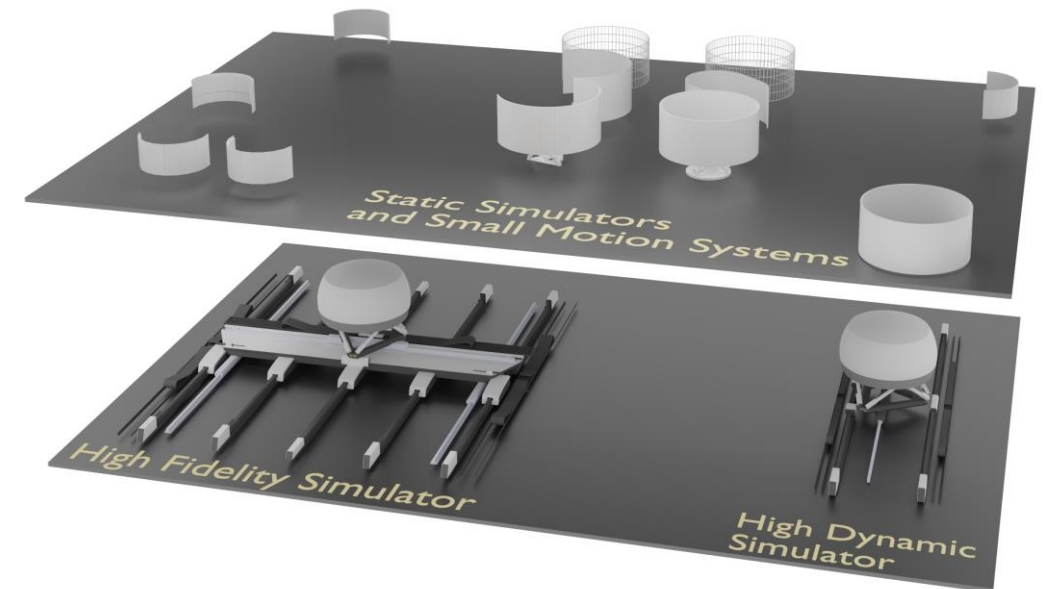# VIRTUAL WORLD GENERATION FOR BMW DRIVING SIMULATION

HUBERT CAO

# KEY FACTS - BMW DRIVING SIMULATION CENTER

- Most advanced and diversified driving simulation center in the automotive industry

- 14 simulators and usability labs

- Up to 100 study participants per day

- Ideal simulation tools for every phase of the vehicle development process - from early concept phase to final function validation

- Main use cases
  - Advanced driver assistance systems
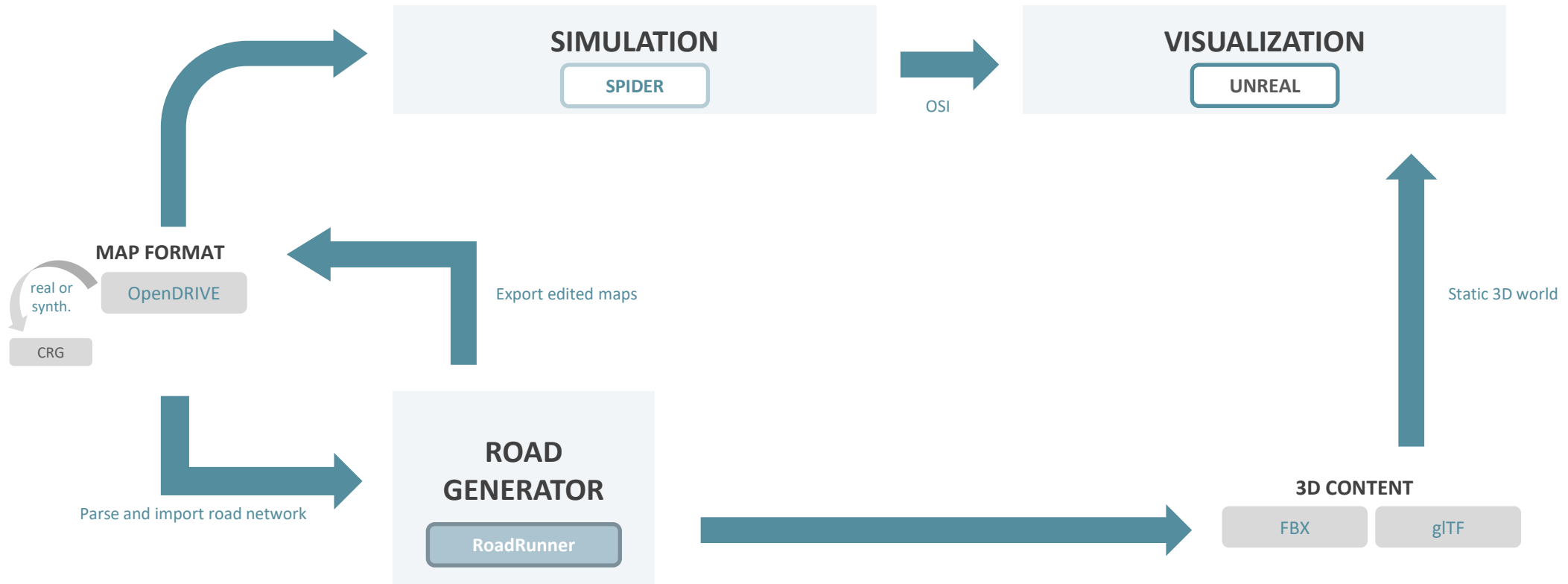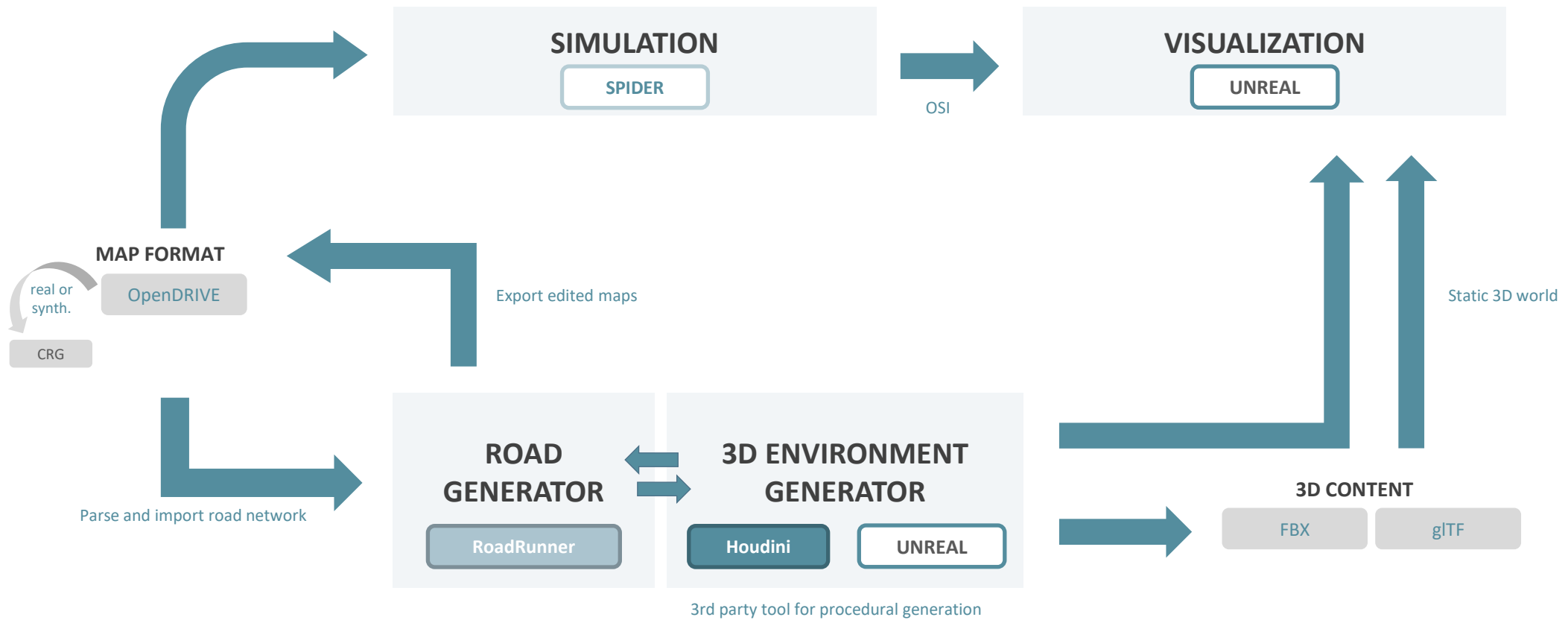  - Driving dynamics
  - UI / UX concepts



Static Simulators and Small Motion Systems

High Fidelity Simulator

High Dynamic Simulator

# BMW DRIVING SIMULATION CENTER

# SIMULATION SOFTWARE

### SIMULATION

SPIDER

→ ASAM OSI

### VISUALIZATION

UNREAL

BMW Driving Simulation Software
20+ years inhouse development
Intelligent traffic agents (vehicles, pedestrians, etc.)
Supports standards e.g. OpenDrive, OSI, OpenCRG
Uses BMW vehicle dynamic models
Interfaces to MATLAB / Simulink

Unreal Engine 5
State of the art game engine
Supports multi-cluster display systems & VR headsets
Enables high visual fidelity & performance
Provides tools to generate realistic content

# SIMULATION SOFTWARE

**SIMULATION**

SPIDER

ASAM OSI

**VISUALIZATION**

UNREAL

**MAP FORMAT**

real or synth.

OpenDRIVE

CRG

Static 3D world

**3D CONTENT**

FBX          glTF

# SIMULATION SOFTWARE



SIMULATION

SPIDER

VISUALIZATION

UNREAL

OSI

MAP FORMAT

OpenDRIVE

real or synth.

CRG

Export edited maps

Static 3D world

Parse and import road network

ROAD GENERATOR

RoadRunner

3D CONTENT

FBX

glTF

# SIMULATION SOFTWARE



**MAP FORMAT**
- OpenDRIVE
- real or synth.
- CRG

Export edited maps

Parse and import road network

**SIMULATION**
- SPIDER

OSI

**VISUALIZATION**
- UNREAL

Static 3D world

**ROAD GENERATOR**
- RoadRunner

**3D ENVIRONMENT GENERATOR**
- Houdini
- UNREAL

3rd party tool for procedural generation

**3D CONTENT**
- FBX
- glTF

# SIMULATION SOFTWARE

# USING ROADRUNNER FOR DRIVING DYNAMICS USE CASES

- OpenCRG is an ASAM open standard file format to describe high precision elevation of road surfaces

- Creation & Editing of real and synthetic road surfaces

- Very relevant for vehicle dynamics simulations

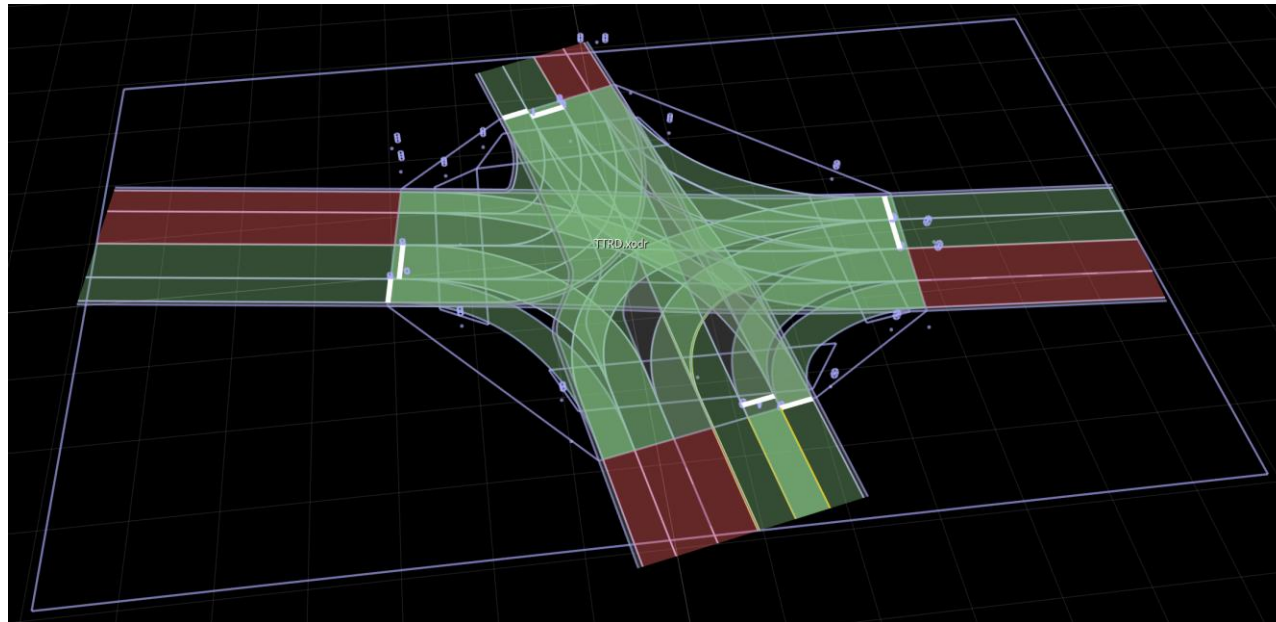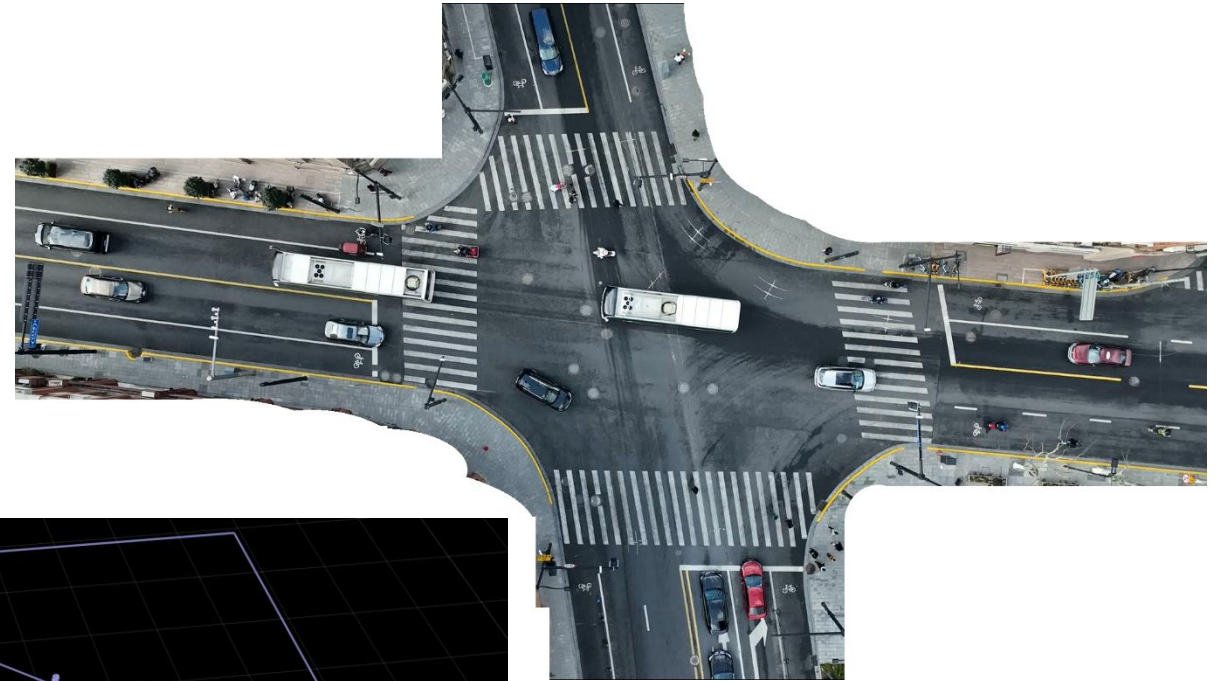- Enables faster iterations on scenarios using CRG
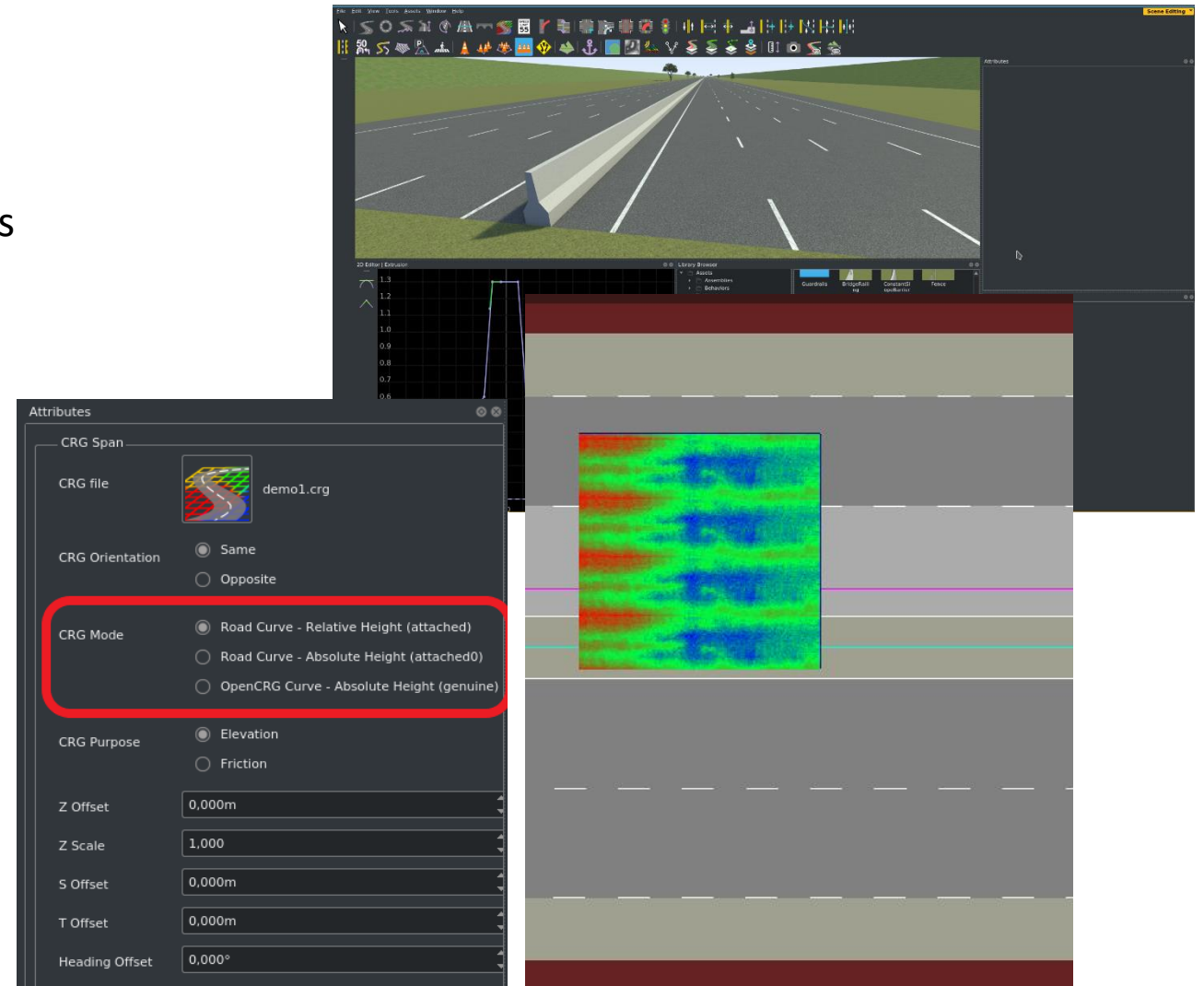
# SIMULATION SOFTWARE
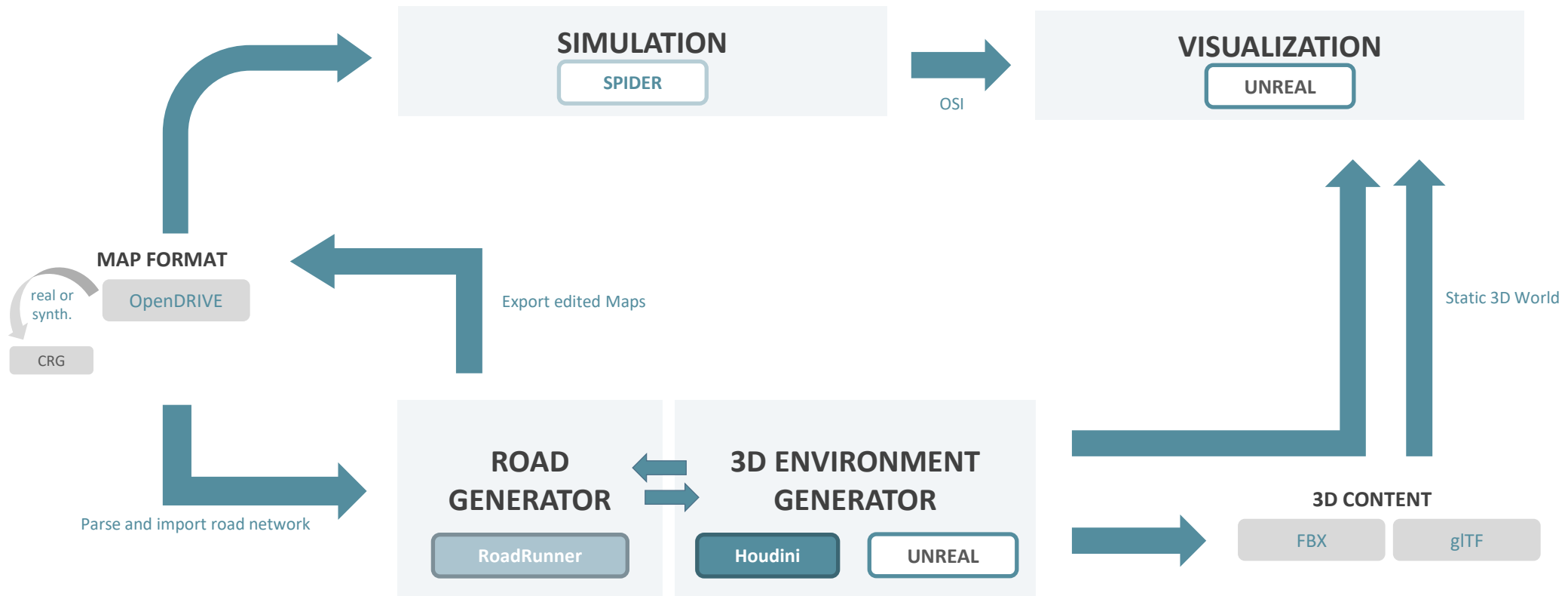
# USING ROADRUNNER TO CREATE ROAD NETWORKS

- Remodelling of real life road networks and junctions

- Export to OpenDrive for driving simulation usage

# USING ROADRUNNER TO CREATE ROAD NETWORKS

- Import of generated height maps

- Definition of area types for environment generation

- Export OpenDrive & road network geometry

- Used for special scenarios & one-shot projects
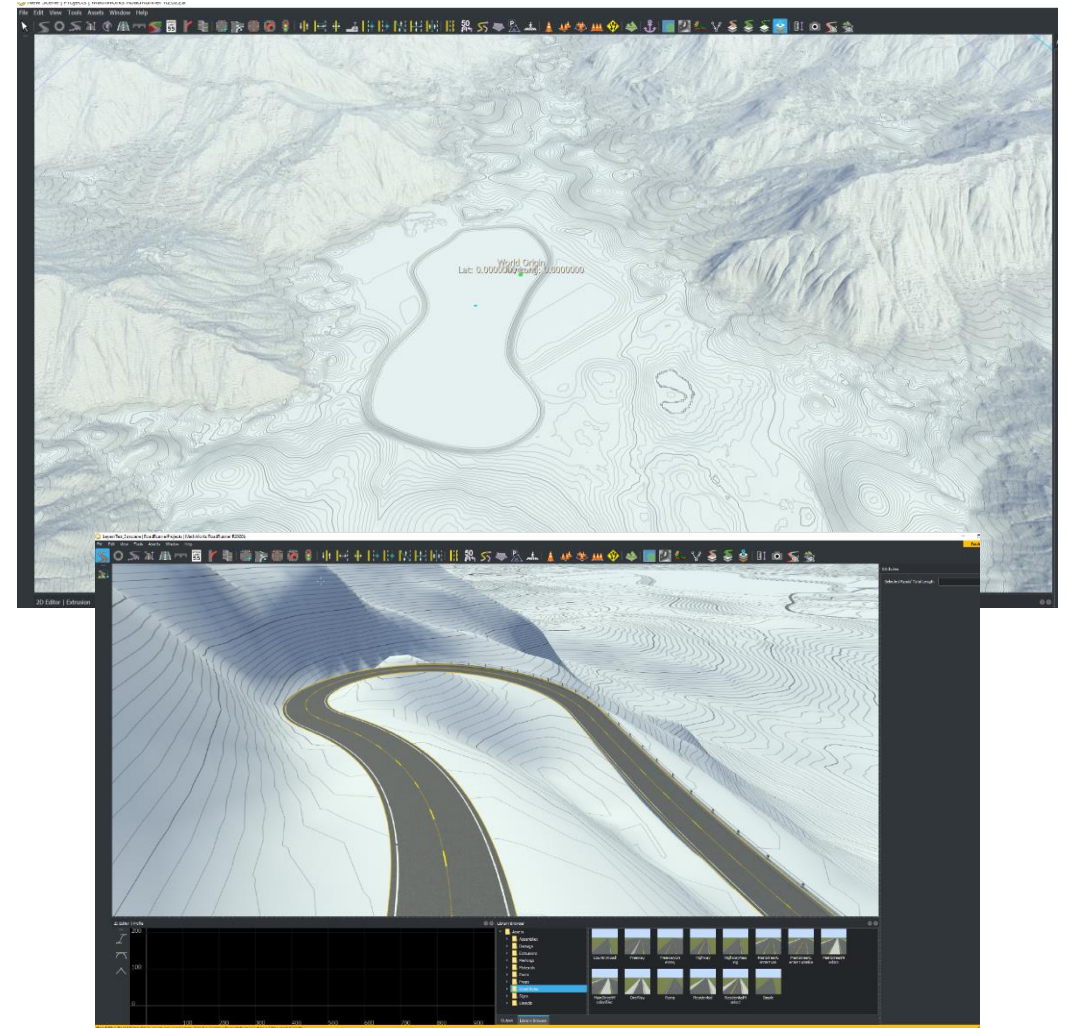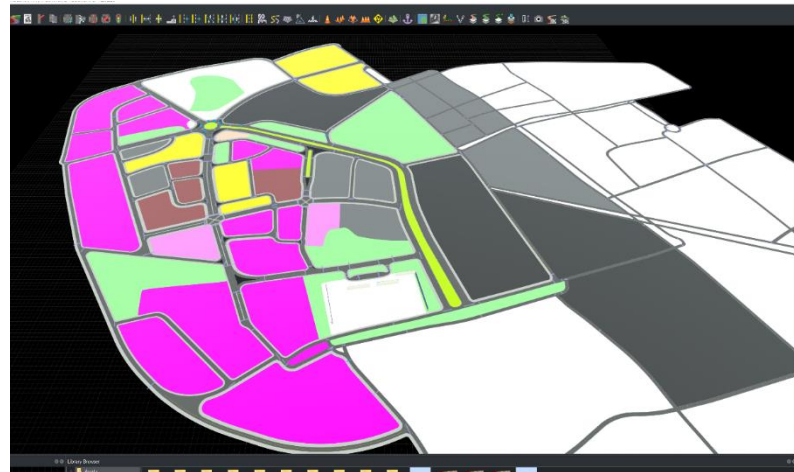
# ENVIRONMENT GENERATOR

- Generates vegetation and buildings procedurally

- Assets are spawned depending on the defined area type

- Utilizes information from the exported Mesh and OpenDrive file
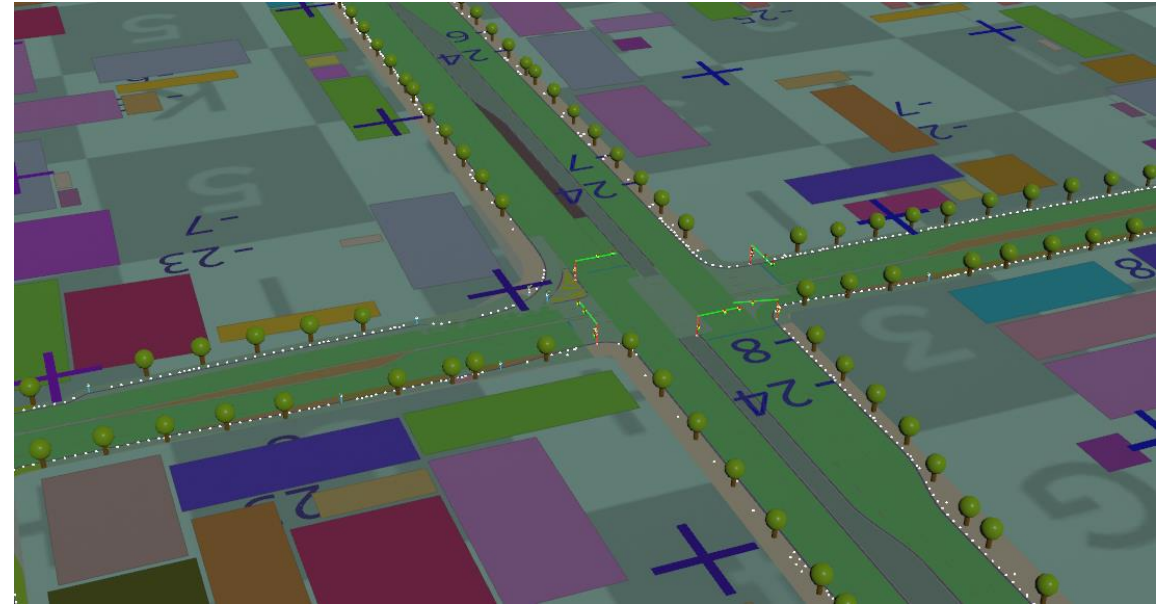
# VISUALIZATION

- Positions of the procedurally placed assets are transferred to the visualization

- High fidelity assets are automatically placed accordingly

- Road materials switched to dynamic materials with better visual quality

# CHALLENGES

- Road networks need to be modelled by hand
    - Time intensive
    - Cost intensive
    - Not scalable
- → Only feasible for special studies with long lead times

→ Script-based automated Road Generation
→ Parts of it available

- Complex tool pipeline
    - Only usable by experts
    - Multiple tools and interfaces
    - Risk of incompatibility issues

→ Procedural placement of 3D environment assets & landscape generation in RoadRunner

# ROADRUNNER @BMW DRIVING SIMULATION

- RoadRunner is used to create road networks with OpenDrive & 3D Geometry consistency

- Great OpenCRG editor with new features being developed

- Straightforward creation of simple road networks

- Modelling large road networks is time and cost intensive

- The addition of a game industry content generation pipeline is required for more sophisticated and realistic environments

THANK YOU FOR
YOUR  ATTENTION!