#### 22.03.16 VVM Mid-term presentation



#### Advancing on the development of a sustainable ecosystem for Autonomous Driving safety assurance in Japan

Jacobo Antona-Makoshi, Ph.D. SAKURA project Japan Automobile Research Institute

### AD safety assurance major challenges

#### AD safety cannot be ensured with long-distance endurance driving tests alone



#### Our approach to overcome the challenges



- Structured scenarios to address root causes affecting the three subtasks of the DDT
- Qualified virtual platform including simulation of sensor weaknesses



#### Safety assurance ecosystem in Japan

#### Today's focus



Aim at a scalable simulation platform to support ADS safety development and evaluation



#### Linked scenario database & virtual platform



SIVP



\*\*\*

Scenario

DB

ALKSシナリオの仮想評価

Virtual

platform

#### Linked scenario database & virtual platform A 標識の高さ 縦断勾配の変化 Explanation Format Item -= ----Identifier for the scenario DB Version Array specify this data to A STATE な曲 占力 認識対象。 specification の距離(「 Read gammatry LA. fates LE. fates LA. fatest Landage Landage -----To store simulation results 認識対象までの距離( Results Grantante Unati Array ( d mt --------for each concrete scenario -And after LC. Cut and 111 111 Weden: Weberst Weden: Annes Uniquely identifies simulator 10.001 | 10.01 | 10 (0.01 **OpenSCENARIO** Tags Item Sid Strina execution concrete scenario Storvboard/Init/Actions/Private/Priv A P C Stores the results observed Ego initial Observer Arrav ateAction/TeleportAction/Position/L by running the simulation position [m] anePosition@s The name of the value Storvboard/Init/Actions/Private/Priv Name Strina measured by the simulator se ateAction/LongitudinalAction/Speed Eqo speed Measurements bv the String [m/s] Action/SpeedActionTarget/AbsoluteT result simulator argetSpeed@value **Test scenario** Knowledge Storyboard/Init/Actions/Private/Priv Perception Simulation 5 Data £ 3A target initial ateAction/TeleportAction/Position/L test data position[m] anePosition@s, t **Real world data** Relative Storyboard/Init/Actions/Private/Priv ateAction/LongitudinalAction/Speed speed with Action/SpeedActionTarget/AbsoluteT perception argetSpeed@value ×0 fixed target [m/s] Storyboard/Init/Actions/Private/Priv Position of ateAction/TeleportAction/Position/R the sign[m] elativeObjectPosition@ds,dt,dz ALKSシナリオの仮想評価 why Assurance Kildos for



### Scenario database





Scenario

DB

Virtual

platform

Carl Cherry Par

## Virtual platform and results management





## Virtual platform and results management

Scenario DB Virtual platform





10

#### **Summary**

- SAKURA scenario database linked to the DIVP virtual platform for AD safety development and evaluation purposes
  - Conversion from a non-deterministic (infinite) traffic system into a deterministic (finite) problem by focusing on subtasks and root causes of the AD system
  - Fully traceable and compatible with simulation platforms and results management tools
  - Gradually incorporating perception scenarios including sensor weaknesses
  - Adaptable to international regulatory, standard, and consumer testing



## Thank you! ajacobo@jari.or.jp

# My perspectives on methodologies/tool chains

- Are there similar elements and structures in scenario based testing and generation of scenarios based on SAKURA/DIVP that you also see in VVM so far?
  - Yes, plenty of them, included in shared strategies for standards (ISO3450X, TS5083, ASAM,...)
- How do you bring in uncertainties in formal test definitions?
  - For traffic disturbance scenarios, we define reasonably foreseeable ranges based on traffic data and we <u>investigate and apply different</u> <u>test generation and search-based techniques</u>
  - For perception disturbance scenarios, we decompose in root causes and physics principles of the system
- Your perspective on "reasonably foreseeable" and on " preventable"
  - <u>Reasonably foreseeable</u>
  - Preventable by a competent and careful human driver

d	
	Conferences > 2020 IEEE 23rd International @
	Incorporating safety relevance and realistic parameter combinations in test-case generation for automated driving safety assessment
	Publisher: IEEE Cite This R PDF
	Silvia Thal; Holger Znamiec; Roman Henze; Hiroki Nakamura; Hisashi Imanaga; Jacobo All A
/	Open Access Article
	Applying Heuristics to Generate Test Cases for
3 /	Automated Driving Safety Evaluation
	by 😩 Leonard Stepien <sup>1,2,*</sup> 🗢 🥥, 😫 Silvia Thal <sup>1</sup> 🔤, 😵 Roman Henze <sup>1</sup> 🖳 🎇 Hiroki Nakamura <sup>3</sup> 🖳 😵 Jacobo Antona-Makoshi <sup>3</sup> 🖳 🥵 Nobuyuki Uchida <sup>3</sup> 🖻 and 😵 Pongsathorn Raksincharoensak <sup>4</sup> 🏵 🧿
	Institute of Automotive Engineering, Technische Universitaet Braunschweig, 38106 Braunschweig, Germany     ITK Engineering GmbH 38122 Braunschweig Germany
	<ol> <li>Japan Automobile Research Institute (JARI) and SAKURA Project, Tsukuba-shi 305-0822, Japan</li> </ol>
	<sup>4</sup> Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology, Tokyo 184-8588, Japan * Author to whom correspondence should be addressed.
:2	Academic Editors: Paweł Drożdziel, Radovan Madleňák, Saugirdas Pukalskas, Drago Sever and Marcin Ślęzak
	Appl. Scl. 2021, 11(21), 10166; https://doi.org/10.3390/app112110166
	Defining Reasonably Foreseeable Parameter
	Ranges Using Real-world Traffic Data for
	Scenario-based Safety Assessment of
	Automated Vehicles
	H. Nakamura <sup>+12</sup> , H. Muslim <sup>+123</sup> , R. Kato <sup>12</sup> , S. Watanabe <sup>12</sup> , H. Nakamura <sup>12</sup> , H. Kaneko <sup>12</sup> , H. Imanaga <sup>12</sup> , J. Antona-Makoshi <sup>12</sup> , S. Kitajima <sup>12</sup> , N. Uchida <sup>12</sup> , E. Kitahara <sup>246</sup> , K. Ozawa <sup>246</sup> ,

S. Taniguchi<sup>247</sup>
<sup>1</sup> Japan Automobile Research Institute, Tsukuba, Japan
<sup>2</sup> SAKURA, projet;
<sup>2</sup> University of Tsukuba, Faculty of Engineering, Information and Systems, Tsukuba, Japan;
<sup>2</sup> Japan Automobile Manifesturers Association, ToKyo, Japan;
<sup>3</sup> Nisan Motor Co, Vickohama, Japan;
<sup>4</sup> Henda Motor Co, Nagoya, Japan



Under review

#### My opinion on what is required for harmonization

- To intensify frequency and technical depth of the related dialogue
  - Continue joint efforts in standardization (ISO3450X, TS5083, ASAM)
  - To resume face-to-face meetings

#### My proposal to VVM on what could be done in 2022/23

To clarify which VVM activities are cooperative and which competititive

 For the cooperative, establish one or two top-priority activities, define the corresponding specific aims, and get started with specific bilateral communications

