



PORSCHE

Verification of Variants in the Development of Vehicle Dynamics Control Systems using CarMaker for Simulink

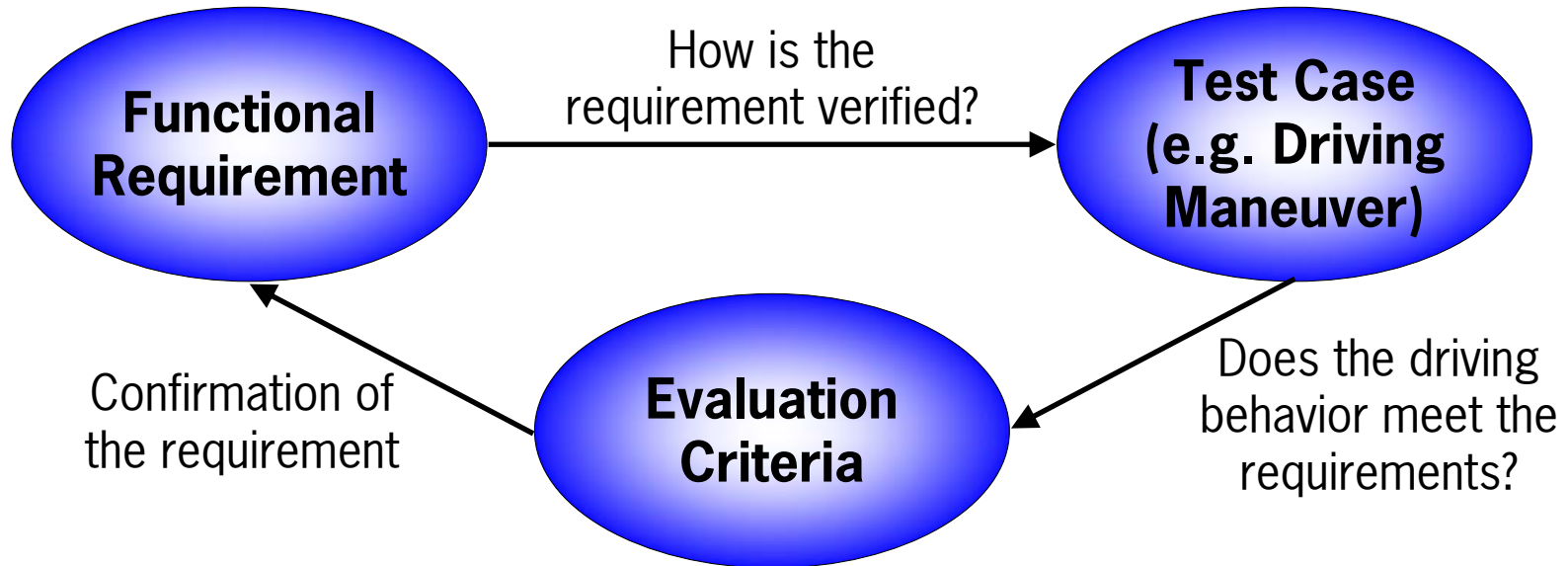
Development of Porsche Stability Management (PSM)

Contents of Presentation

- 1) Motivation for Verification of Variants using Simulation
- 2) Verification of Variants in the Past & the Future
- 3) Developed Tool Chain in Cooperation with IPG
- 4) Further Application of Tool Chain
- 5) Summary

Motivation

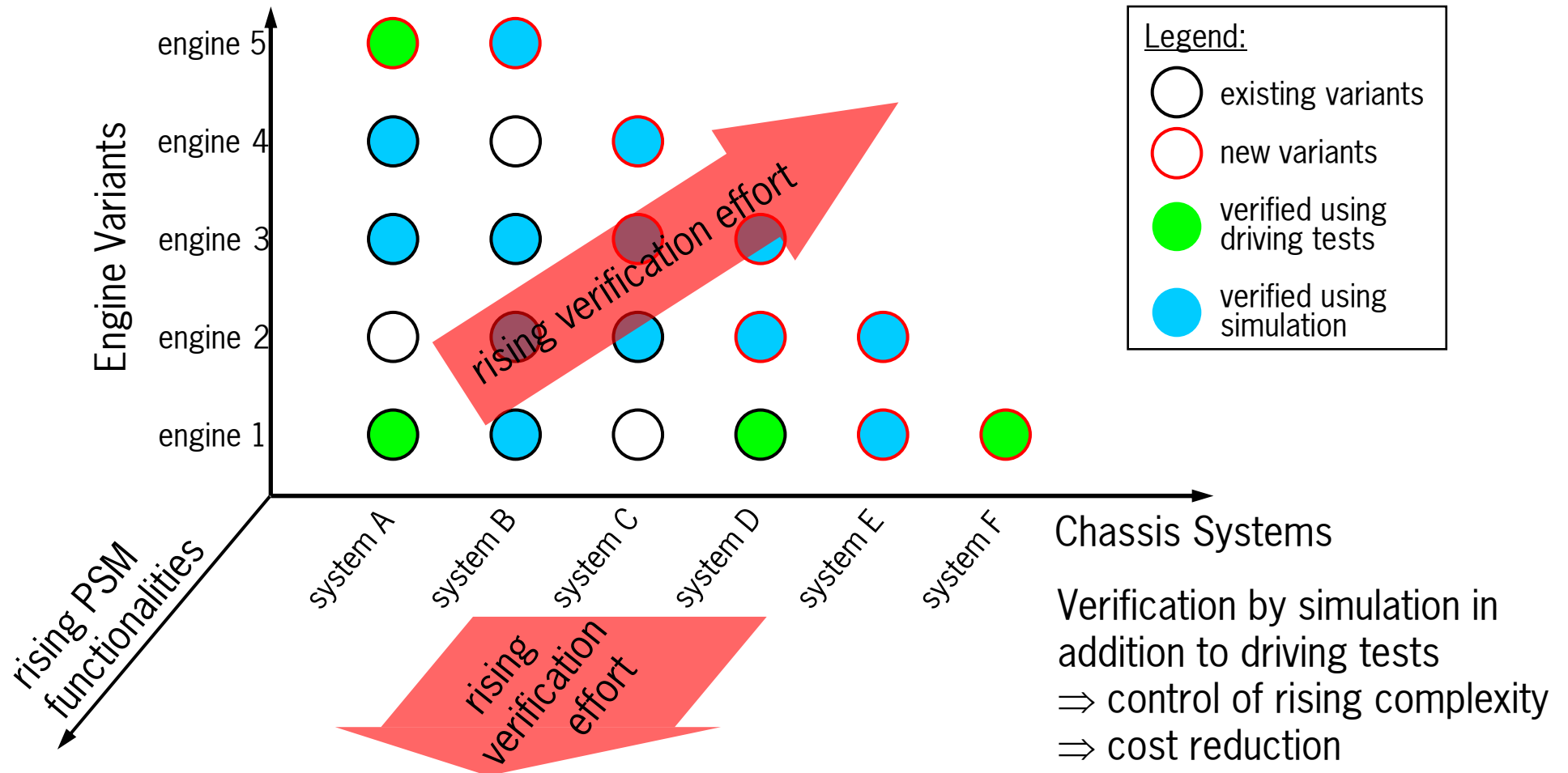
Relationship between Requirements, Test Cases and Evaluation



Aim: No Requirement without Verification

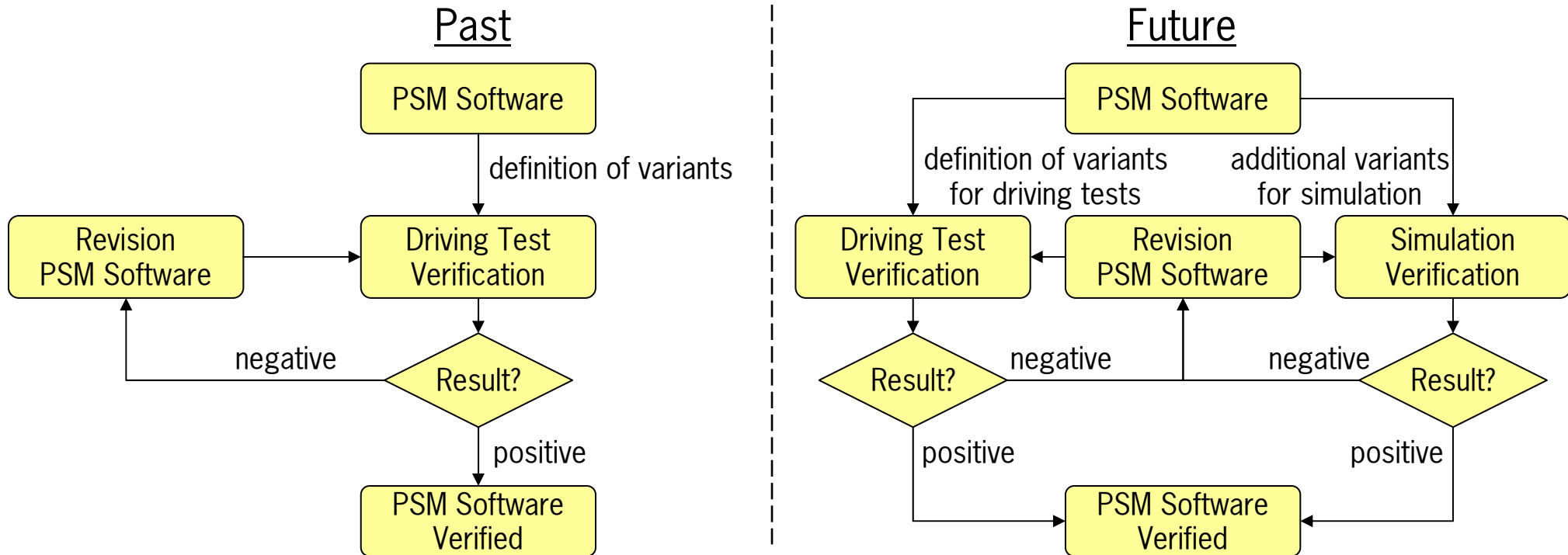
Motivation

Rising Effort regarding Verification



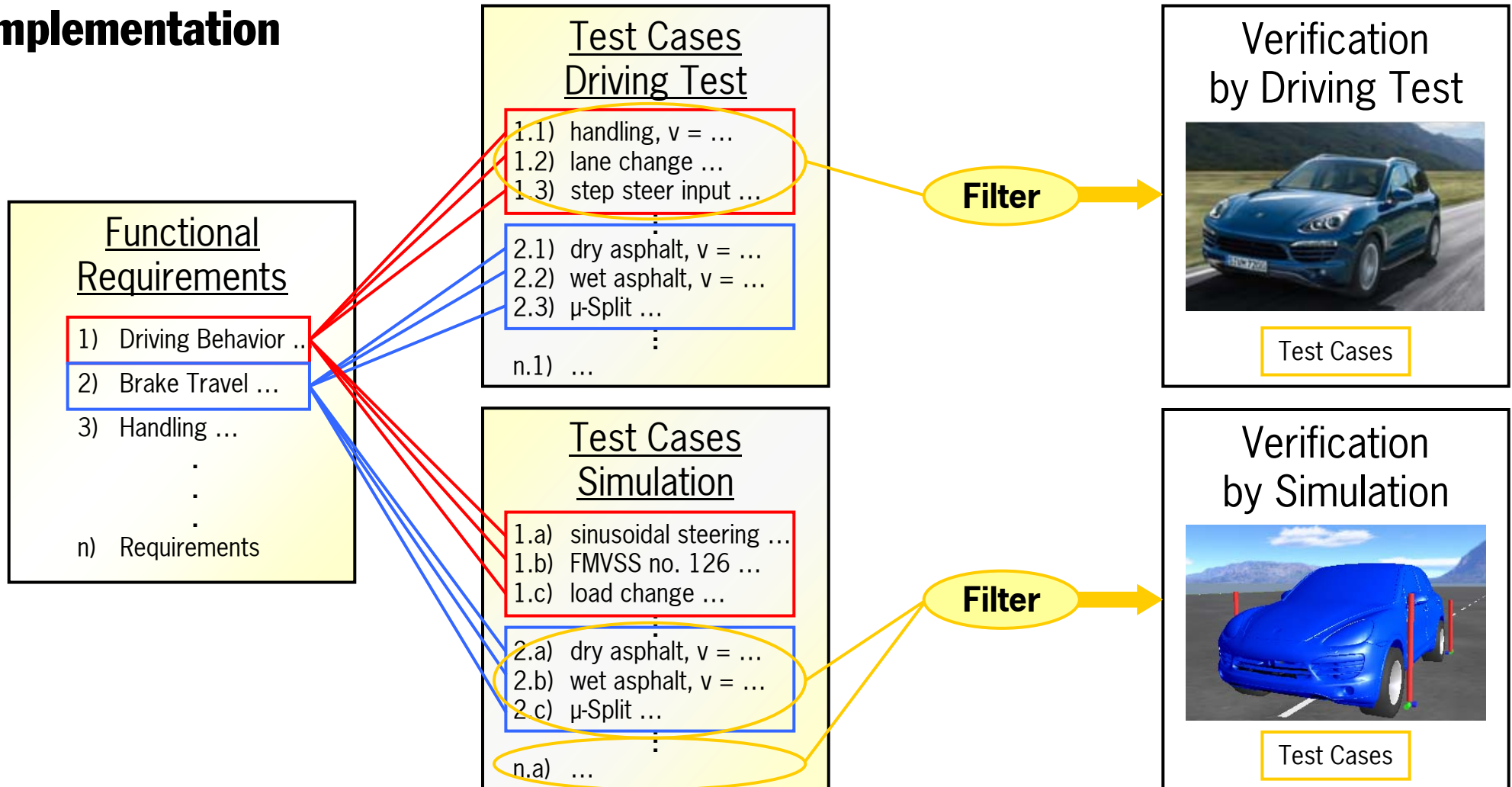
Verification of Variants in the Past & the Future

Schematic Process



Verification of Variants in the Past & the Future

Implementation



Developed Tool Chain in Cooperation with IPG

Overview

Data Bases

Test Setup

Simulation

Evaluation

Report

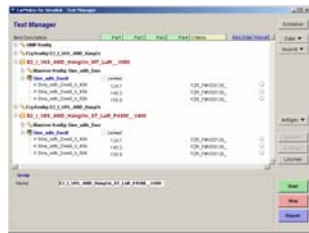
Vehicle Config.

Maneuver

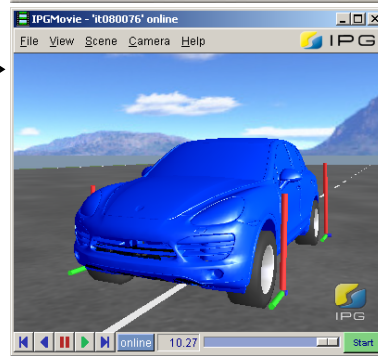
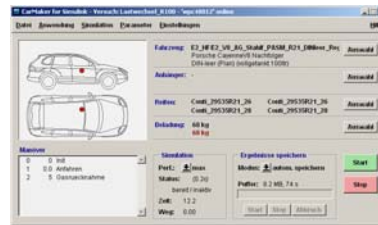
Eval. Criteria

Requirements

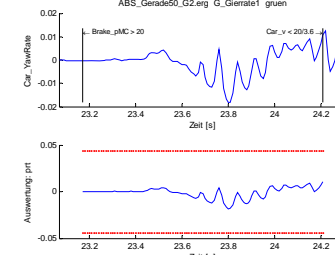
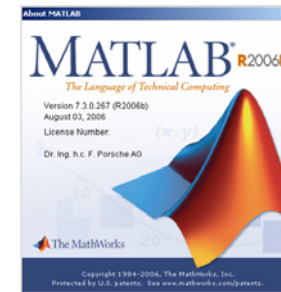
DOORS



CarMaker for Simulink
TestManager



CarMaker for Simulink



Matlab

Simulation Report			
Standardabweichung	Prozentile	Prozentile	Prozentile
Manöver: PSM_ABS_Gerade			
ABS_Gerade_01	Brake_pMC	20	20
ABS_Gerade_02	Brake_pMC	20	20
ABS_Gerade_03	Brake_pMC	20	20
ABS_Gerade_04	Brake_pMC	20	20
ABS_Gerade_05	Brake_pMC	20	20
ABS_Gerade_06	Brake_pMC	20	20
ABS_Gerade_07	Brake_pMC	20	20
ABS_Gerade_08	Brake_pMC	20	20
ABS_Gerade_09	Brake_pMC	20	20
ABS_Gerade_10	Brake_pMC	20	20
ABS_Gerade_11	Brake_pMC	20	20
ABS_Gerade_12	Brake_pMC	20	20
ABS_Gerade_13	Brake_pMC	20	20
ABS_Gerade_14	Brake_pMC	20	20
ABS_Gerade_15	Brake_pMC	20	20
ABS_Gerade_16	Brake_pMC	20	20
ABS_Gerade_17	Brake_pMC	20	20
ABS_Gerade_18	Brake_pMC	20	20
ABS_Gerade_19	Brake_pMC	20	20
ABS_Gerade_20	Brake_pMC	20	20

HTML

Data flow between the tools is managed by TestManager extensions developed by IPG for Porsche

Developed Tool Chain in Cooperation with IPG Data Bases in Requirements Management Software DOORS

e.g. Vehicle Configuration:

Spez_Fzg_Model	Exgoerz_Spez_Fzg	Exportauswahl	FzgMdl_Ordner	Reifen_VA	Reifen_HA	Schafter_PSM	Schafter_Sport	Mzus	PosMzusX	PosMzusY	PosMzusZ	MTMzus	Matlab_Expressions
E2 I VES 4WD_HangOn AT Stabil passiv	passiv konventionell offen OG_18_cp38.60 OG_18_cp18.99 330	ja	VMP	295_35R21 _LATITUDE_SPORT_N1_ 2b6_XY	295_35R21 _LATITUDE_SPORT_N1_2b6 _XY	0	0	0.000000	0.000000	0.000000	0.000000	0.000000	
E2 I VES 4WD_HangOn AT Stabil PASM	PASM konventionell offen OG_18_cp38.60 OG_18_cp18.99 330	ja	VMP	295_35R21 _LATITUDE_SPORT_N1_ 2b6_XY	295_35R21 _LATITUDE_SPORT_N1_2b6 _XY	0	0	0.000000	0.000000	0.000000	0.000000	0.000000	

definition drivetrain & chassis systems

definition of tire models

switches chassis systems

definition of additional mass

optional Matlab expression

e.g. Maneuver Parameters:

Beschreibung	Export_Clu	Objekt_Kategorie	Para1	Para2	Para3	Para4	Para5	Para6	Para7	Para8	Para9	Verlinkte_Kriterien
2 Funktionen	Header	Kommentar										
2.7 ABS	Header	Kommentar										
2.7.1 Voll-/Teilbremsung geradeaus	Header	Kommentar										
BremsGerade_OL	Header	TestRun										
ViMP/ABS	Header	TestRun_Ordner										
BremsGerade_OL	Header	Output_Pfad										
Parameter-Bezeichnung	Header	Parameter_Bezeichnung	vVeh	AppLen	pBrake	tpBrake	Declutch	Gear	Mue			
Parameter-Kategorie	Header	Parameter_Kategorie	NValue+	NValue+	NValue+	NValue+	NValue+	NValue+	NValue+			
BremsGerade_OL_v100_Br60_dtBr02_Kup1_Gang3_Mue02		Simulations_Name	100	140	0.6	0.2	1	3	0.2			MLExp

parameter description used in CarMaker TestRun

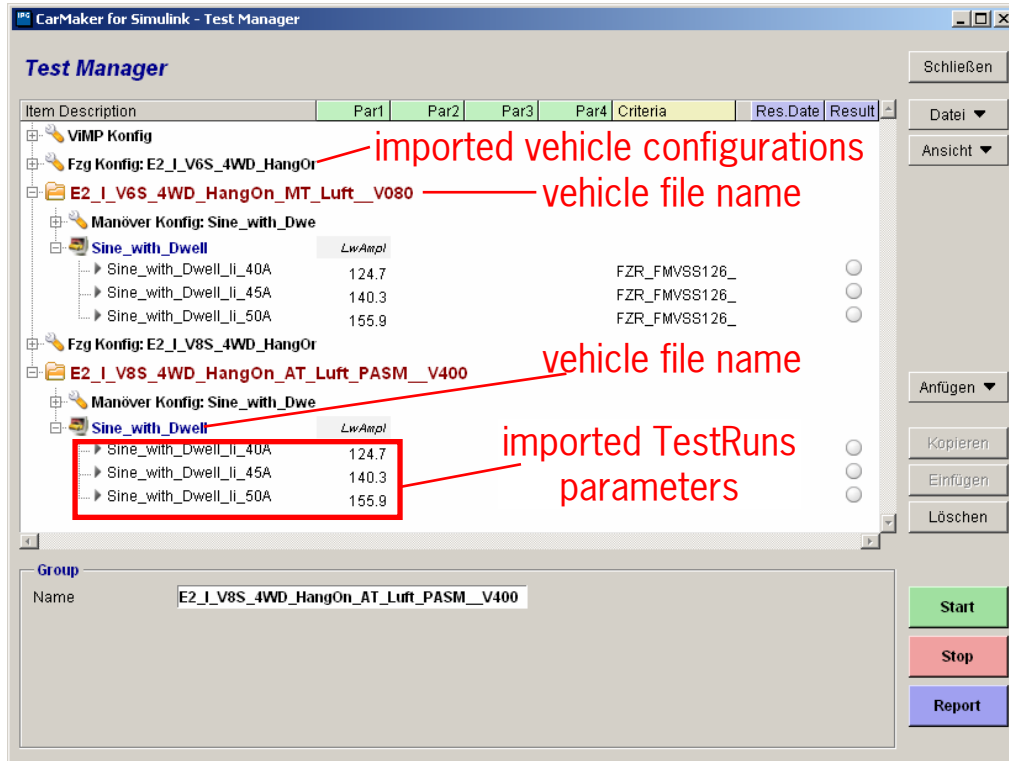
parameter values

linked criteria to evaluate this maneuver

optional Matlab expression

Export of data base contents in xml-format based on Requirements Interchange Format (RIF)

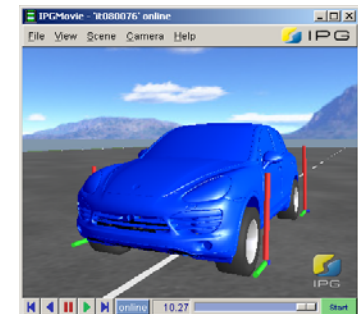
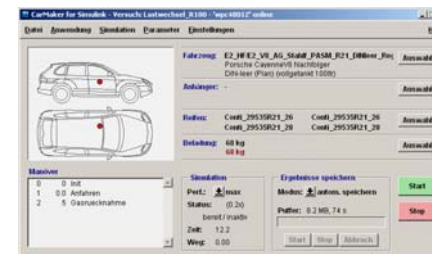
Developed Tool Chain in Cooperation with IPG Test Setup and Simulation



- Composition of a user defined test-series using TestManager with Porsche-specific features
- Import of vehicle-, maneuver- and criteria-parameters from data bases
- Further restriction of selection possible

Automated simulation of test-series in CarMaker; selection between the following modes:

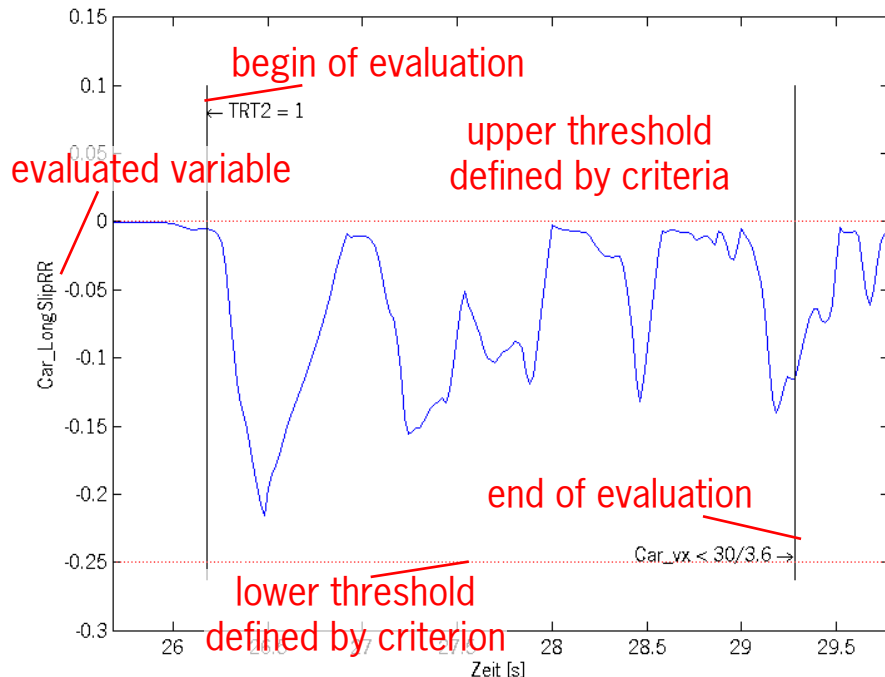
- Simulation and evaluation
- Simulation only
- Evaluation only (previous simulation results necessary)



Developed Tool Chain in Cooperation with IPG

Evaluation and Test Report

- Evaluation in Matlab using parameters from data base import
- graphical display of evaluation results for every criterion



Report ViMP Auswertung

Globale Informationen
 Letzte Änderung: Mon 09. Nov 2009, 17:15:23
 SL-Modell: Reglerverbund_E2
 Weitere Info: LogTS.bt

additional information

name of vehicle model
 Fahrzeug: E2_I_V8S_4WD_HangOn_AT_Luft_PASM_V400

TestRun name
 Manöver: BremsGerade_OL

Simulationname	Ampelstatus	Kriterium	Datum
BremsGerade_OL_v50_Br30_dBr02_Kup1_Gang2_Mue02	grün	ABS_Lambda_VL_G_OptBereich	Mon 09. Nov 2009, 17:15:23
BremsGerade_OL_v50_Br30_dBr02_Kup1_Gang2_Mue02	grün	ABS_Lambda_VR_G_OptBereich	Mon 09. Nov 2009, 17:15:23

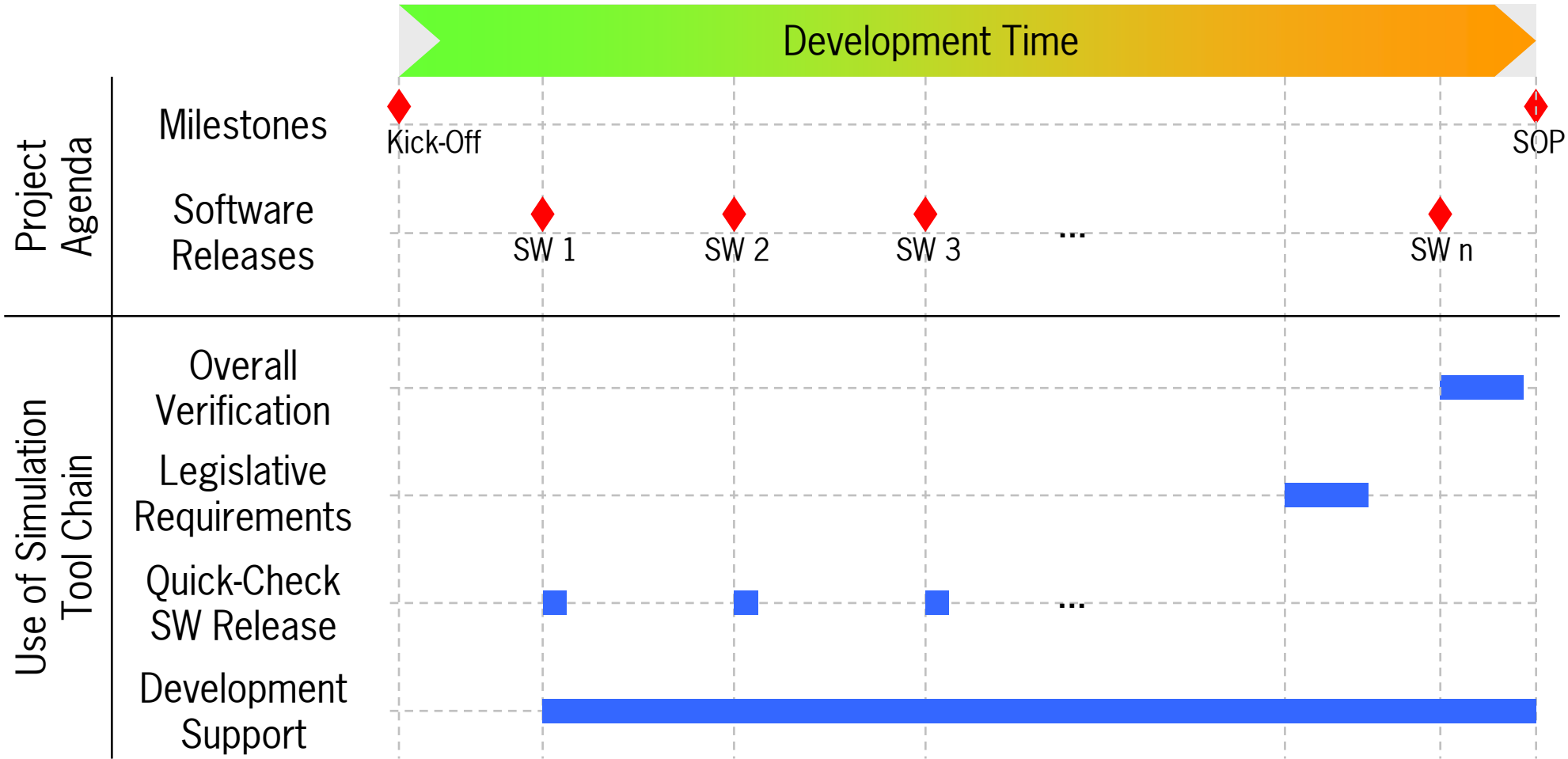
evaluation result

evaluation criteria

- Automatic generation of test report in HTML-format
- Clear visualization of evaluation results:
 - green: criterion passed
 - yellow: evaluation error (e.g. end condition not found)
 - red: criterion not passed

All simulation- and evaluation results are automatically saved.

Further Application of Tool Chain



Summary

- Porsche developed a simulation tool chain for the verification of vehicle variants in cooperation with IPG
- The developed tool chain is applied in addition to driving tests in order to handle the increasing diversity of vehicle variants and PSM functions
- The introduced simulation procedure depicts an efficient tool for a functional verification of a large number of PSM variants
- The tool chain can be used for further applications in the PSM development process such as quick-checks of new software releases, conduction of a functional parameter study, etc.
- The use of the developed tool chain can be transferred to other vehicle dynamics control systems