="CollisionWithAgent" Value="1"/>
    </Parameters>
</Event>
```

PCM 5.0 PROTOTYPE – IMPORT STANDARD_OBJECTS ➔ OSI OBJECTS



Variable	Description	Unit	Type
CASEID	Unique case identifier	[]	Short text
OBJID	Object identifier per CASEID	[]	Long int.
OBJTYPE	Type of object	[]	Long int.
REFX	Global x-Coordinate of reference point	[m]	Double
REFY	Global y-Coordinate of reference point	[m]	Double
REFZ	Global z-Coordinate of reference point	[m]	Double
REFROTX	Global rotation angle around x-axis at reference point (cardan angles)	[rad]	Double
REFROTY	Global rotation angle around y-axis at reference point (cardan angles)	[rad]	Double
REFROTZ	Global rotation angle around z-axis at reference point (cardan angles)	[rad]	Double
SCALEX	Scaling factor in x-direction at reference point	[]	Double
SCALEY	Scaling factor in y-direction at reference point	[]	Double
SCALEZ	Scaling factor in z-direction at reference point	[]	Double

standard_objects | library_DE_standard_objects

OBJTYPE	SURFID	POINTID	X	Y	Z
550	1	2	1	0,25	0
550	1	3	1	-0,25	0
550	1	4	-1	-0,25	0
550	1	5	-1	0,25	0
550	1	1	-1	0,25	0
550	2	1	-1	0,25	1,1
550	2	2	1	0,25	1,1
550	2	3	1	-0,25	1,1
550	2	4	-1	-0,25	1,1
550	2	5	-1	0,25	1,1
550	3	1	-1	0,25	0
550	3	5	-1	0,25	0
550	3	4	1	0,25	0

```
    <objects>
        <object height="1.5" width="1.818" length="4.545" hdg="3.03736" s="4993.63" t="-5001.85" id="2" type="car" name="statioary car" pitch="0" roll="0" zOffset="0" orientation="+"/>
        <object height="1.4" width="1.632" length="3.535" hdg="3.08516" s="4999.63" t="-5002.56" id="1" type="car" name="statioary car" pitch="0" roll="0" zOffset="0" orientation="+"/>
    </objects>
  </road>
</OpenDRIVE>
```

OPENPASS PCM WORKSHOP

Topics:

- Use case “PCM simulation”
- openPASS overview & history (PCM in v0.5 etc.)
- openPASS v0.8 configs with PCM data
- Examples for PCM simulation
  - Agent without system ➔ collision
  - Agent with AEB and view obstruction by object
- **Discussion – how to proceed with PCM data in OpenDrive, OpenScenario..**

WORKSHOP
HOW TO USE ACCIDENT DATA IN SIMULATION

General question – how to define a „scenario model“? How to validate it?

- Accident data ➔ list of PCM cases = scenario model
- OpenScenario description (xml format) = scenario model
- Realistic, virtual traffic model = scenario model

Note: this was initial challenge of openPASS!

PCM ➔ OpenScenario:

- Data: GIDAS / GIDAS-PCM represenative sample of accident statistics,
- Concrete scenario (see PEGASUS): in-depth accident description – plus reconstructed scenarios

Current status:

- each accident case ➔ one „scenario“ (run, experiment..)
- for 100 rear-end cases on 2-lane motorways ➔ 100 different xodr, 100 veh. catalogs, 100 xosc with trajectories

Do we want to transfer each case? – no!

WORKSHOP
APPROACHES & NEXT STEPS

Different options – how to define a „scenario model“?

Discussion:
Demo cases? Exemplary scenario?
Follow up activities?

1. Create OpenX configs during accident investigation
2. Convert data from PCM format to OpenX configs
3. Derive histograms/distributions for scenario parameters

➔ All three are needed: „3“ as the target format, „2“ for existing formats, „1“ for new cases

Concept

„GIDAS table for OpenScenario“
GIDAS information ➔ parameters
V0 ➔ initial speed of init action

Config Writer

OpenDRIVE /OpenSCENARIO for UTYPs
(templates in openPASS)

Requirements towards openPASS: what kind of „standard accident scenarios“ could be starting point

FURTHER INFORMATION

OpenPASS Working Group | The Eclipse Foundation

Eclipse Projects / Eclipse simopenpass / simopenpass · GitLab

Home · Wiki · Eclipse simopenpass · GitLab

OpenPASS-WG – Eclipsepedia

GUI Plugins — OpenPASS Documentation (eclipse.org)

Eclipse sim@openPASS - Branches (8) [Eclipse Projects / Eclipse simopenpass / simopenpass] [Jenkins]

Impact model: https://graz.pure.elsevier.com/files/3680910/2_01_03_Kolk.pdf

PARTICIPANTS