



# VMAD/SG1A - Scenario Abstraction Levels

Gil Amid ([Gil.Amid@Foretellix.com](mailto:Gil.Amid@Foretellix.com))  
SAFE – Autonomous Vehicle Initiative  
[avi@secureenergy.org](mailto:avi@secureenergy.org)

# Outline

- Recap: 3 levels of abstractions for scenarios
- Introduction of “Abstract Scenario”
- Discussion points

# Pegasus Scenario Abstraction Levels

Functional scenarios	Logical scenarios	Concrete scenarios
<b>Base road network:</b> Three-lane motorway in a curve, 100 km/h speed limit indicated by traffic signs	<b>Base road network:</b> Lane width [2..4] m Curve radius [0,6..0,9] km Position traffic sign [0..200] m	<b>Base road network:</b> Lane width 3 Curve radius 0,7 km Position traffic sign 150 m
<b>Stationary objects:</b> -	<b>Stationary objects:</b> -	<b>Stationary objects:</b> -
<b>Moveable objects:</b> Ego vehicle, Traffic jam; Interaction: Ego in maneuver „approaching“ on the middle lane, traffic jam moves slowly	<b>Moveable objects:</b> End of traffic jam [10..200] m Traffic jam speed [0..30] km/h Ego distance [50..300] m Ego speed [80..130] km/h	<b>Moveable objects :</b> End of traffic jam 40 m Traffic jam speed 30 km/h Ego distance 200 m Ego speed 100 km/h
<b>Environment:</b> Summer, rain	<b>Environment:</b> Temperature [10..40] °C Droplet size [20..100] µm rainfall [0,1..10] mm/h	<b>Environment:</b> Temperature 20 °C Droplet size 30 µm rainfall 2 mm/h



# VMAD Scenario Catalog – FUNCTIONAL level

- VMAD current direction is to create a scenario catalog at the functional level
- Example – China's proposal :

## 4. Tunnel

The test road consists of at least two straight lanes, and the tunnel appears at one part of that.



Figure4 Testing scenario for passing tunnel

# Introduction of an additional level – Jan-2021

- Pegasus-VVM ( a Pegasus family project ) recently published: “[Criticality Analysis for the Verification and Validation of Automated Vehicles](#)”
- The paper is introducing and discussing criticality analysis for scenarios.
- Following the requirement of this methodology, a new scenario abstraction level is being introduced: “Abstract Scenario” – a level in between “Functional Scenario” and “Logical Scenario”

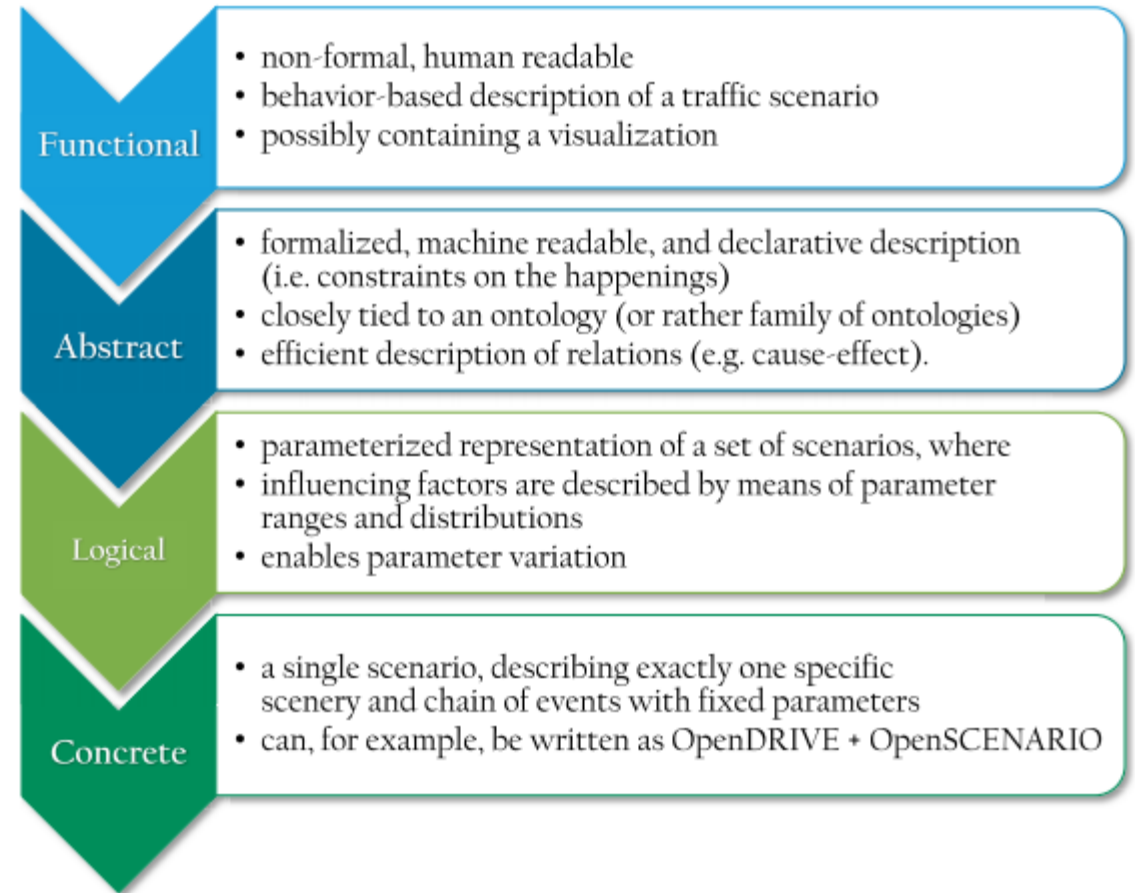


# Abstract Scenario

- “we introduce the *abstract scenario*, situated in between the functional and logical scenario with respect to the abstraction level, as depicted in Figure 14.

*Definition 13 (Abstract Scenario):* **An abstract scenario is a formalized, declarative description of a traffic scenario focusing on complex relations, particularly on causal relations.”**

- **Note: No values, no physical parameters**



**FIGURE 14.** An overview of the different qualifications of scenario description.



# Example #1: M-SDL ( Reference of OpenSCENARIO 2.0 )

- Example for a formal language specification of a high level scenario with various hazardous conditions:

```
scenario dut.right_cut_in_emergency_vehicle:  
  my_emergency_car: emergency_vehicle  
  my_road: road with:  
    keep(it.lanes>=2)  
  
do cut_in() with:  
  keep(side == right)  
  keep(road == my_road)
```

```
scenario dut.cut_in_and_Hazards: # abstract  
  my_tp: traffic_participant  
  road: road  
  do mix: # Create mixes of cut-in and various hazards  
    right_cut_in_emergency_vehicle(my_road: road)  
    my_tp.cross_road(my_road:road)  
  one_of: #one of several bad things  
    snow_storm()  
    mechanical_failure()  
  ...
```



# Example #2 – Stief:

## Scenario Overview:

" Complex Scenario " scenario is located in Germany on a Freeway .

## Layer4(Positioning and Velocity):

Following Vehicle Group #1 drives on Segment #1 :

Vehicle #1 is located on the Driving Lane #2 and drives .

Following Vehicle Group #2 drives on Segment #2 :

Ego Car #2 drives behind of the Truck #3 .

Truck #3 is located on the Driving Lane #3 and drives .

## Layer4(Maneuvers):

Phase #1 considers following maneuver sequence(s) :

Truck #3 decelerates strongly until standing .

Ego Car #2 is assisted and shall change to the nearest left lane .

Phase #2 considers following maneuver sequence(s) :

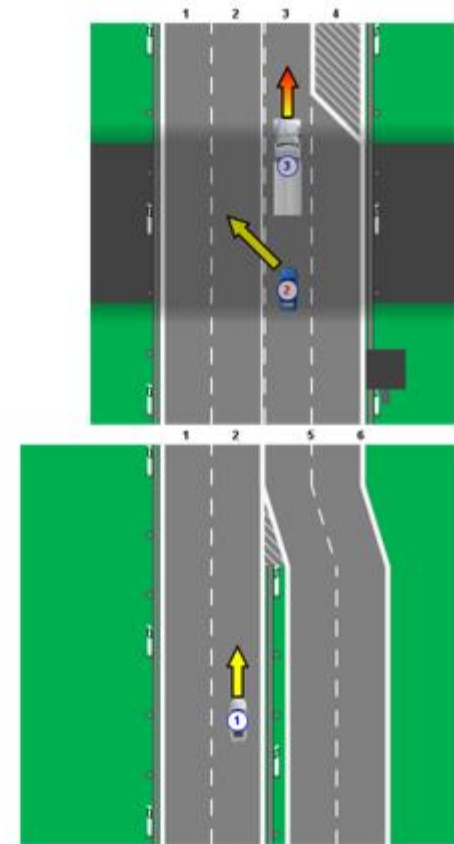
Truck #3 stands .

Ego Car #2 is assisted and shall accelerate .

Phase #3 considers following maneuver sequence(s) :

Truck #3 stands .

Ego Car #2 is assisted and shall drive .



Source: stiEF – A textual scenario description language <https://www.youtube.com/watch?v=PM82RBef5OI>





# Future Discussion Points for SG1A

- Key messages: Abstract scenarios are less ambiguous compared to Functional scenarios, and can be used to specify a more accurate intent and goal.
- Should VMAD and NATM adopt these additional definitions, and refer to them in their documents and processes? (e.g. Scenario based Virtual Testing Methods)
  - Recommendation - YES
- Should UNECE Scenario Catalog contain also abstract scenarios, or should it contain only functional level?
  - Recommendation: for now continue with Functional level, and the catalog forms, consider adding Abstract Scenario – for more accurate interpretation.

