Model-Based Testing and Test Automation applied to Advanced Driver Assistance Systems Validation

MBT & Test Automation

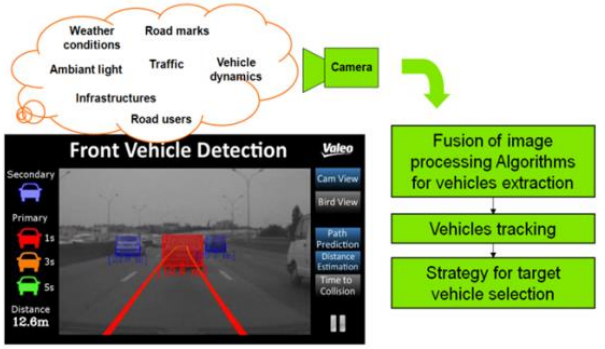
17/09/2014 – UCAAT 2014, Munich

Laurent RAFFAELLI – ALL4TEC

laurent.raffaelli@all4tec.net

Xavier ROUAH – INTEMPORA

xavier.rouah@intempora.com



Agenda

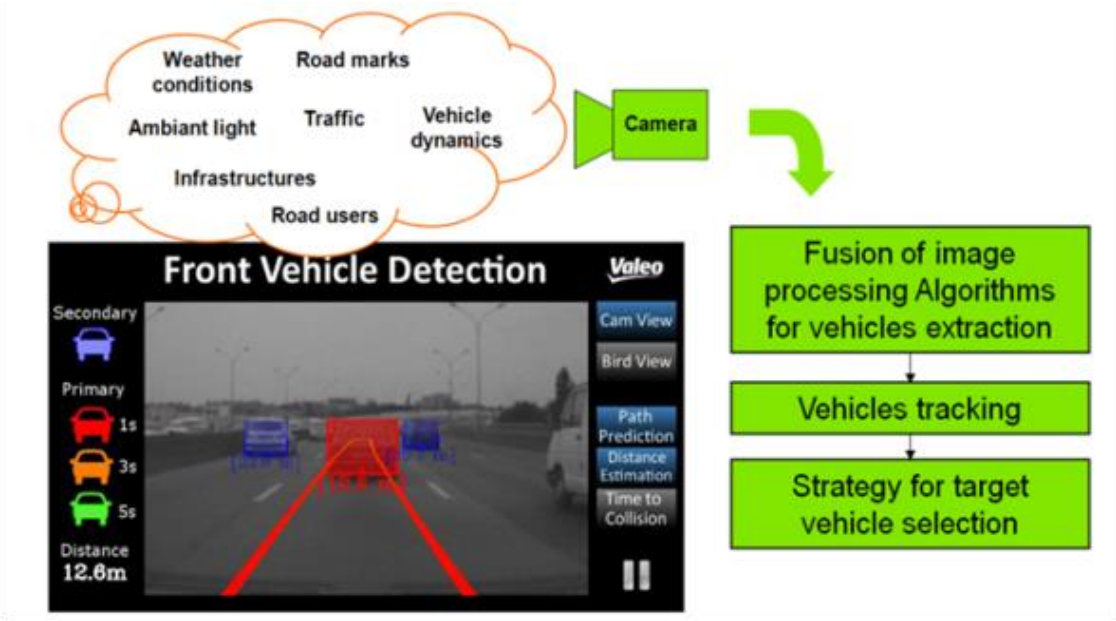
1. What is an ADAS ?
2. Why is ADAS Validation Complex ?
3. State of the Art in ADAS Validation
4. MBT for ADAS Validation
5. Test Automation for ADAS Validation
6. Expected Benefits
7. COVADEC

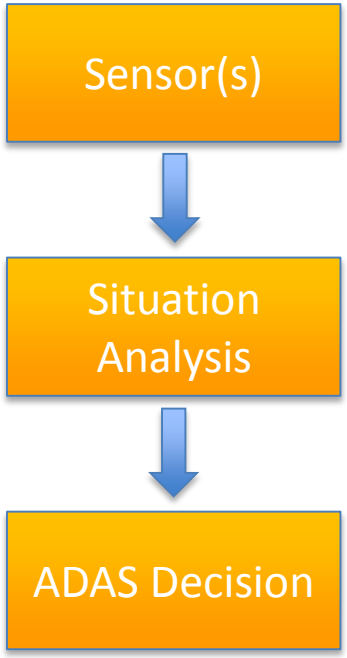
What is an ADAS ?

- ADAS: Advanced Driver Assistance Systems
  - Used in more and more vehicles to assist drivers
  - Trend: develop more autonomous vehicles with more ADAS
  - Commercial autonomous vehicles (without a human driver) could become a reality before the next decade

What is an ADAS ?

❑ ADAS Principles



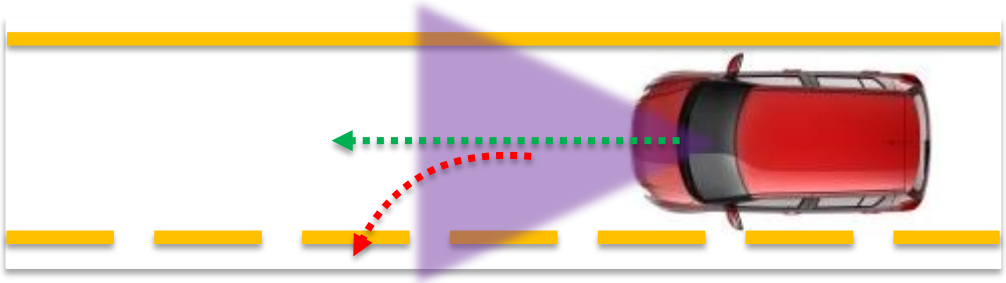


What is an ADAS ?

❑ Multiple kinds of outputs

- Example: lane detection system (LDW – LKA)

One decision: unwanted trajectory leaving the current lane



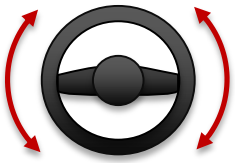
Multiple possible actions

Vibrations on drivers seat

Message on screen

Vibrations on steering wheel

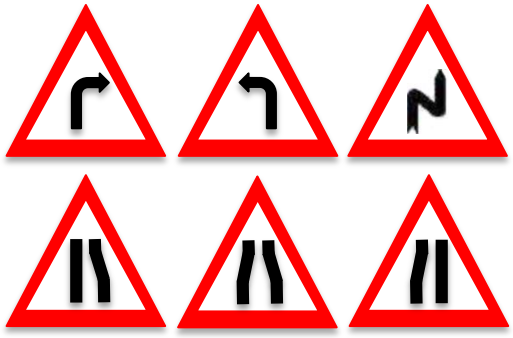
Sound signal



Torque on steering wheel

Why is ADAS Validation Complex ?

- Numerous situations may occur



Why is ADAS Validation Complex ?

- Sensitivity to context

Why is ADAS Validation Complex ?

- Standards such as ISO 26262 strongly constrain validation

ASIL	Observable Incident Rate
D	$<10^{-9}$/h
C	$<10^{-8}$/h
B	$<10^{-8}$/h
A	$<10^{-7}$/h

(from: ISO 26262-8, Table 7)

- ADAS validation should address deterministic (safety concept) and non-deterministic aspects

State of the Art in ADAS Validation

- Use of driving Tests
  - A lot of kilometers are required

For proven in use arguments and a confidence level of 70%, **480 000 000 kilometers** are required for **ASIL A**

- Use of video sequence libraries

MBT for ADAS Validation

- Two types of tests are needed to validate ADAS dependability:
  - Safety oriented
  - Reliability oriented
- Safety Oriented Test Cases:
  - Verify that the ADAS behavior is compliant with safety requirements

Models based on the following pattern:

MBT for ADAS Validation

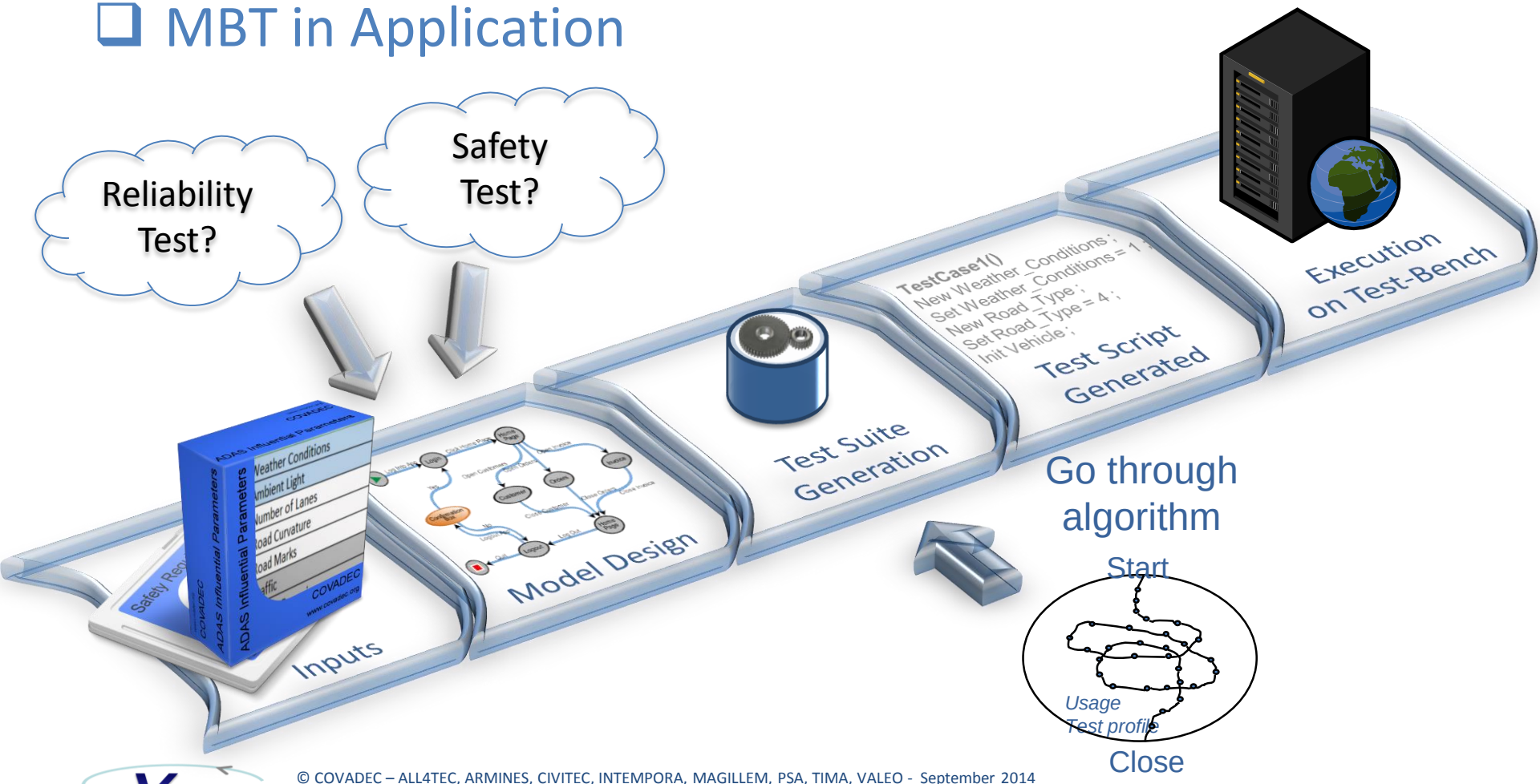
- Reliability Oriented Test Cases:
  - Verify that the ADAS bad decisions rate is lower than a threshold (reliability goal)

  Models based on the following pattern:

  - Use of Markov chains and Monte Carlo Method

MBT for ADAS Validation

❑ MBT in Application



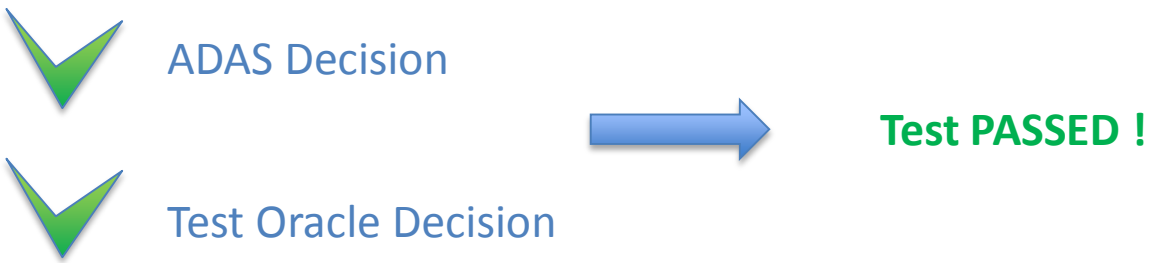
OPERATIONAL COVERAGE

Test Automation for ADAS Validation

- "Translate" test cases to sensor datasets
  - Extracted from real database
  - Generated with a simulator
- "Execute": Batch execution of ADAS against test cases
- "Interpret": Compare ADAS decisions with data from Test Oracle

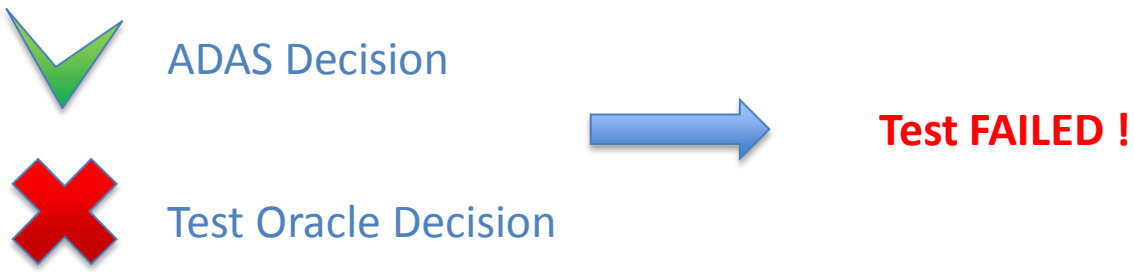
Test Automation for ADAS Validation

- Focus on Test Oracle
  - Dynamically calculate the ADAS expected behavior
  - Integrated in the test bench as a separate block
  - Use of non-video data provided by the simulator
  - Test Bench Server compares ADAS decision with the Test Oracle decision



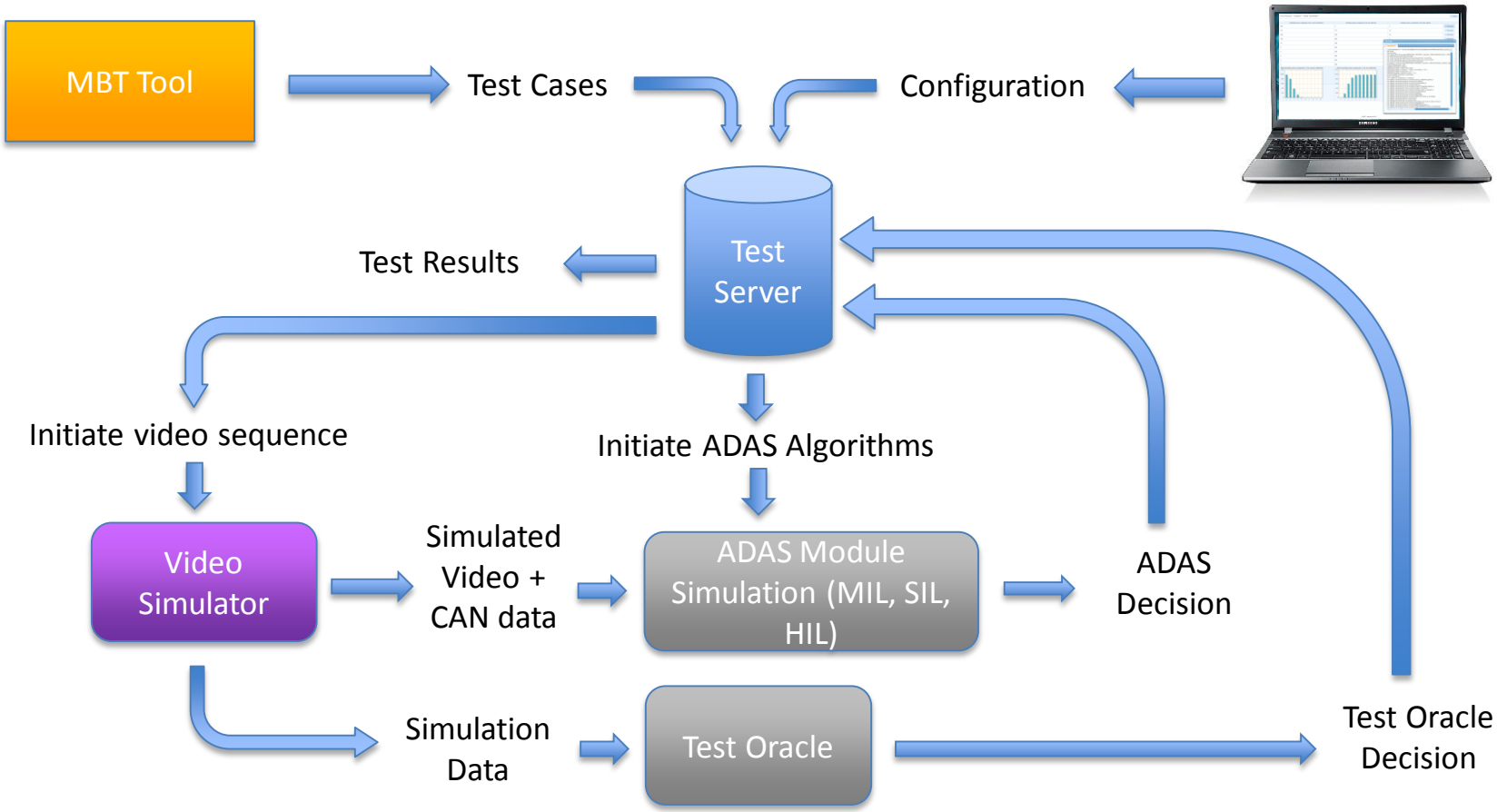
Test Automation for ADAS Validation

- Focus on Test Oracle
  - Dynamically calculate the ADAS expected behavior
  - Integrated in the test bench as a separate block
  - Use of non-video data provided by the simulator
  - Test Bench Server compares ADAS decision with the Test Oracle decision



Test Automation for ADAS Validation

❑ Test automation



Expected Benefits

- Generate test cases representative of more real driving situations
- Reduce number of test cases by improving test strategy

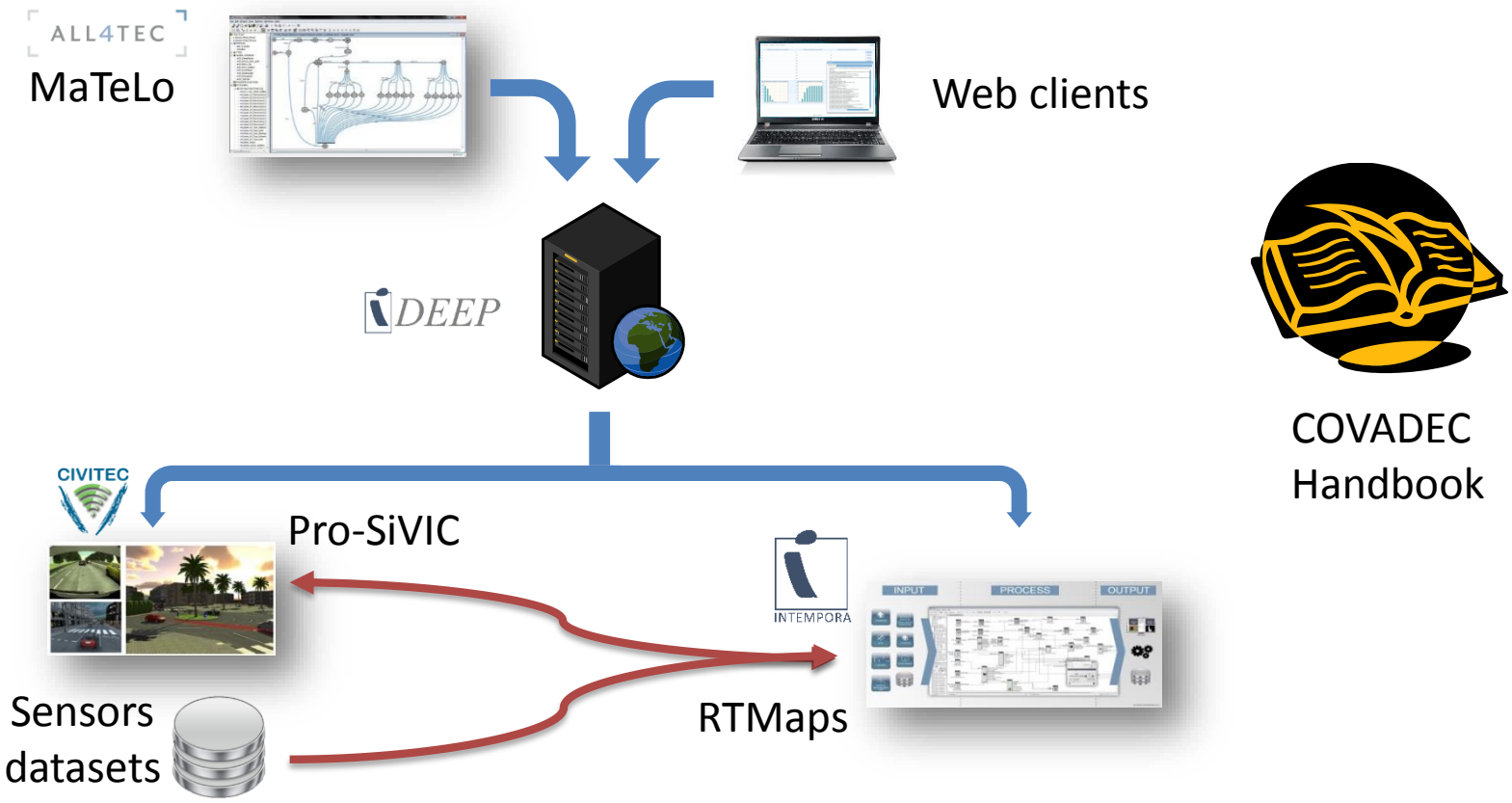
- Reduce needed driving kilometers and improve tests efficiency
- Focus on rare situations with safety concerns
- Focus on tests results, not on test execution

- No other alternatives !

COVADEC

- FUI (French Research Fund) Project from September 2013 to September 2016
- Consortium with:
  - Vehicle Manufacturer: PSA
  - Automotive OEM: VALEO
  - Laboratories: ARMINES
    TIMA
  - SME: CIVITEC
    INTEMPORA
    MAGILLEM
    ALL4TEC

❑ COVADEC Tool Suite + Handbook



To Conclude

- MBT combination with simulation makes possible to resolve many difficulties of ADAS testing: representativeness and automation
- There are still limits:
  - Representativeness of Test Models
  - Acceptability of simulated validation in Standards
- Nevertheless, provide a good support to generate and test at affordable prices a high number of rare situations
- Medium term, could become unavoidable (test of autonomous vehicles could be dangerous in real driving conditions with real road users)
- COVADEC final results and tool suite will be available in September 2016

Thank you

Questions ?

http://www.covadec.org