

GenericXiL with CarMaker

From Scenario to driving Function

Janik Braun (TV-CE)

WE
TRANSFORM
AUTOMOTIVE
MOBILITY

We transform automotive mobility

CARIAD
A VOLKSWAGEN GROUP COMPANY

Agenda

- Generic XIL
- Scenario Modelling and Methodology
- OpenScenario XML
- Virtual Environment Framework „FEP“
- Development
- System Demo

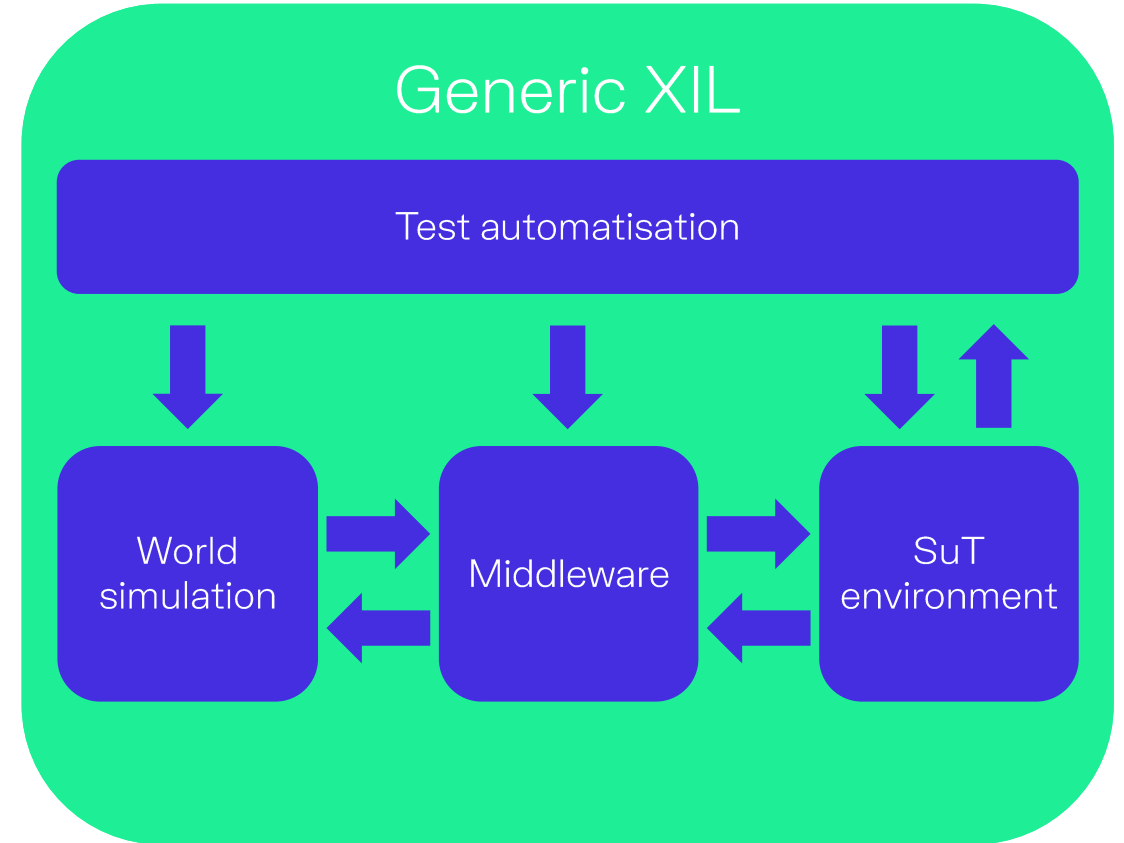


Generic XiL



What is Generic XiL?

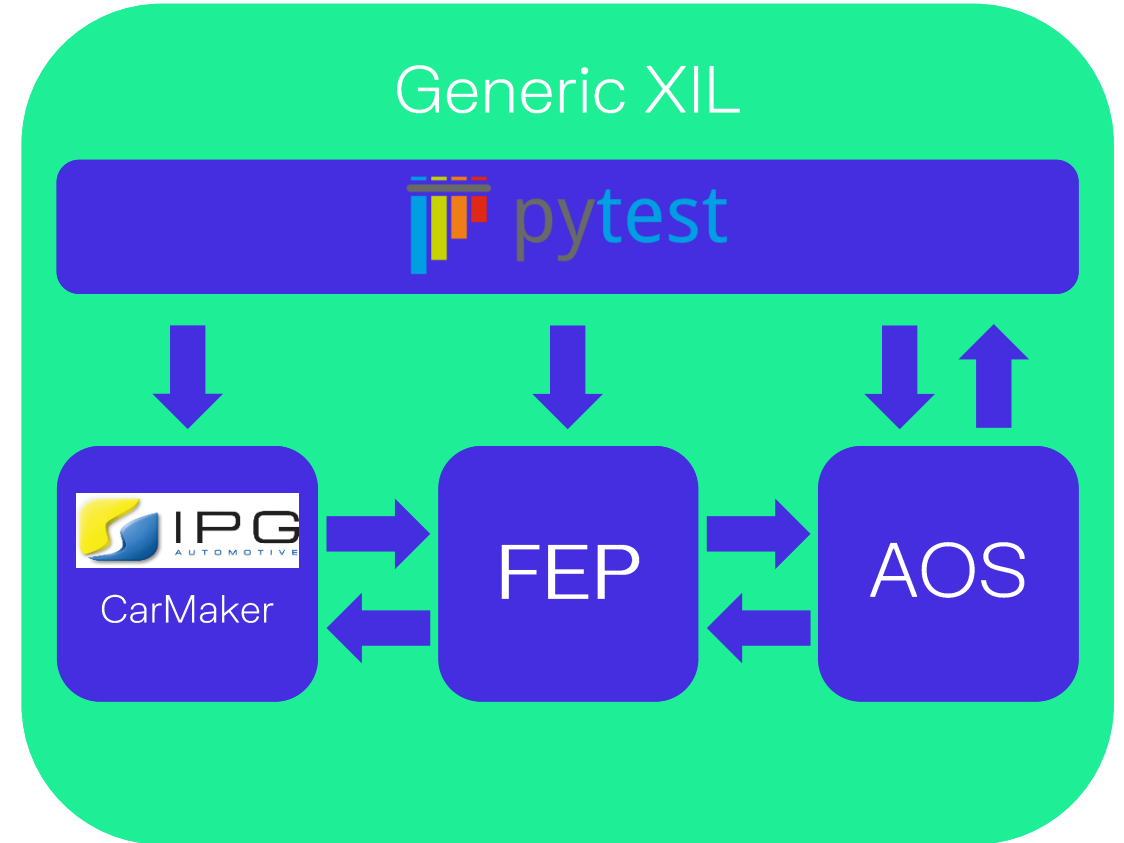
- Basic test bench to derive specific test bench
- Not contain specific residual bus and System und Test
- Share common configuration with specific test benches
- Tools:
 - Test automatisaton
 - World simulation
 - Middleware
 - System under Test environment
- Specific combinations in dedicated version
 - reduce development support
 - cover the variety of customer needs



Pre-configured, integrated and tested tools for the typical test bench set-ups

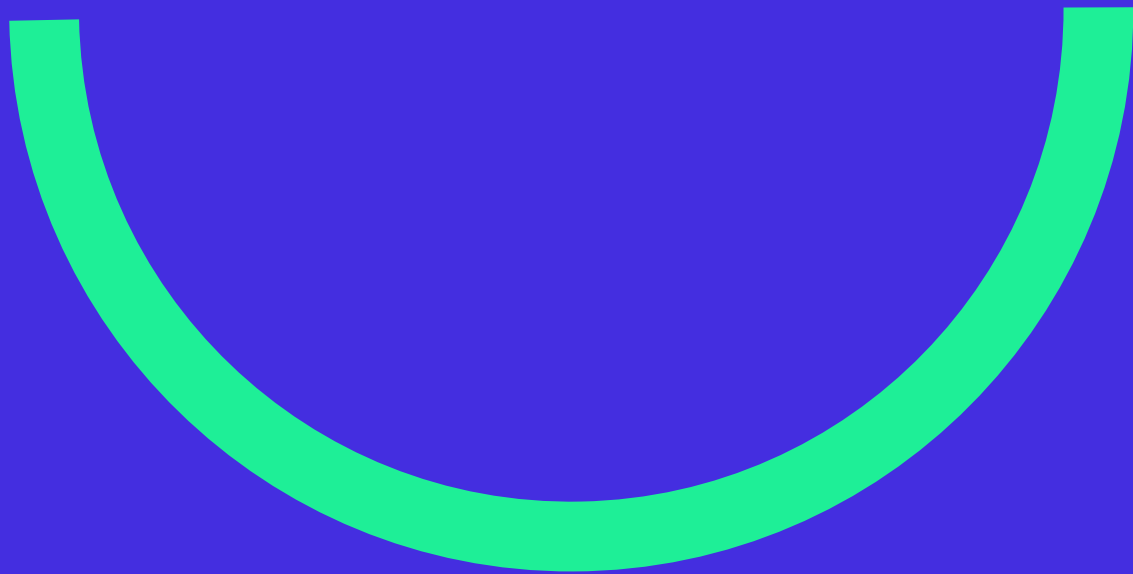
What is Barcelona?

- Specific test bench
- Tools:
 - Test automation: Pytest
 - World simulation: IPG CarMaker
 - Middleware: FEP
 - System under Test environment: AOS
- VEF Data Model is used for communication, which covers most use cases
- Communication across operating systems
 - Windows: PyTest
 - Linux: AOS



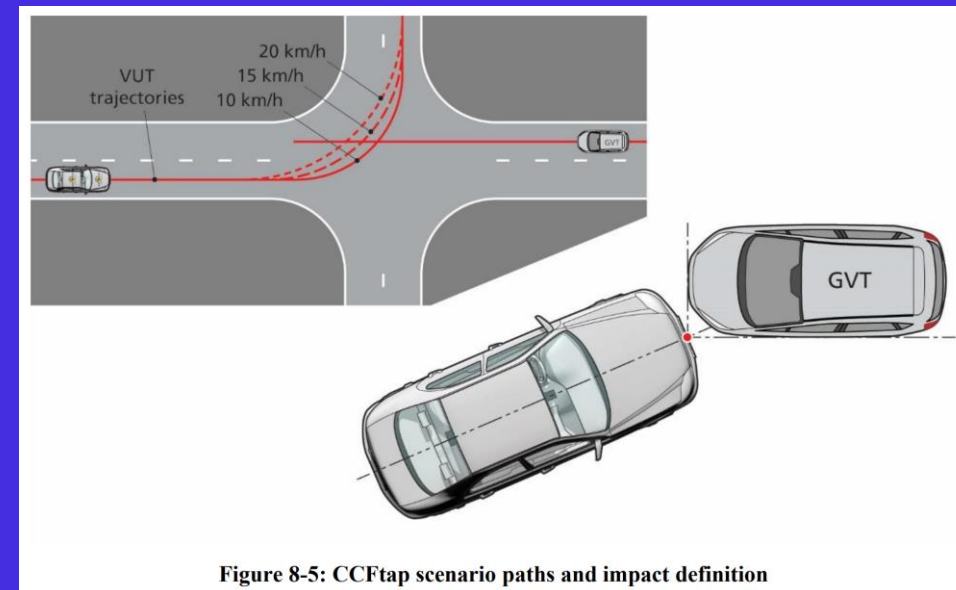
Specific test bench with a high percentage of generic usage

Scenario Modelling and Methodology Development



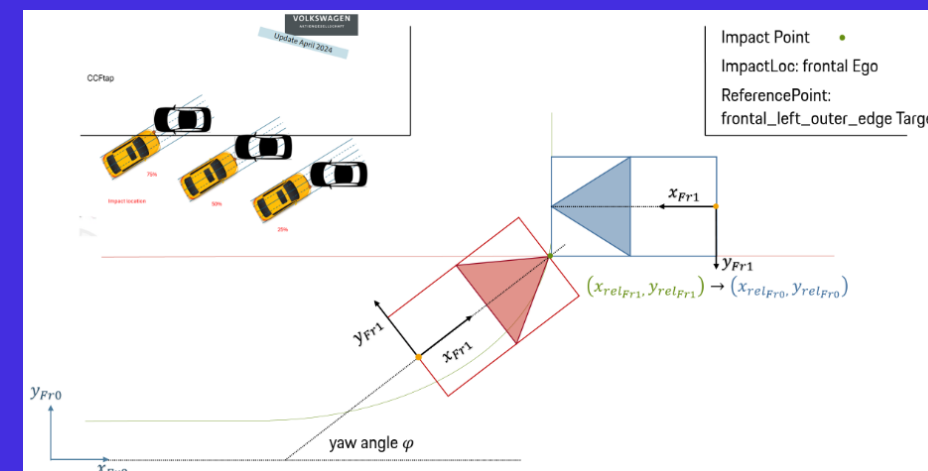
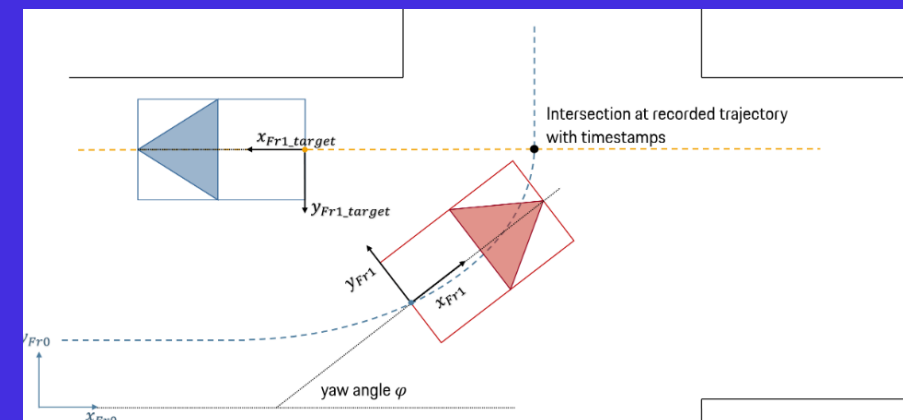
Modelling scenarios for NCAP

- Modeling approach
 - Most NCAP scenarios can be modeled by exact triggering entities in CarMaker
 - Lot if variations of concrete scenarios
 - NCAP scenarios require exact positioning of road users / impact position
- Triggers
 - Specific condition that control actions of road users



Modelling scenarios for NCAP

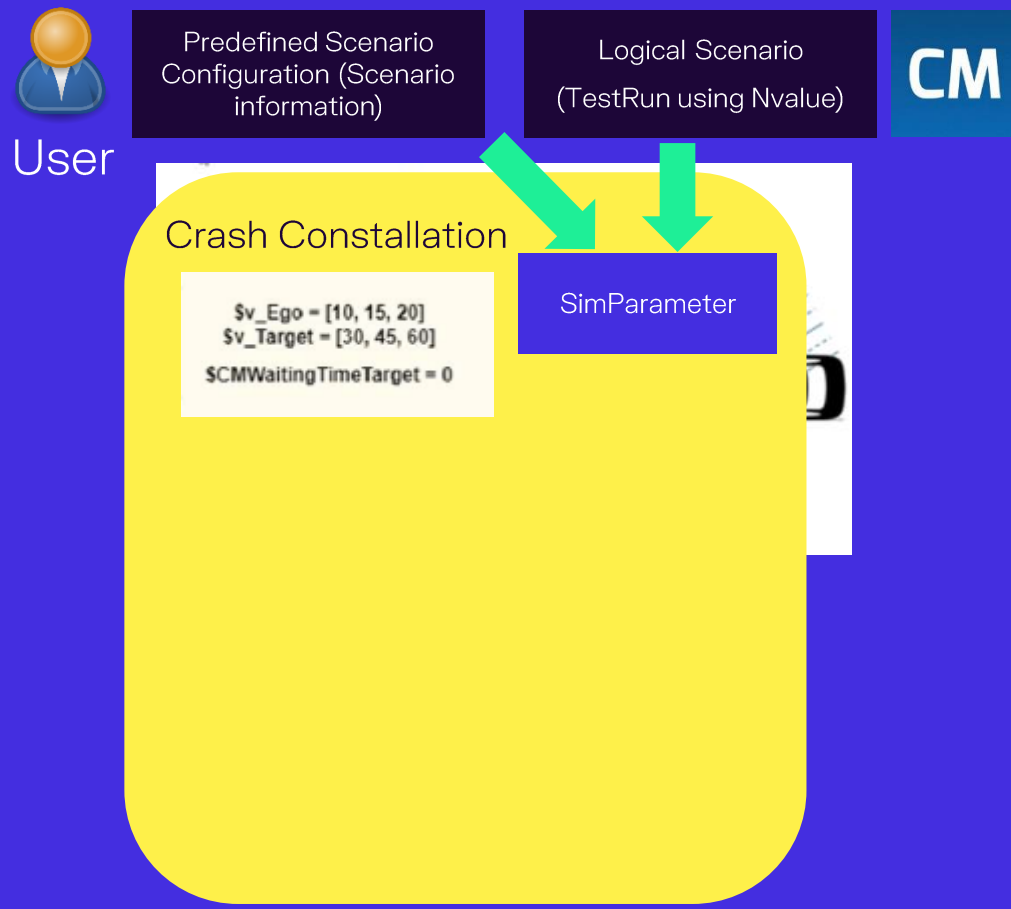
- Challenges in NCAP Scenario Modelling: Triggers → **Where? Or When?**
 - Manual setup of complex scenarios
 - Time-consuming manual analysis and manipulation
 - Difficulty in ensuring consistency across tests
 - Scenario revision required each time software, feature, or vehicle model updates occur



Idea: Analyze trajectories recorded simulation run and compute time trigger for scenario maneuver

Crash Constellation Tool Workflow

- 1. Configuration Input
 - User provides NCAP scenario details



Crash Constellation Tool Workflow

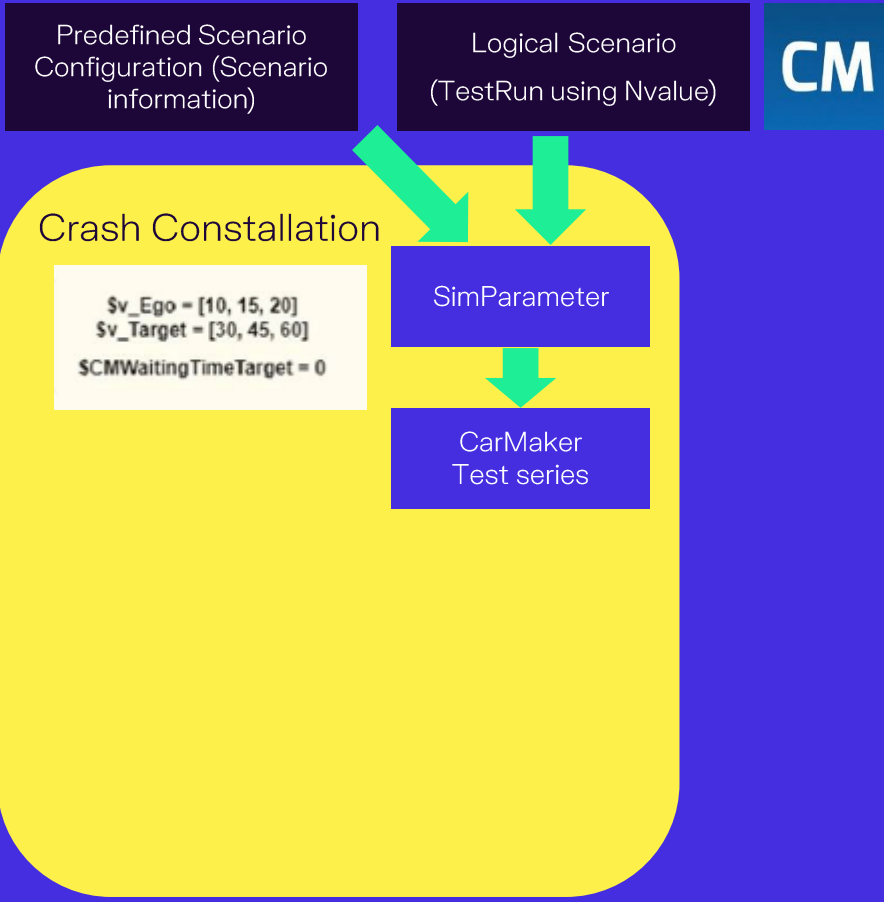
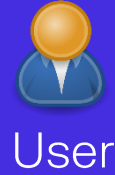
2. Automated Scenario Configuration

- Tool generates concrete scenarios with initial timing triggers

CarMaker - Test Manager CCFtap_frontalCollision_ENC26_frontal_left_outer_edge.ts

Execution mode: Sequential

Item Description	Par1	Par2	Par3	Par4	Res.Date	Result
Global Settings						
My Vehicle						
Car	AU416_PVS_1BD_PK5_WBA_NCAP					
Settings						
GrundSzenarien/NCAP/CCFtap						
	v_Ego	v_Target	CM_Waiting	impact_loca		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	31.097999	0		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	30.829999	25		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	30.531999	50		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	30.193999	75		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	29.801999	100		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	45.0	35.375999	0		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	45.0	35.133999	25		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	45.0	34.861999	50		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	45.0	34.553999	75		



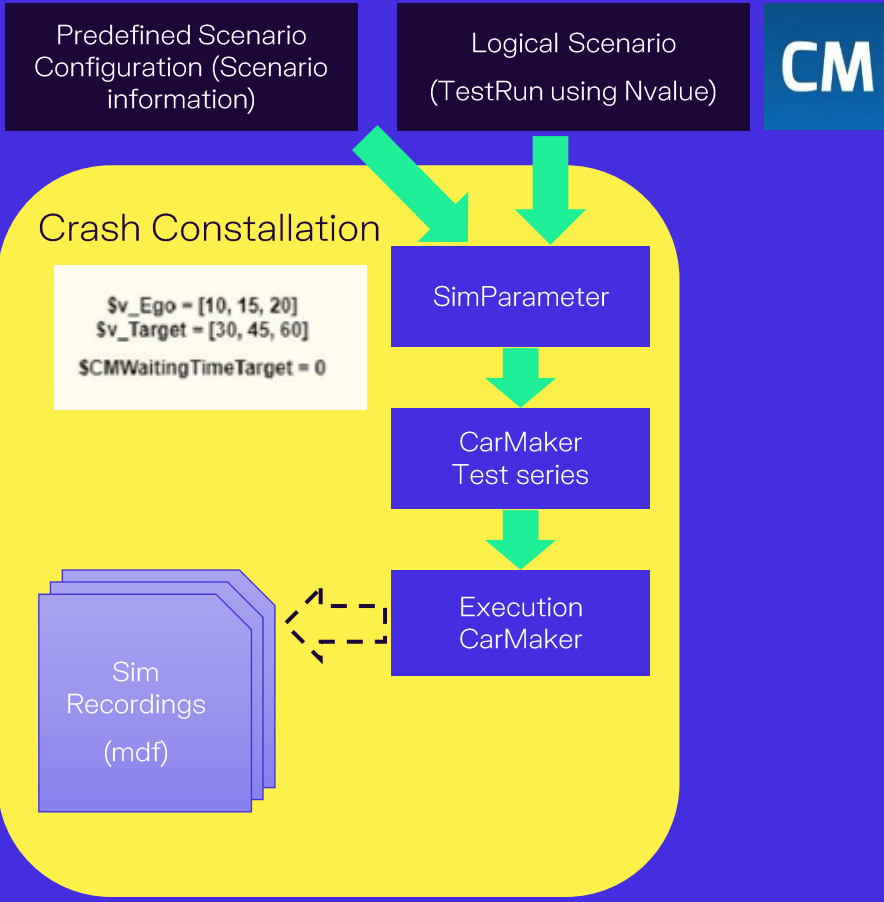
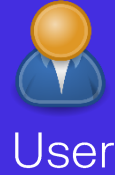
Crash Constellation Tool Workflow

- 3. Simulation Execution
 - Scenarios run in CarMaker
 - Record trajectories

CarMaker - Test Manager CCFtap_frontalCollision_ENC26_frontal_left_outer_edge.ts

Test Manager Execution mode: Sequential

Item Description	Par1	Par2	Par3	Par4	Res.Date	Result
Global Settings						
My Vehicle						
Car	AU416_PVS_1BD_PK5_WBA_NCAP					
Settings						
Grund Szenarien/NCAP/CCFtap						
	v_Ego	v_Target	CM_Waiting	impact_loca		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	31.097999	0		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	30.829999	25		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	30.531999	50		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	30.193999	75		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	30.0	29.801999	100		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	45.0	35.375999	0		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	45.0	35.133999	25		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	45.0	34.861999	50		
▶ CCFtap_frontalCollision_ENC26_frontal_I	10.0	45.0	34.553999	75		

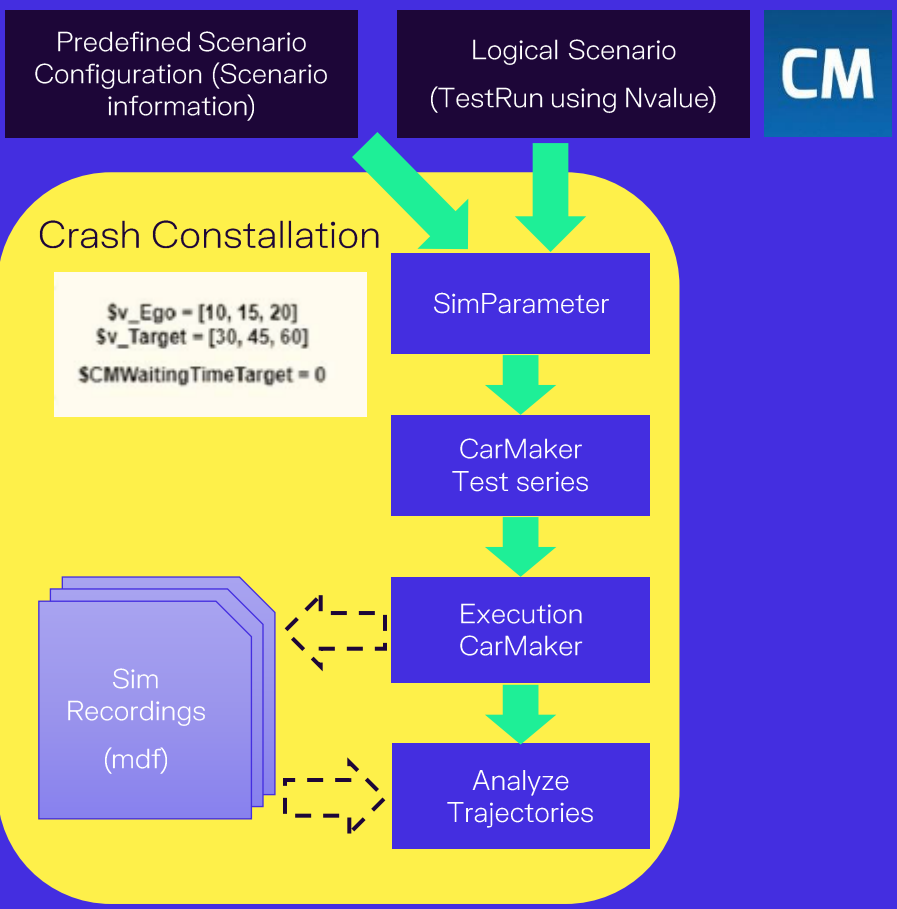


Crash Constellation Tool Workflow

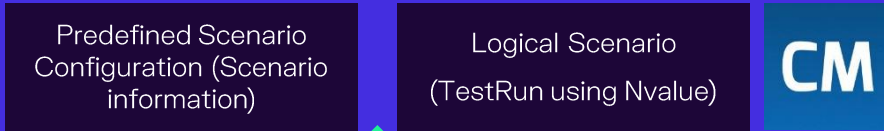
4. Recordings Analysis

- Tool analyzes simulation Data
- Manipulates precise timing triggers

Item Description	Par1	Par2	Par3	Par4	Res.Date	Result
Global Settings						
My Vehicle						
Car	AU416_PVS_1BD_PK5_WBA_NCAP					
Settings						
Grund Szenarien/NCAP/CCftap						
	v_Ego	v_Target	CM_Waiting	impact_loca		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	30.0	31.097999	0		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	30.0	30.829999	25		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	30.0	30.531999	50		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	30.0	30.193999	75		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	30.0	29.801999	100		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	45.0	35.375999	0		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	45.0	35.133999	25		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	45.0	34.861999	50		
▶ CCFtap_frontalCollision_ENC..._frontal_I	10.0	45.0	34.553999	75		

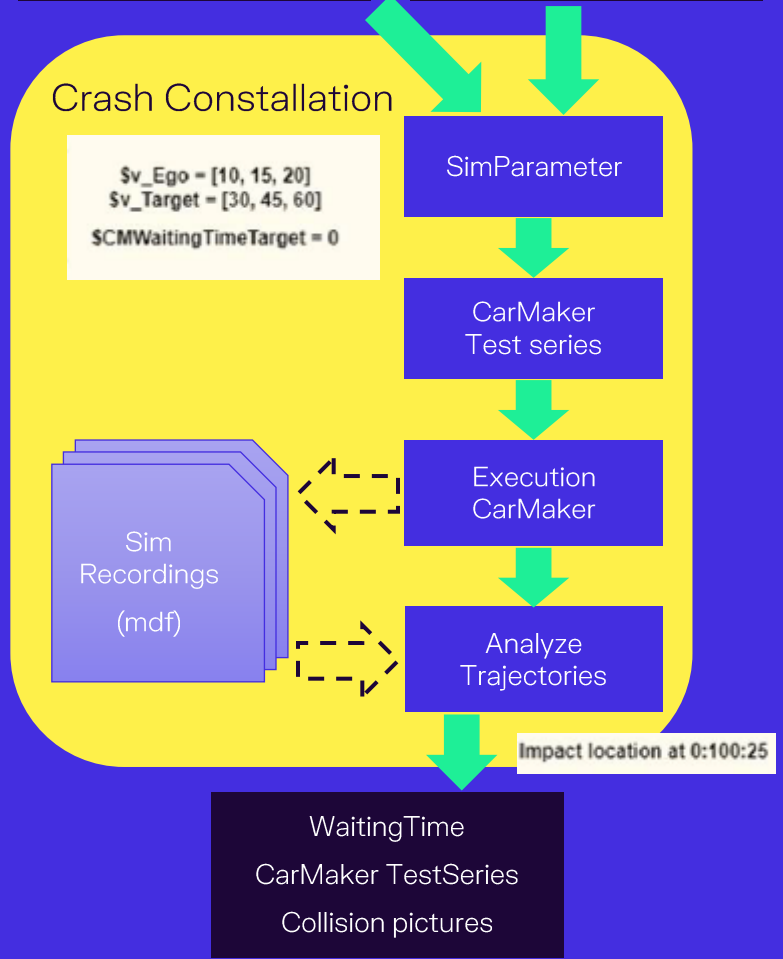
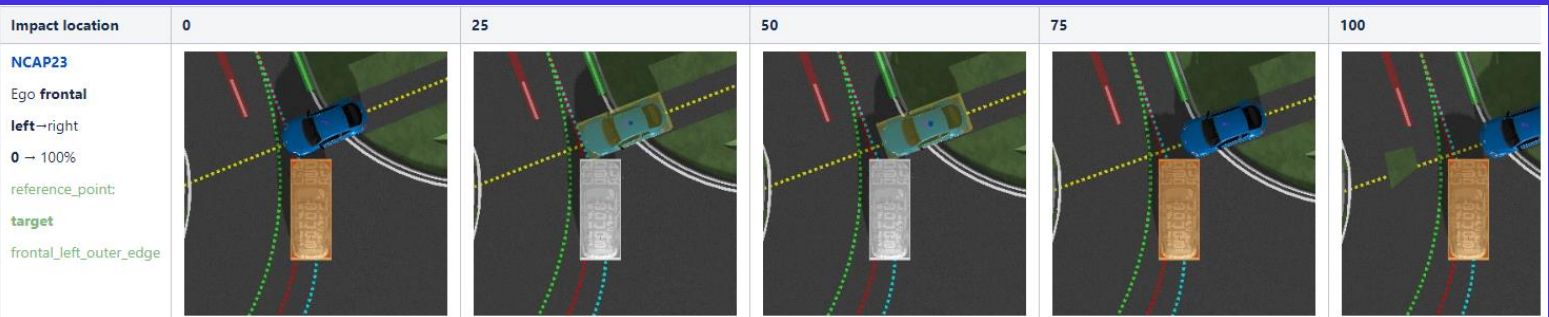
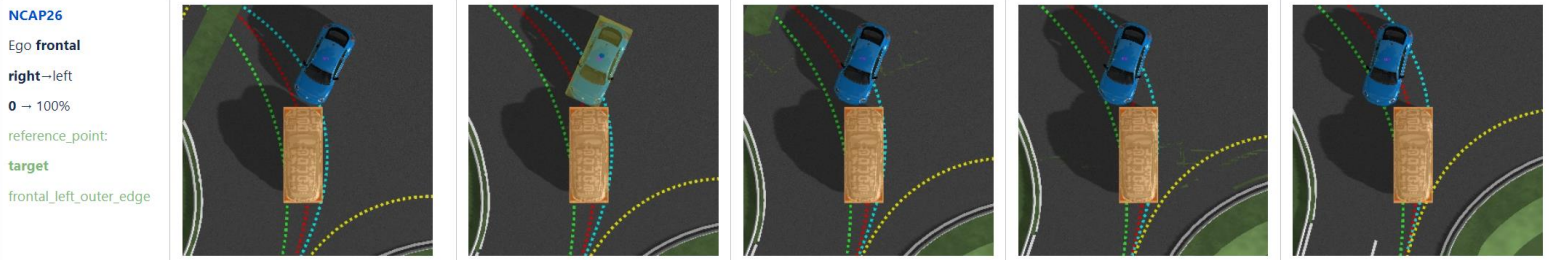


Crash Constellation Tool Workflow



5. Results Generation

- Waiting Time saved in lookup table (CSV)
- Configured CarMaker TestSeries
- Screenshots view of collision area in IPGMovie



From the NCAP description to the CarMaker test series with various crash constellations

Benefits

1. Maintainability

- Automates re-calculation
- Revision of NCAP scenario

2. Efficiency

- Quickly generated
- Validate multiple NCAP scenarios

3. Consistency

- Ensure crash constellations remain accurate and consistently aligned with desired impact
- Analysis based on simulation behavior within CarMaker

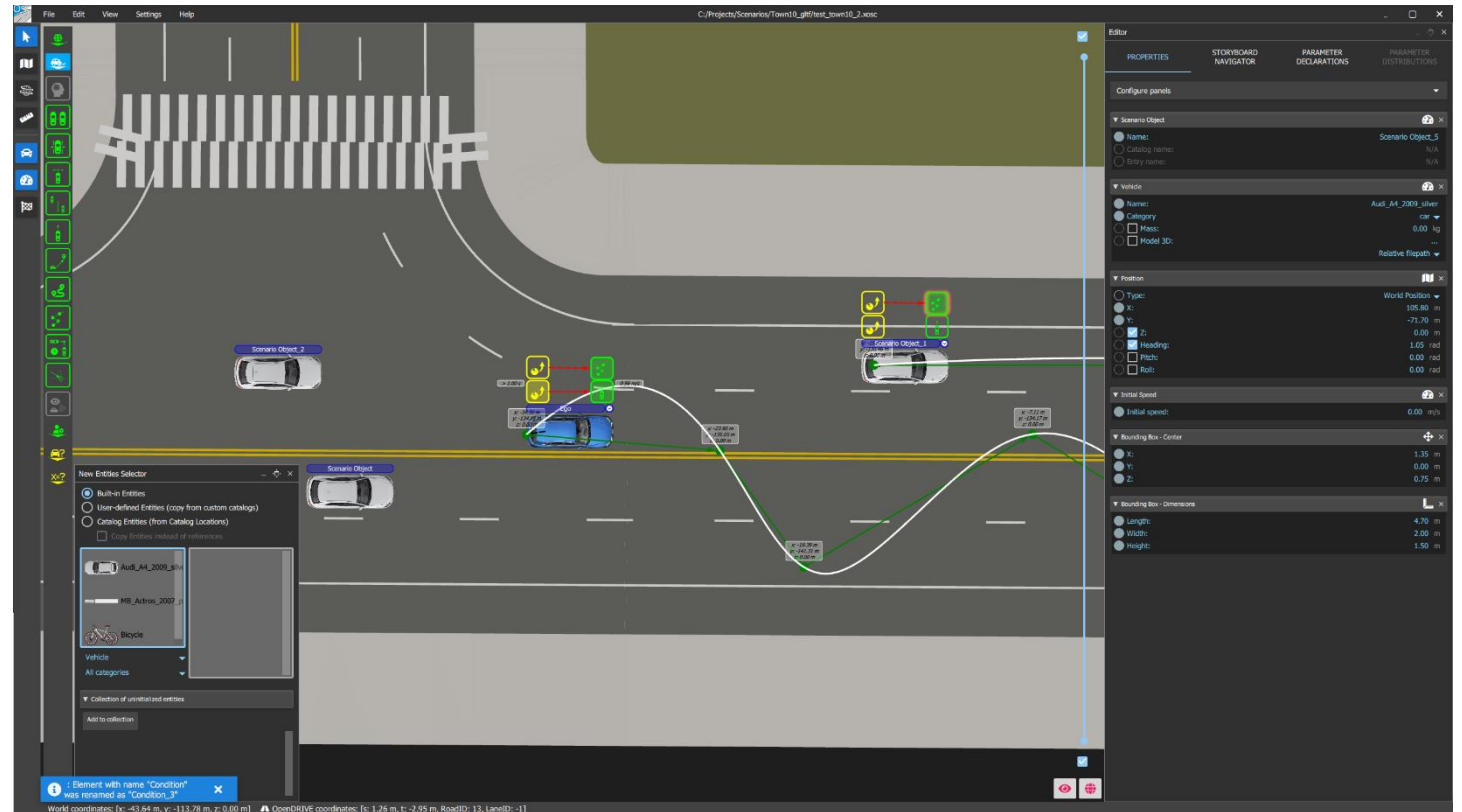
4. Flexibility

- Easily adaptable to different scenarios and protocols

5. Scalability

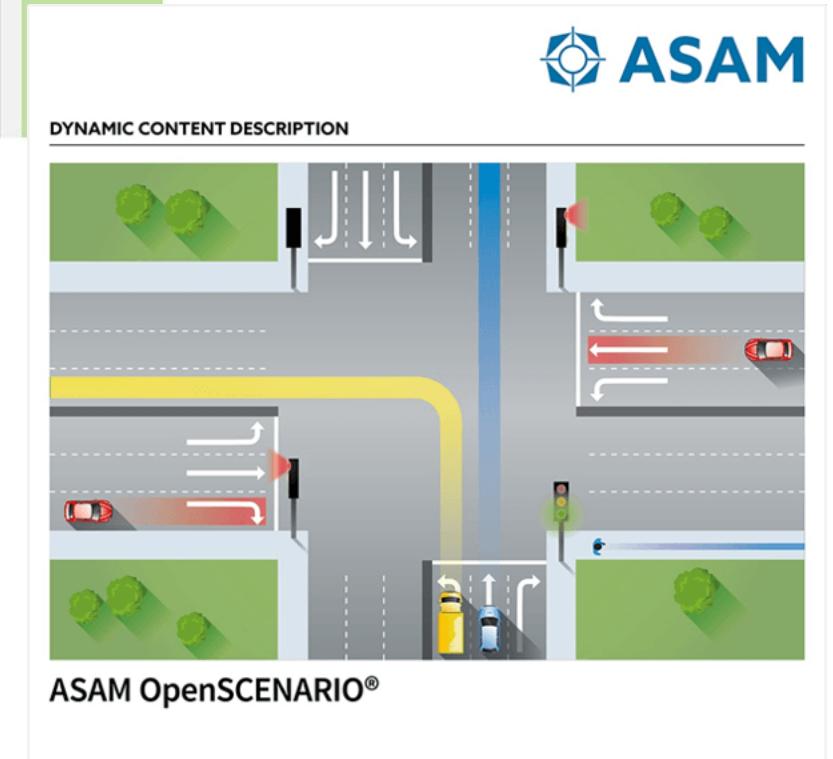
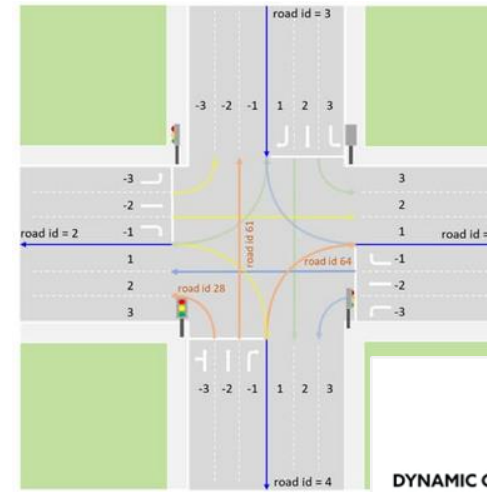
- Complex scenarios with large parameter sets

OpenSCENARIO in CarMaker



OpenSCENARIO in CarMaker

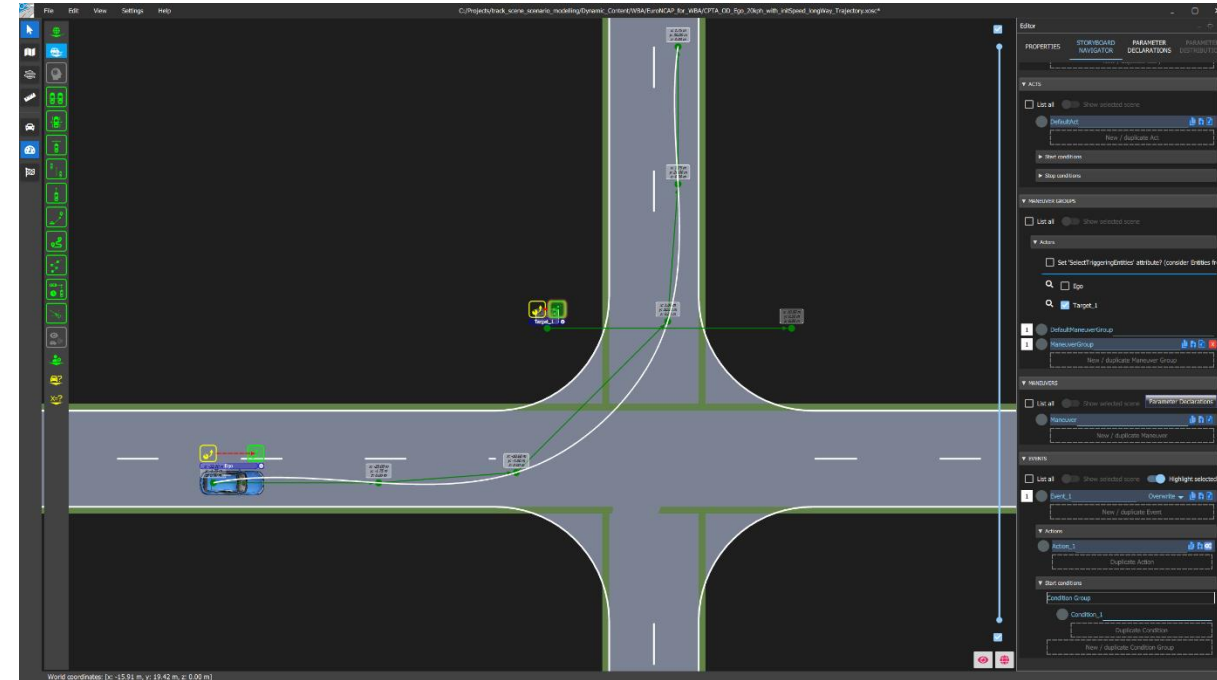
- Future: all scenarios written as OSC
- Lot of internal and external tools e.g. for
 - Modelling
 - Visualizing
 - Testing
- ASAM Q-Checker helps maintaining quality standards for OSC and OpenDRIVE



A lot of internal and third-party tooling for OSC available, making it a stable and reliable solution

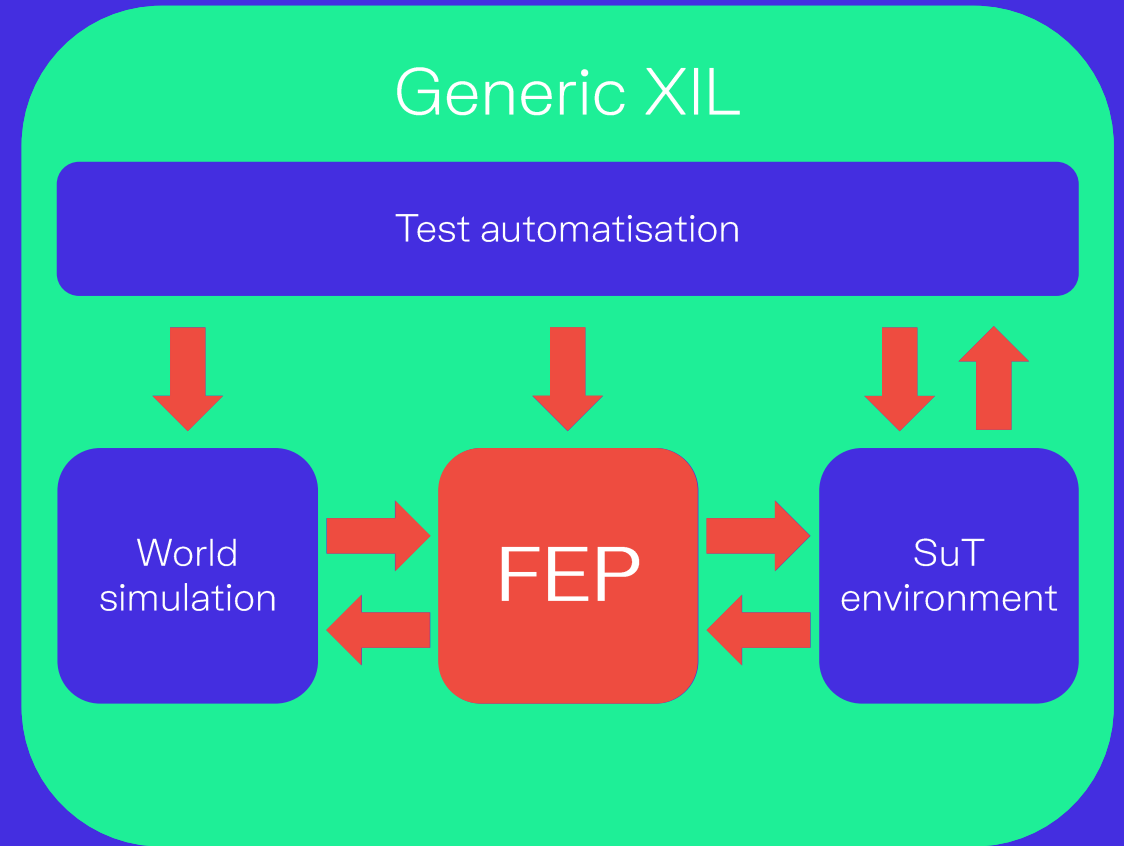
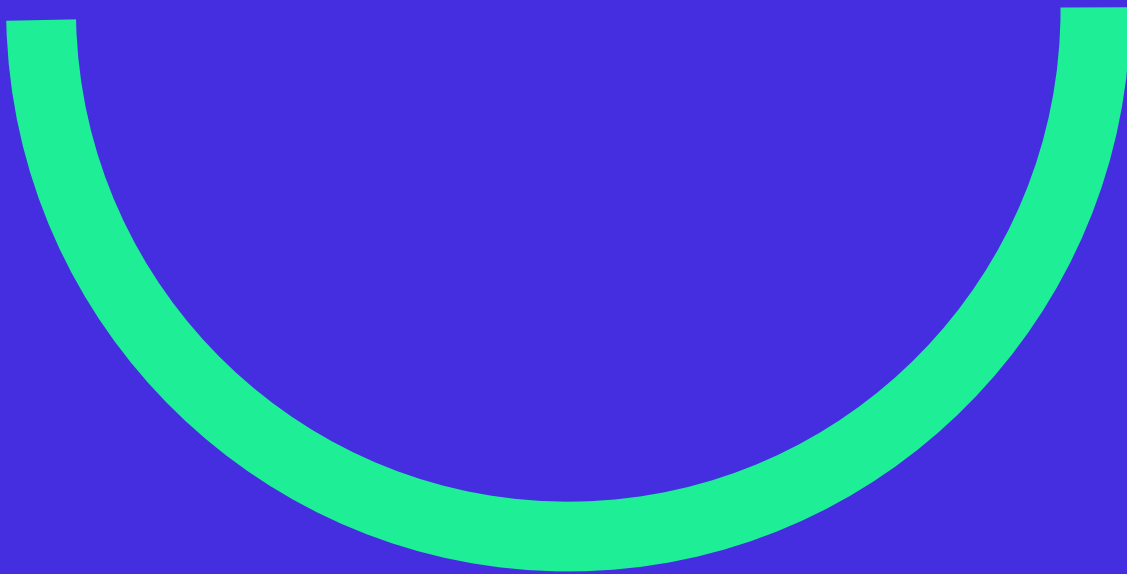
OpenSCENARIO XML

- Inhouse editor is used to create scenarios
- Result execute with lightweight simulators locally
- On various testbenches with CarMaker
- OSC support in CarMaker improved drastically with recent iterations
- Around 80% of our Warn, Break, Evade scenarios can be modelled with OSC and executed correctly in CM



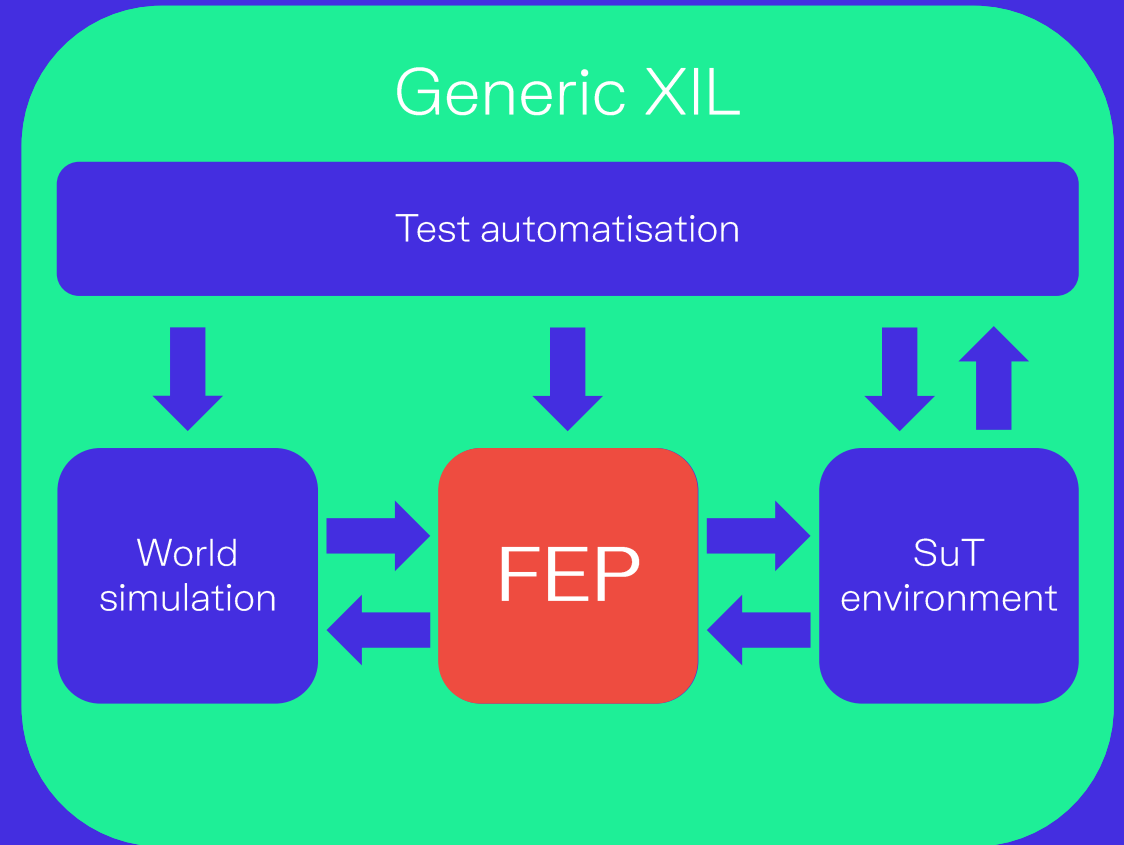
OSC development looks promising for CM

Virtual Environment Framework „FEP“



What is FEP?

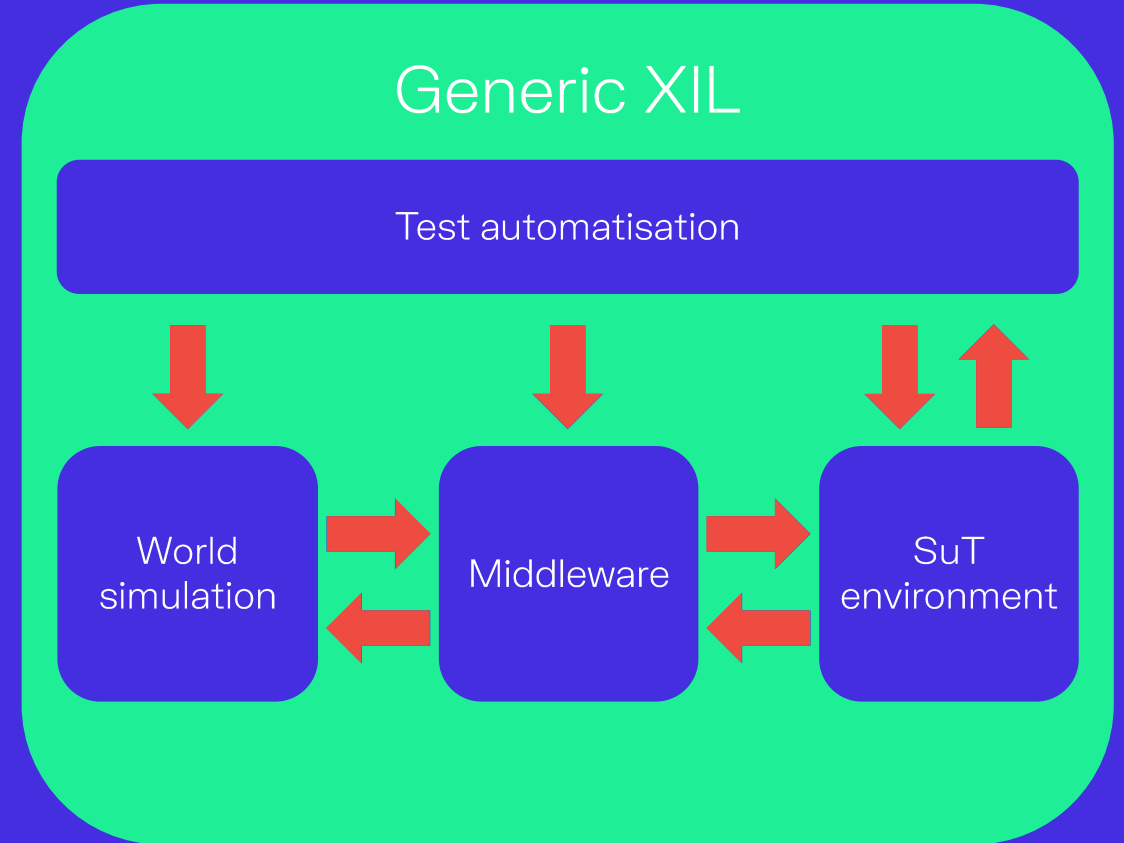
- FEP serves as communication middleware
- Interprocess communication
- Windows and Linux systems provided
- Cross-operating system communication
- Easy starting and connection of different participants
- Enables the creation of complex structures
- Simple deployment



Building a small suite consisting of individual tools that can be easily connected to each other via tooling

What does FEP do in GenericXiL?

- Simple connection of various participants (world simulation, ..)
- Consistent interfaces (VEF Data Model) to enable simple exchangeability



What does FEP do in GenericXiL?

- Simple connection of various participants (world simulation, ..)
- Consistent interfaces (VEF Data Model) to enable simple exchangeability
- Simple starting of the various participants
- Easy entry point for the developer (VSCodium)

```

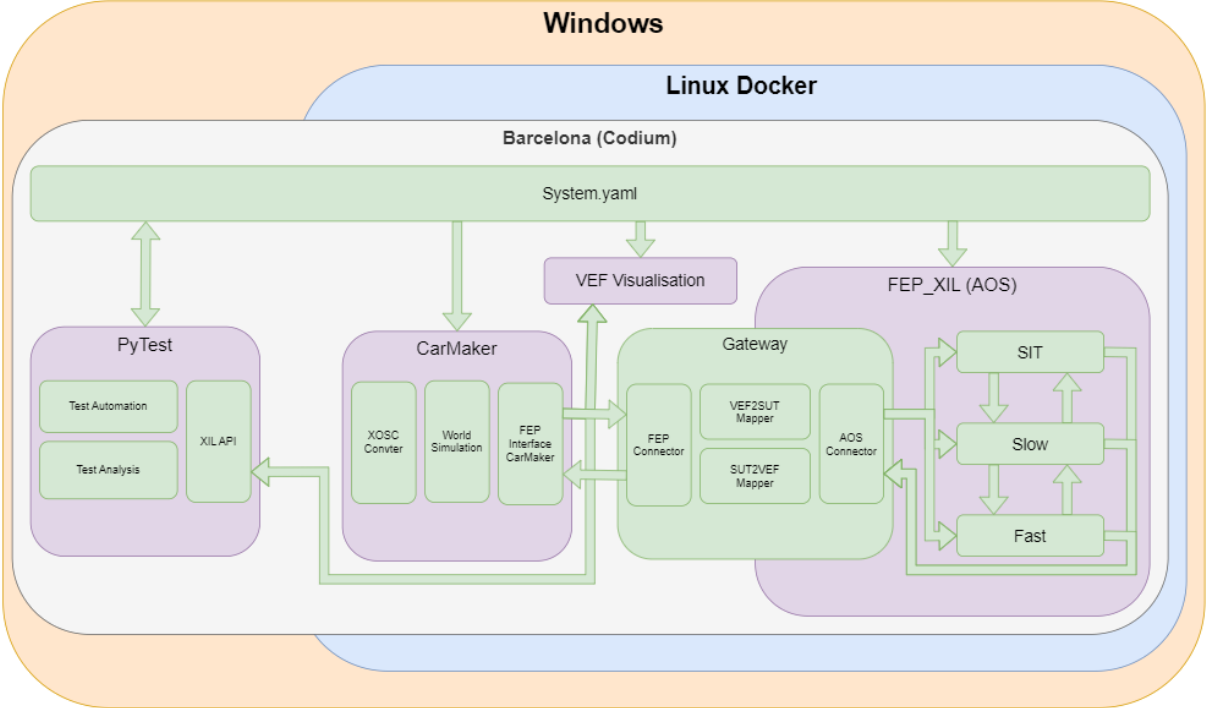
system:
  name: wba_xil
  element_instances:
    #VEF_Visualization:
      #conan_reference: fep_vef_visualization/1.0.0@fep/stable
    VEF_Provider_CarMaker:
      conan_reference: fep_interface_carmaker/2.2.0+20230914@fep/integration
      #conan_options: -o cm_version=12.0.1
    wba_aos_gateway:
      conan_reference: wba_aos_gateway/0.18.0@wba/testing
    #wba_debug_consumer:
      # conan_reference: wba_debug_consumer/1.0.0@wba/testing
  data_packages:
    scenario_package:
      source_type: conan
      conan_reference: generic_xil_barcelona_scenario/2022.11.25@pasit_scenarios/stable

```

CONTROL									
Participant		State							
VEF_Provider_CarMaker	TIMING MASTER	Time: 00:00:00.000000000	● Initialized	↑	↓	▶	⏸	⏹	⚙
wba_aos_gateway			● Initialized	↑	↓	▶	⏸	⏹	⚙

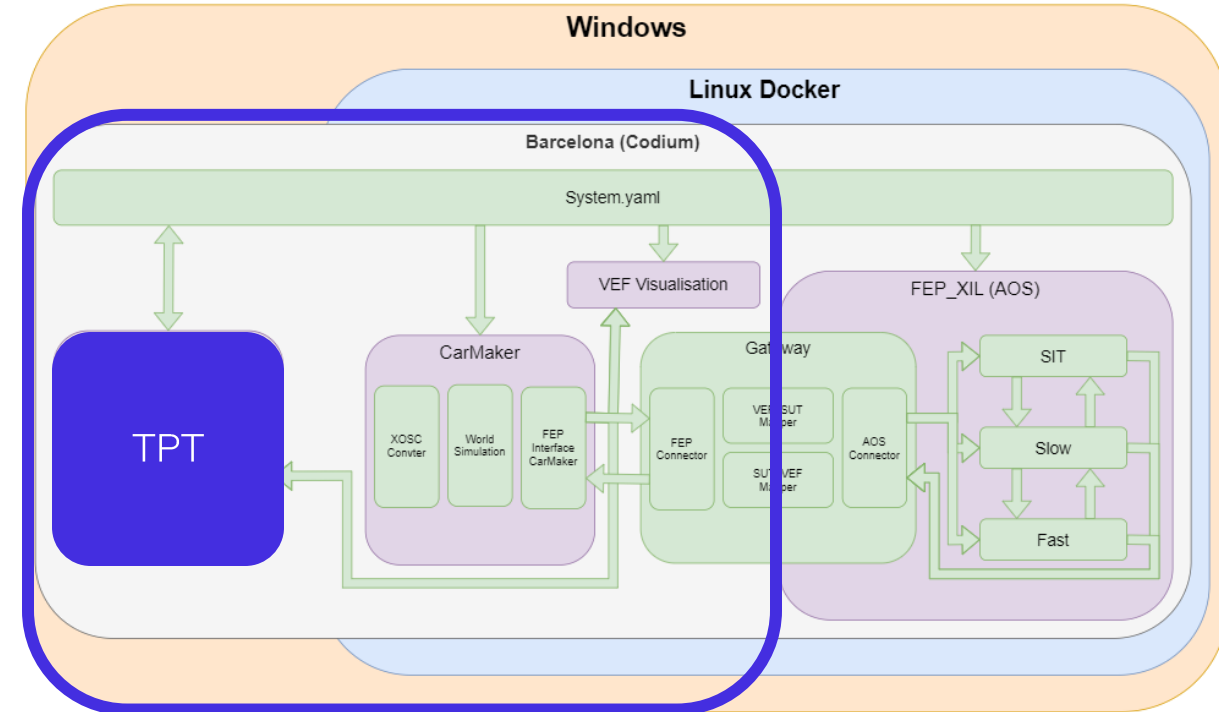
Simple integration of the basic test bench into the specific test bench

Development



How does this structure help us?

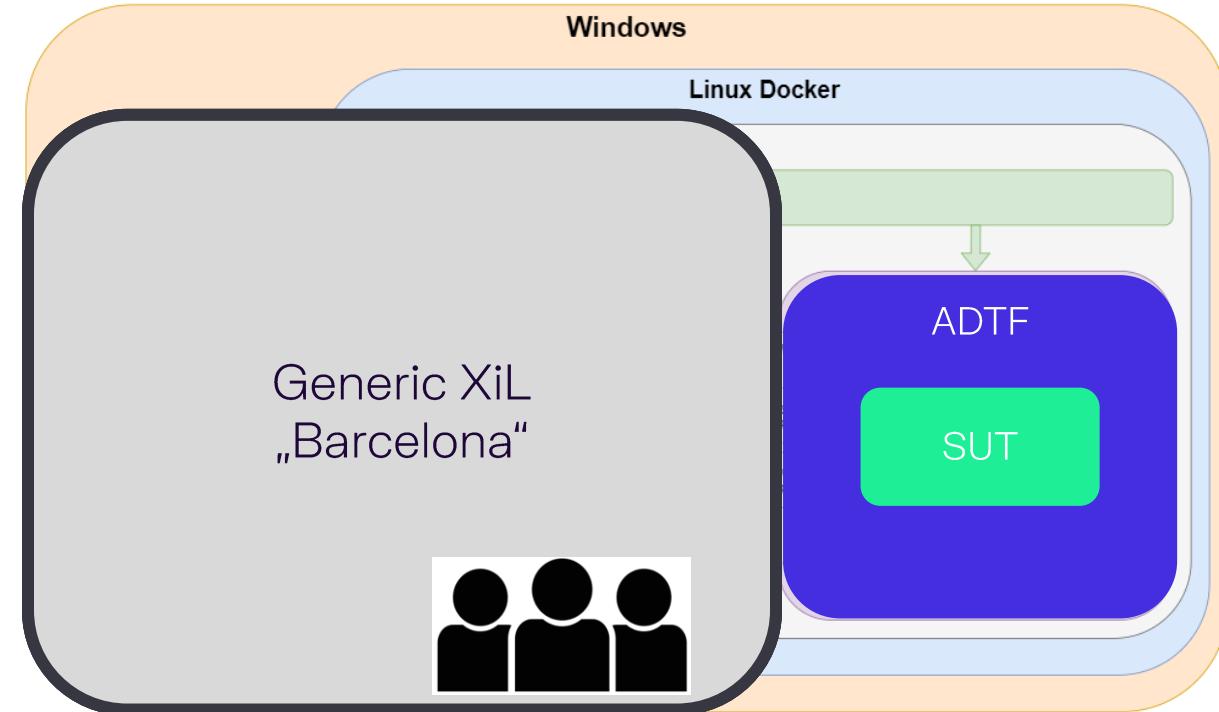
- Basic structure is versatile
(Exchange conversion to SuT)
- One development helps many customers
(Can be used across vehicle development)
- Easy to replace tooling depending on customer requirements
- Solution is quickly available



Central development for different customers and test benches

What are the advantages for the developer?

- Don't have to worry about the simulator
- Customer can easily test and experience function using synthetic data
- Live Debugging with desired scenarios
- Direct contact person for problems
- Easy exchangeability of the SUT environment for further development of the SUT



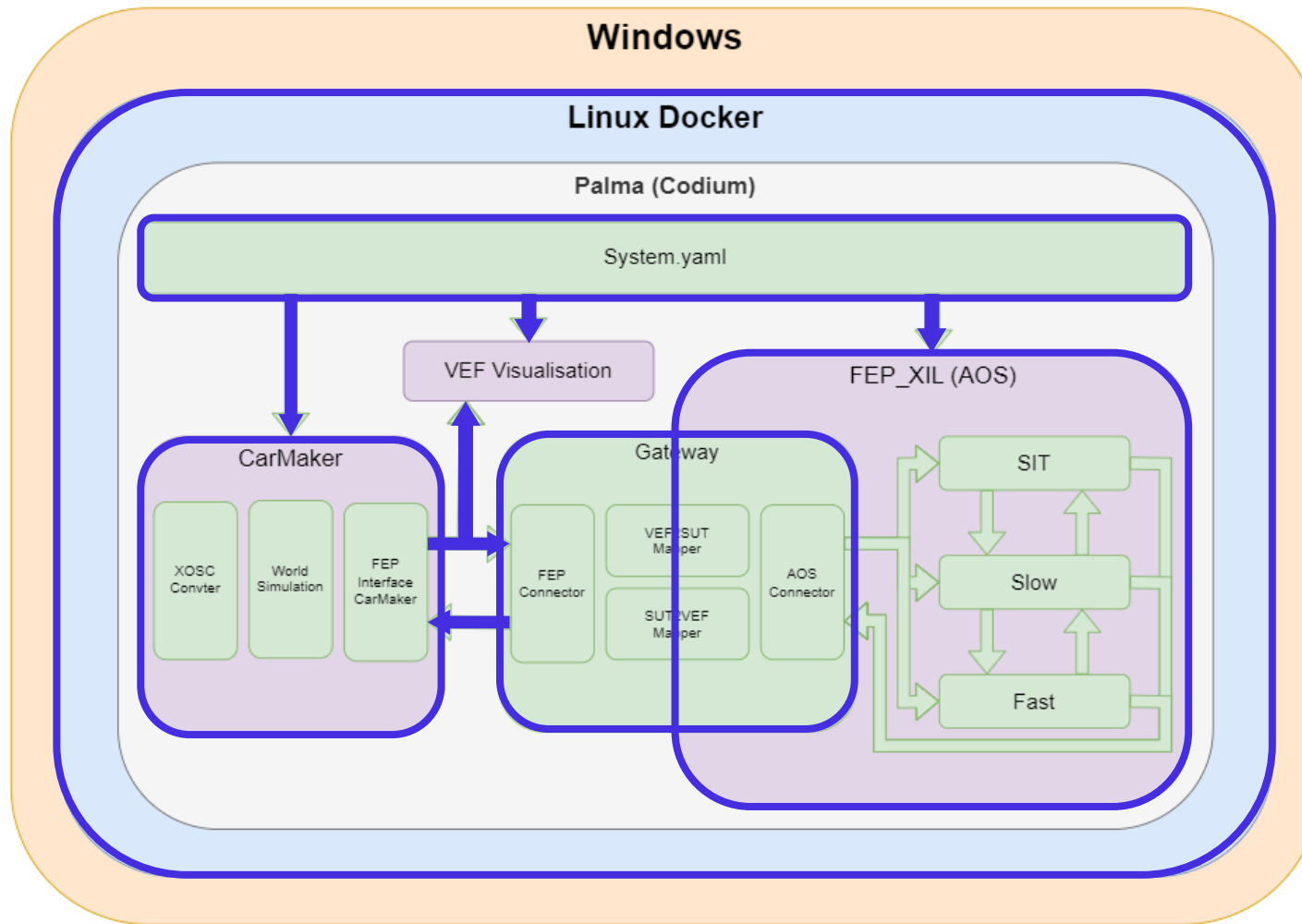
Early and continuous testing already possible with the developer

SystemDemo

How to use



What does the SystemDemo test bench look like?



- Linux docker container
- World simulation: CarMaker
- SuT environment: AOS
- SuT: Warnen Bremsen Ausweichen „WBA“
- Converters were created with the automation „GINGER“
- FEP Communication
- VEF Data Model
- Control all parts via VSCodium

```
dockeruser@fdt-c-pcs-0005: ~ X + v
dockeruser@fdt-c-pcs-0005:~$ info
#####
## Welcome to WBA AOS 0.18.0 Docker ##
#####

Available shortcuts:

info          Show this info.
ccaos         Conan create wba_aos_gateway.
cdaos         Change to ../AOS_WBA/ ../AosAwv/aos directory.
runaos        Run palma via start script.
runcodium     Launch VSCodium ready for WBA metamodel launch.
fep_agent     Launch fep_agent.
fep_control   Launch fep_control.
cm            Launch CarMaker.
novnc         Launch noVNC. Access via: http://localhost:8080/vnc.html.
killaos       Shutdown all running xterm processes.

dockeruser@fdt-c-pcs-0005:~$

Lucas@FDT-NB-0195-WSL:~$ | Lucas@FDT-NB-0195-WSL:~$ | Lucas@FDT-NB-0195-WSL:~$ |
```

Thank you!

