20th ITS World Congress Tokyo 2013

Automated Tool Chain for Evaluation of Real World Tests Developed and Applied in eCoMove and interactIVe

Tokyo, 14th – 18th October 2013

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Agenda

- interactIVe and eCoMove project
- Requirements on the design of an evaluation tool
- Process flow & General Data structure
- Minimum set of measures
- Calculation of derived measures and indicators

interactIVe - Overview

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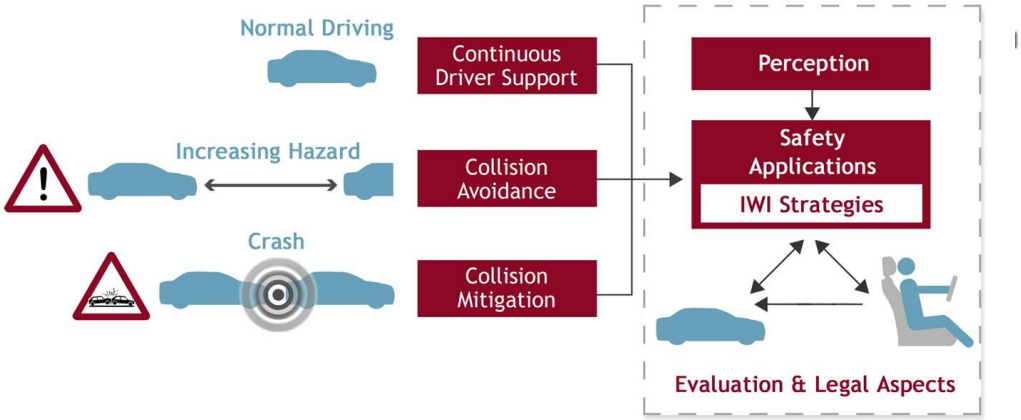
The interactIVe vision:
Accident-free traffic and active safety systems in all vehicles

- Facts:
  - Duration: 48 months (January 2010 – November 2013)
  - 29 partners of 10 countries
  - Budget: 30 Million € (Founding by the European Commission: 17 Million €)
- interactIVe systems:
  - SECONDS (Safety enhancement through continuous driver support)
  - INCA (Integrated collision avoidance and vehicle path control)
  - EMIC (Cost-efficient emergency intervention for collision mitigation)



interactive – Demonstrator vehicles

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SECONDS

- Continuous Support
- Curve Speed Control
- Enhanced Dynamic Pass Predictor
- Safe Cruise

INCA

- Lane Change Collis. Avoid.
- Oncoming Vehicle Collis. Avoidance/Mitigation
- Rear End Collis. Avoidance
- Side Impact Avoidance
- Run-off Road Prevention

EMIC

- Emergency Steer Assist
- Collision Mitigation







eCoMove - Overview

Cooperative Mobility Systems and Services for Energy Efficiency

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General facts:

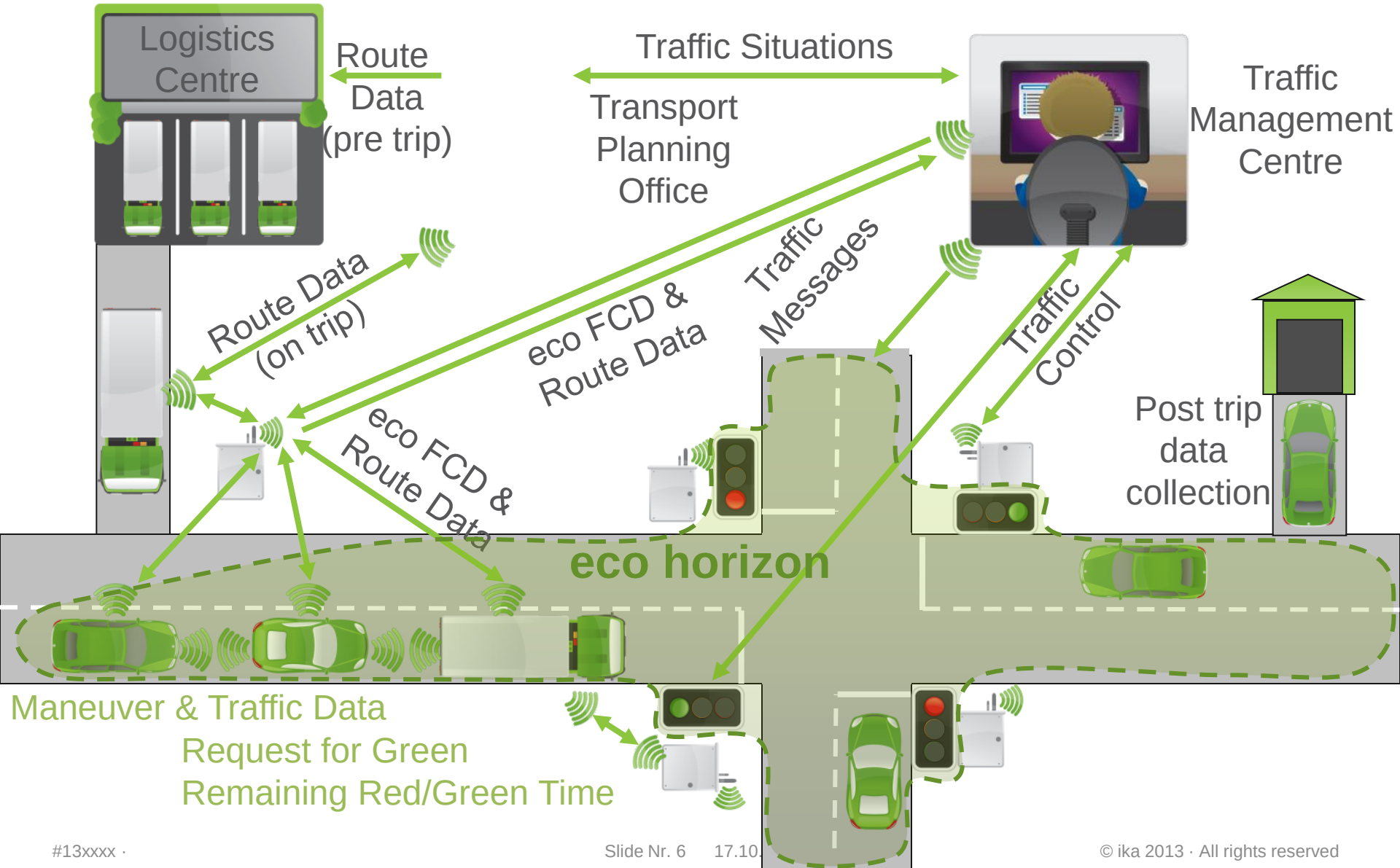
- Duration: 44 months (March 2010 to November 2013)
- 31 partners from 10 countries
- Budget: 30 Million € (Funding by the European Commission: 17 Million €)

Project aim:

To develop a **combination of cooperative systems and tools** using V2V and V2I communication to help:

- drivers sustainably eliminate unnecessary fuel consumption;
- fleet managers manage their vehicles more economically and promote eco-driving through feedback & incentives;
- road operators balance traffic flows in the most energy efficient way.

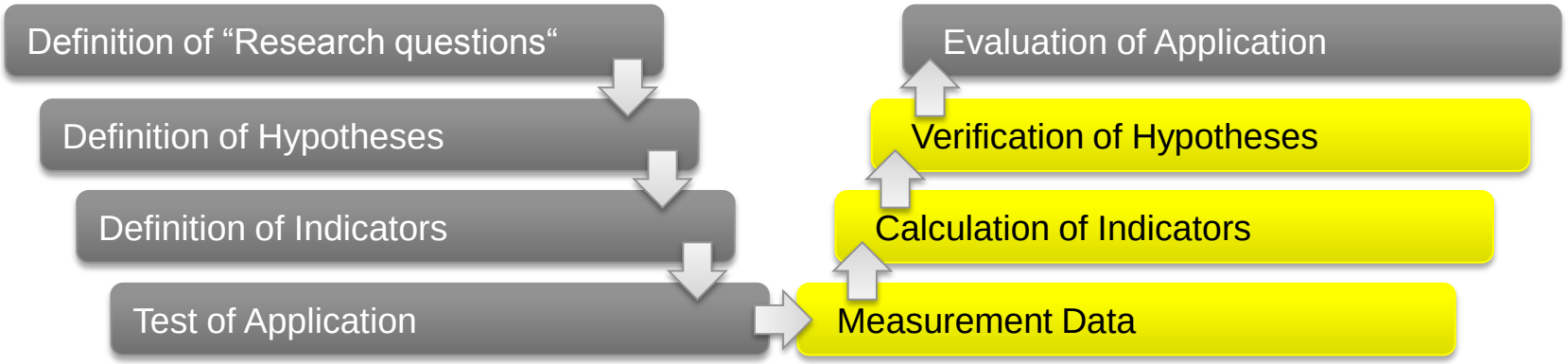
eCoMove - cooperative network



Evaluation Methodology

- Although the scope of both projects and also the test design is different, the main steps for the evaluation of the test data are common
- Following scientific approach of evaluation of test data, as for example proposed by the FESTA or PReVAL methodology

- Step 0: System and function description
- Step 1: Expected impact and hypotheses
- Step 2: Test scenario definition
- Step 3: Evaluation method selection
- Step 4: Measurement plan
- Step 5: Test execution and analysis



Why is a tool needed?

- Test and evaluation amount in interactIVe
  - 11 different functions in 7 demonstrator vehicles
  - Over 900 test runs of 8 different conflict types (e.g. rear-end)
  - 30 general hypotheses (relevant for all functions) and 63 specific hypotheses
- Test and evaluation amount in eCoMove
  - Simulations to evaluate the impact of traffic management strategies
  - Driving simulator studies
  - Test runs in the cooperative network of the City of Helmond with 4 passenger cars and 2 trucks

Automated evaluation is necessary!

Requirements on the design of an evaluation tool

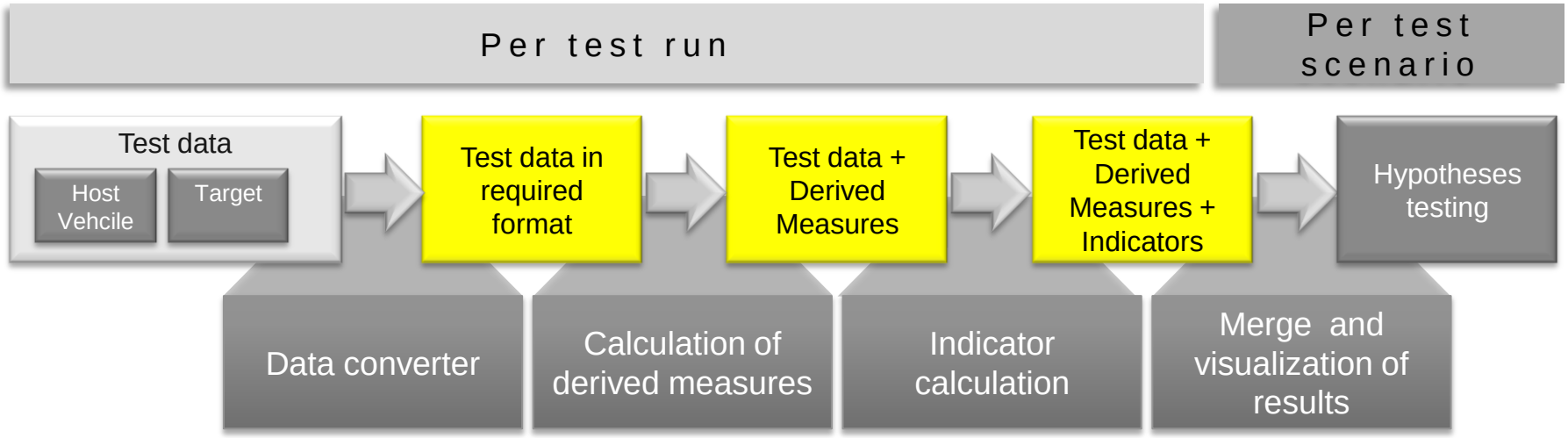
- Automated handling of test data puts several requirements on the tools to be developed.

- Especially the usage of the data structure within both projects must be defined carefully.

- The following requirements result from various discussions with the validation experts of the two projects eCoMove and interactIVe:
  - Flexibility with respect to data format of logged data
  - Flexibility with respect to measures considered and indicators derived
  - High processing performance
  - Automated and fast processing of huge amounts of test data
  - Automatic plotting of relevant data and storage of statistical data
  - Storage of indicators without connection of confidential data

Process flow & General Data structure

- Evaluation tool is subdivided into different modules



- Evaluation tool is implemented in MATLAB

- The structure clusters logged data as well as derived data in four main categories, which are:
  - **General:** includes a description of the test case
  - **Signal:** includes all logged signals of the test run
  - **DerivedMeasures:** includes all base on the signals calculated derived measures
  - **Indicators:** includes all based on the signals and derived measures calculated indicators

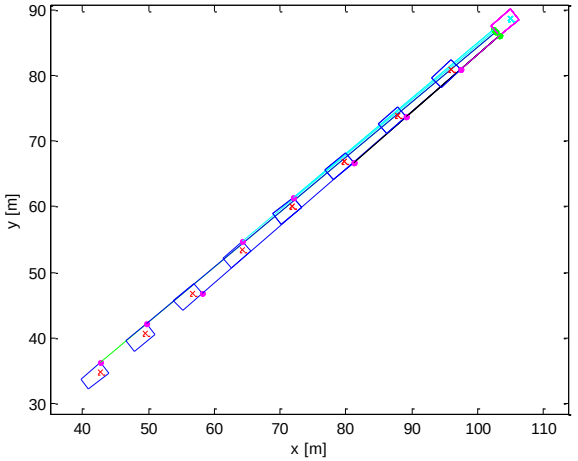
Minimum set of measures

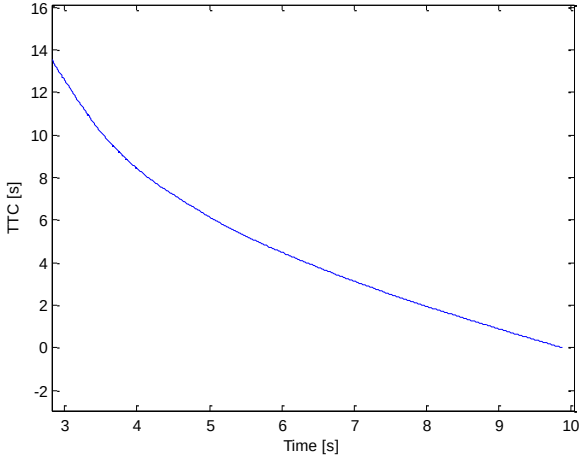
- For the evaluation a standard set of measures to be logged in the test runs has been agreed

Measurement Name	Unit or data format	Logging frequency	eCoMove	interactIve
Examples of common measures				
Vehicle movement related measures				
Vehicle speed	km/h	10 Hz	x	x
Longitudinal acceleration	m/s^2	10 Hz	x	x
Lateral acceleration	m/s^2	10 Hz	x	x
GPS position (lat /long)	°	10 Hz	x	x
Distance driven	m	10 Hz	x	x
Driver input related measures				
Gas pedal position	% [0 (= not pressed) to 100 (=fully pressed)]	10 Hz	x	x
Brake pedal position or status	% [0 (= not pressed) to 100 (=fully pressed)]	10 Hz	x	x
Gear usage	Integer representing different stati	Event	x	x
Function related measures				
System ON or OFF	Integer representing different stati	Event	x	x
Engine related measures				
Engine speed	1/min	10 Hz	x	x
Target object related measures				
Distance to vehicle in front	m	10 Hz	x	x
Absolute velocity of vehicle in front	m/s	10 Hz	x	x
Examples of project specific measures				
Vehicle air conditioning status: on / off	Byte representation	Event	x	
windows status: open /close	Byte representation	Event	x	
Accumulated Fuel consumption per vehicle	litres	10 Hz	x	
Clutch position or status	% [0 (= not pressed) to 100 (=fully pressed)]	Event	x	
Engine torque	Nm	10 Hz	x	
Trip Active: to identify the duration of a trip (to exclude standstills and pauses)	Integer representing different stati	Event	x	
Status Brake Light	Byte representation	10 Hz		x
Distance to lane marking	m	10 Hz		x
Yaw Rate	Rad /s	10 Hz		x
Steering wheel angle	°	10 Hz		x
…				

Calculation of derived measures and indicators

- Derived measures
  - Derived measures are signals, which cannot be directly obtained from the measurement files, because the signals are not available
  - Examples TTC, TLC
- Indicators
  - Indicators are quantitative or qualitative single values which characterise the test run
  - Indicators are required in order to test the hypothesis and must be chosen according to the analysed hypothesis
  - Examples: Minimum TTC, Average fuel consumption
- Calculation scripts for derived measures and indicators are available in a library and can be chosen according to the evaluation question





Implementation of tool

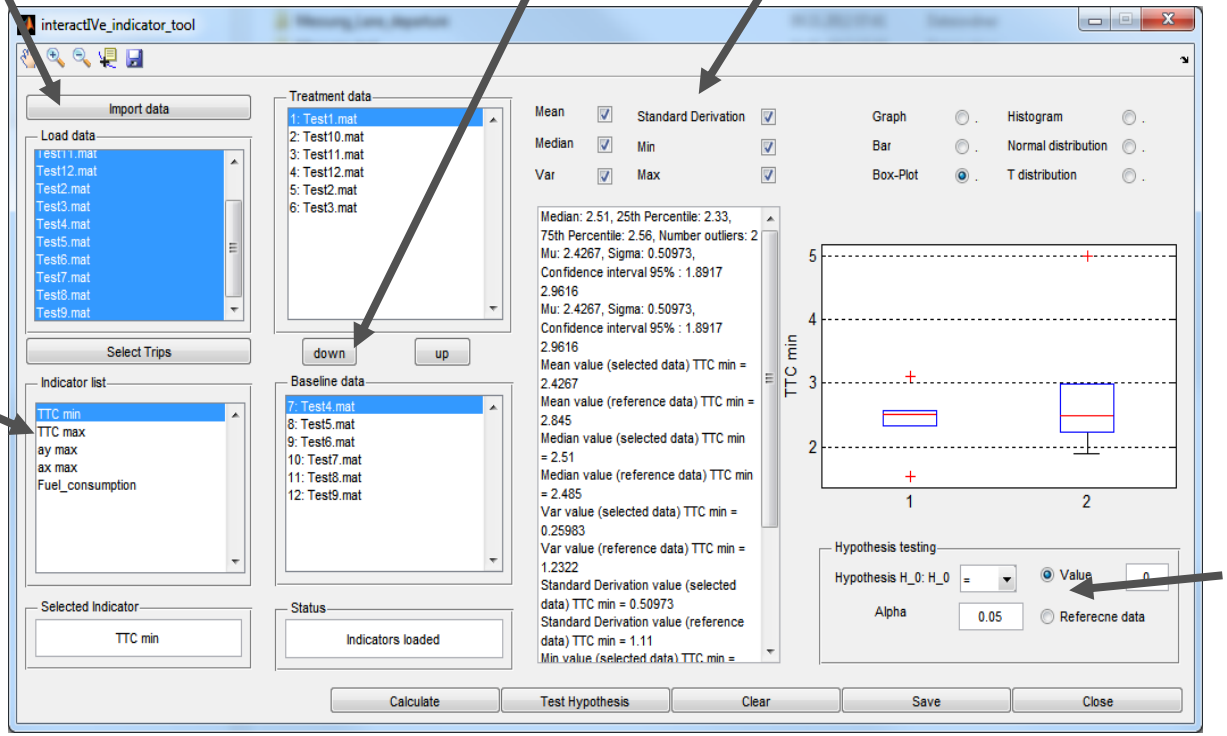
Hypotheses Testing Tool (interactIVe)

Select values to be calculated

Select test runs (with indicators)

Divide test data in treatment and baseline

Select relevant indicator



Values for hypothesis testing

Conclusion

- Automated Tool Chain for Evaluation of Real World Tests
- Applied in two European projects interactIVe and eCoMove
- Common data structure for the evaluation in both project
- Tool implemented in MATLAB
- Library for indicator and derived measure calculation scripts

Contact

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