TREMEC®

Torque Transfer Solutions™

Virtual ECUs for high performance transmissions

Presented by:
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Application software engineer

A kuo Group Company

Contents

- Tremec and high performance DCTs
- Transmission controls and Application Software
- Simulation and testing philosophy
- Performant Simulation Environment

Tremec develops and produces high performance transmissions

TREMEC key facts

- Fully owned subsidiary of Kuo Group
- Focus on high torque/high requirements
- Leader in performance transmissions & transmission subsystems
- Active in performance Dual Clutch Transmission systems since 2003
- Active in Europe, USA, Mid & South America
- 1.650 employees
- 225 m$ turnover LTM 2017

KUO key facts

- Controlled by Senderos family
- Long term strategic holding company
- Activities in:
  - Consumer – food
  - Chemical – synthetic rubber & polystyrenes
  - Automotive – transmissions & aftermarket
- Active in 70 countries – HQ in Mexico City
- 20.000 employees
- 2.100m$ turnover LTM 2017

Tremec Belgium focuses on DCT hardware and software

Sales & program management office for North-American OEM's

USA – Wixom MI

TREMEC center of competence for development & production of gear systems

Mexico – Querétaro

TREMEC center of competence for development & production of performance DCT transmissions & subsystems

- Hardware development of DCTs in the 600 Nm – 1000 Nm range
- Development of Controls hardware and Controls software

Belgium – Zedelgem

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Tremec has expertise in all disciplines needed for transmission control

Electronics

- TCU using multicore technology
- Design compatible with multiple transmission configurations

OBD

- CARB 1968.2 compliance
- Electrical, Controller, Consistency and Performance Diagnostics

Base software

- AUTOSAR framework and Operating System
- Control and diagnostics of IO
- Communication with other ECUs

Safety software

- ISO 26262 compliance
- Safety goal monitoring

Application software

- High level functionality for drivability
- Mid level functionality for hydraulic and mechatronic control
- Model based algorithms
- Generic modules calibratable per application

Application software makes the difference in DCT applications

- A DCT gearbox can handle a wide range of shift feelings
- A brand specific car temperament can be created just by changing software
- The same DCT gearbox can be used in different models
  - different calibrations are used to match driveline experience with type of car

Luxuriously Comfortable **Ferociously Sporty**

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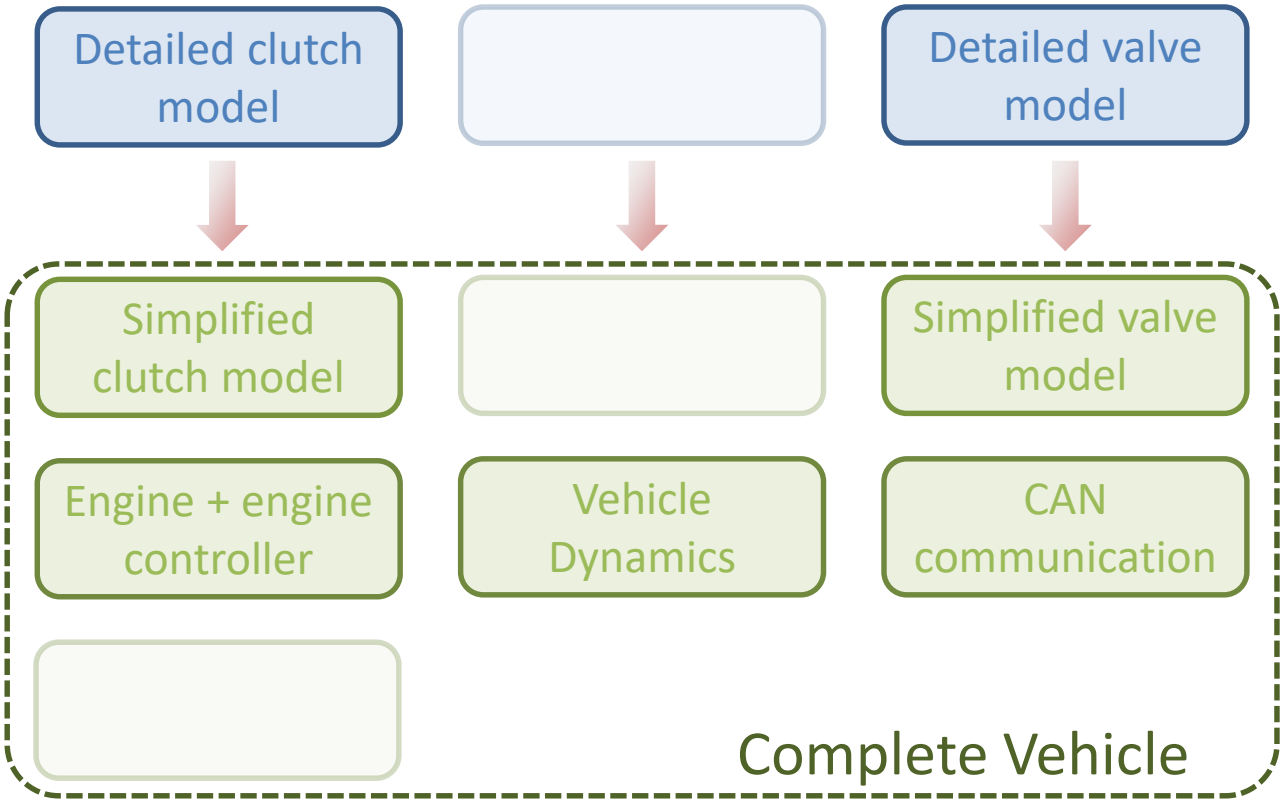
Complete powertrain simulation aids both the Hardware & Software design

HW: Component design
SW: Control algorithm development

HW: System behavior
SW: Testing of complete application

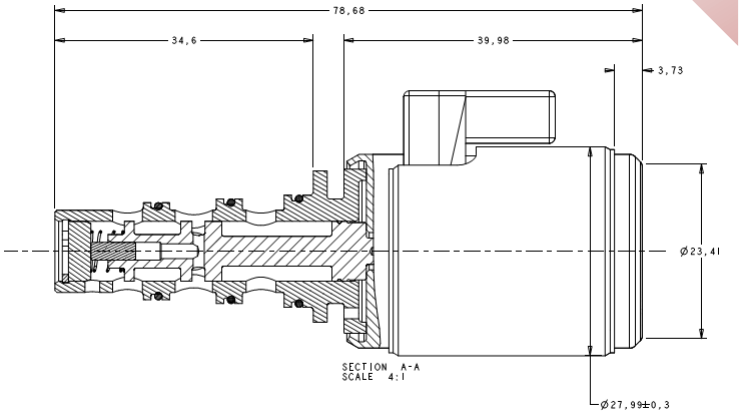


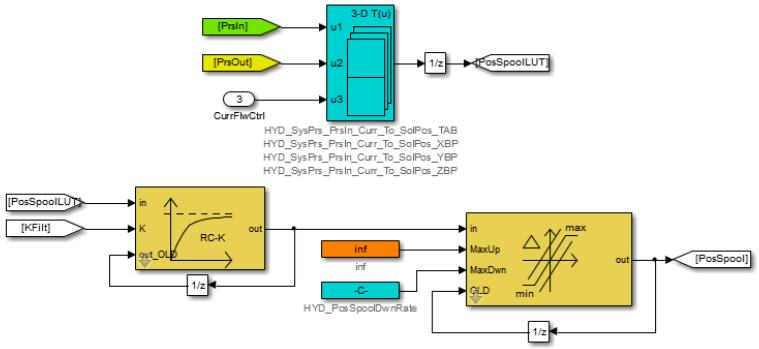
Different simulation models are used for different goals

Detailed dynamics
Variable step solver
Focus on correct behavior
No focus on performance

Simplified dynamics
Fixed step solver
Focus on execution time
Approach real behavior

$$F_{Flow} = \iint_{C.S.} (\rho v_x . \vec{v} . \vec{n}) dA = \frac{\rho \cos\theta}{C_D A(x)} . Q^2$$





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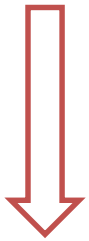

Verifying hardware design
Developing dedicated controls application

Real-time testing of application on a real or virtual TCU

Contents

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Business case
Tremec targets high performance applications

Parallel development of all components (short time to market)

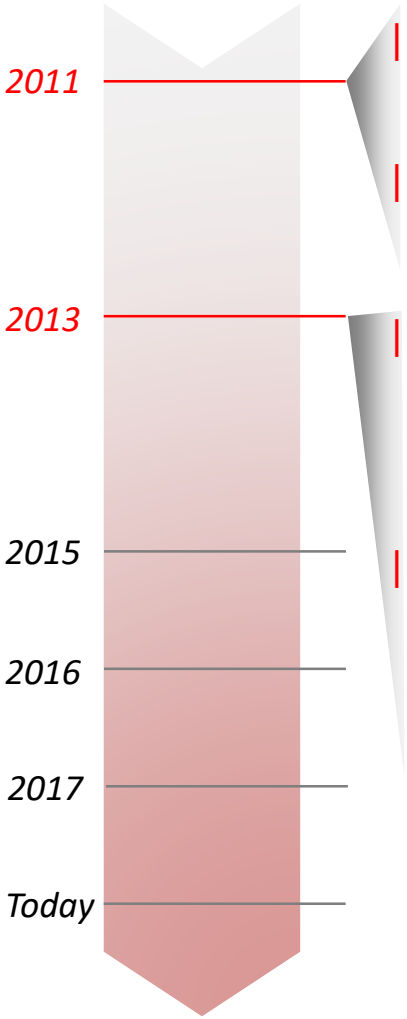
- SW development needs to start before HW is finalized
- Limited availability of test vehicles

OEMs want unique character and stand-out features

- Agile SW implementation and testing environment
- Confidence in new algorithms before vehicle testing
- Possibility to explore new concepts and variants

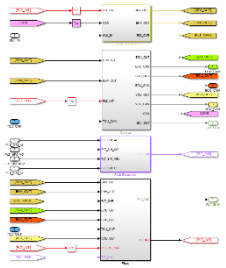
Tremec needs a performant simulation environment to reach the desired SW maturity

Performant Simulation Environment
Buildup of know-how and initial tools

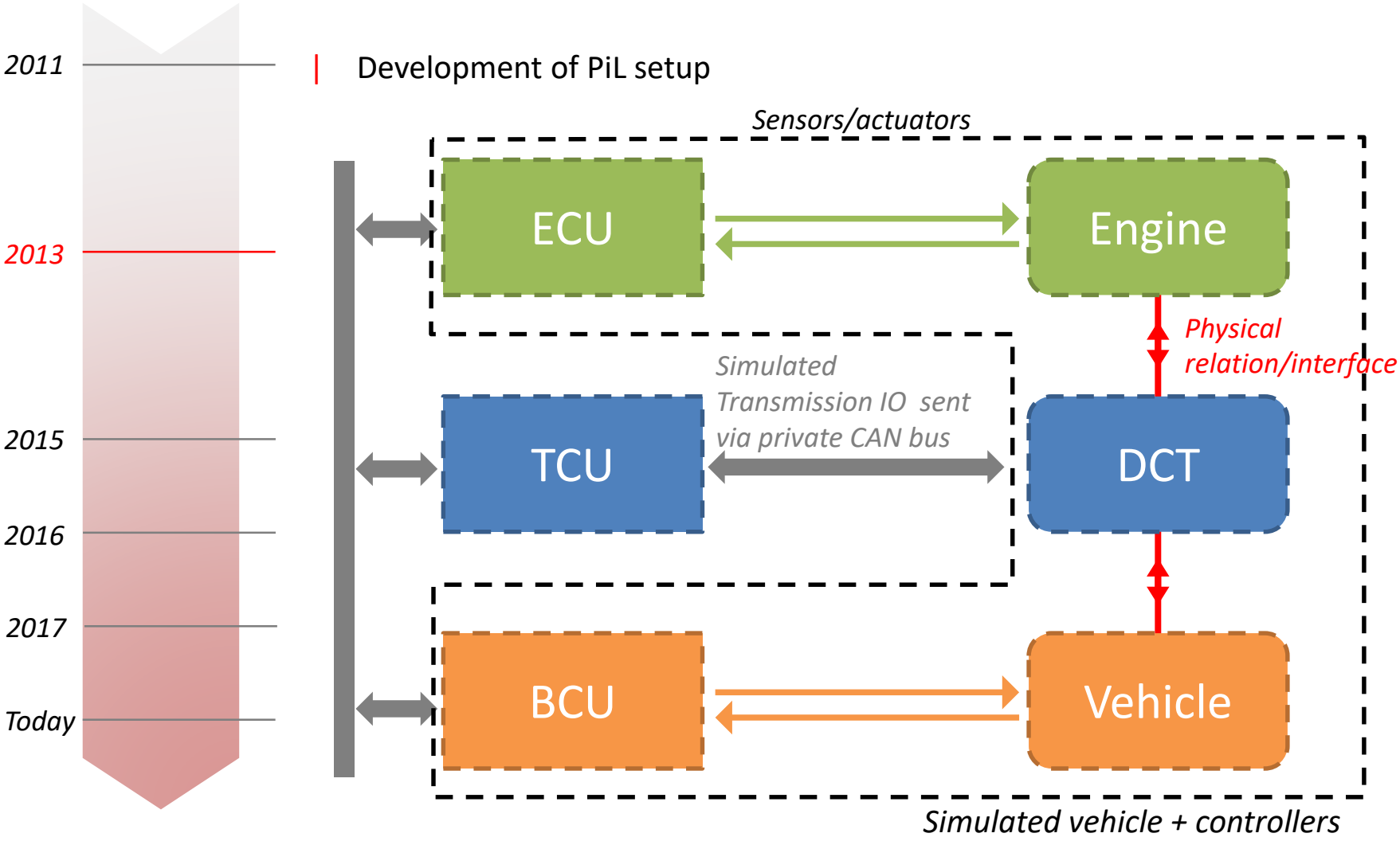


- Software testing in MiL environment
  - Test patterns applied to inputs
  - Testing of only one software module
- Out-dated HiL setup
  - No in-house knowledge of updating the configuration

- Development of complete vehicle simulation
  - Detailed model of hydraulic and mechatronic transmission components
  - Simplified model of vehicle dynamics
  - Basic implementation of other vehicle controllers
- Development of PiL setup
  - *Processor in the Loop:* TCU is connected to a simulated vehicle but without IO processing
  - Possibility to test full Application Software functionality and integration



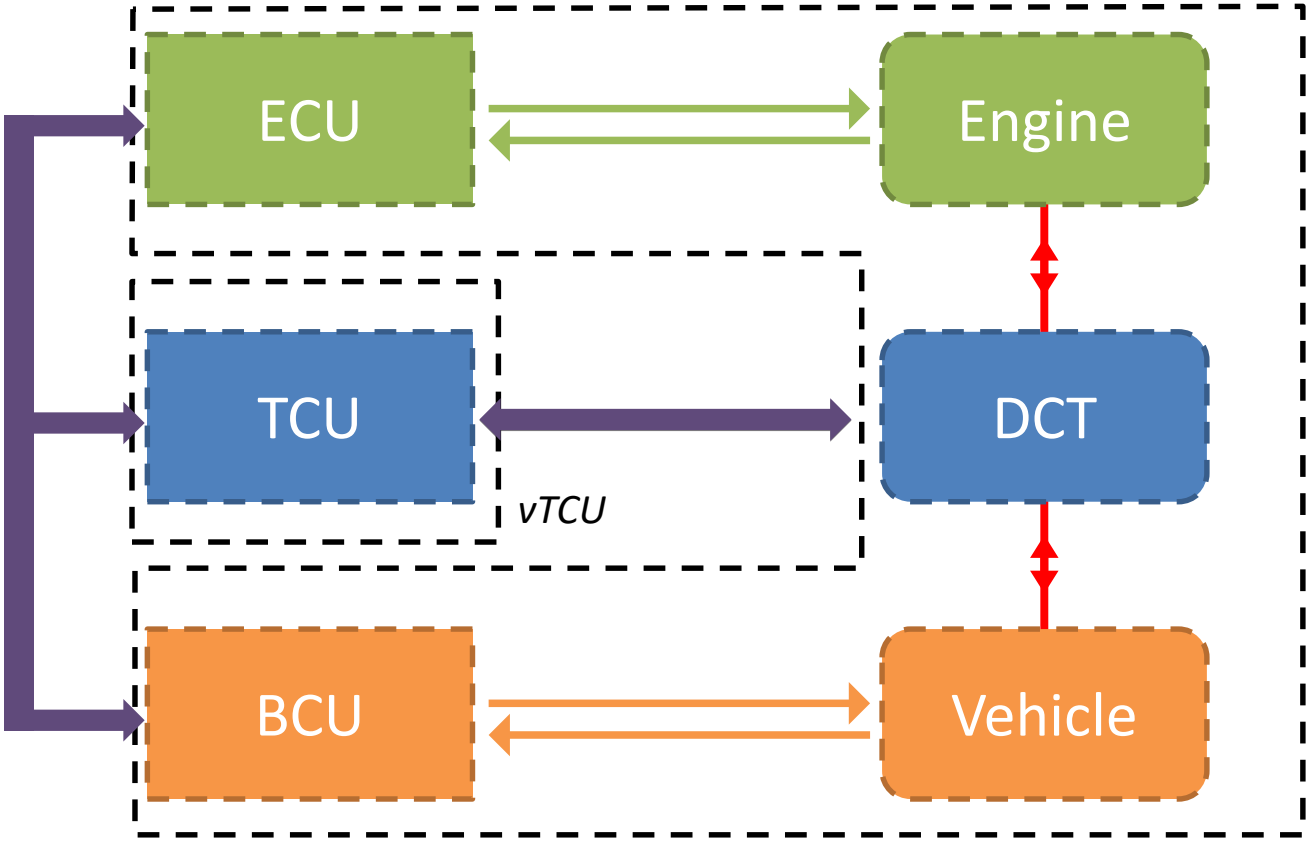
Performant Simulation Environment
PiL setup for full ASW testing



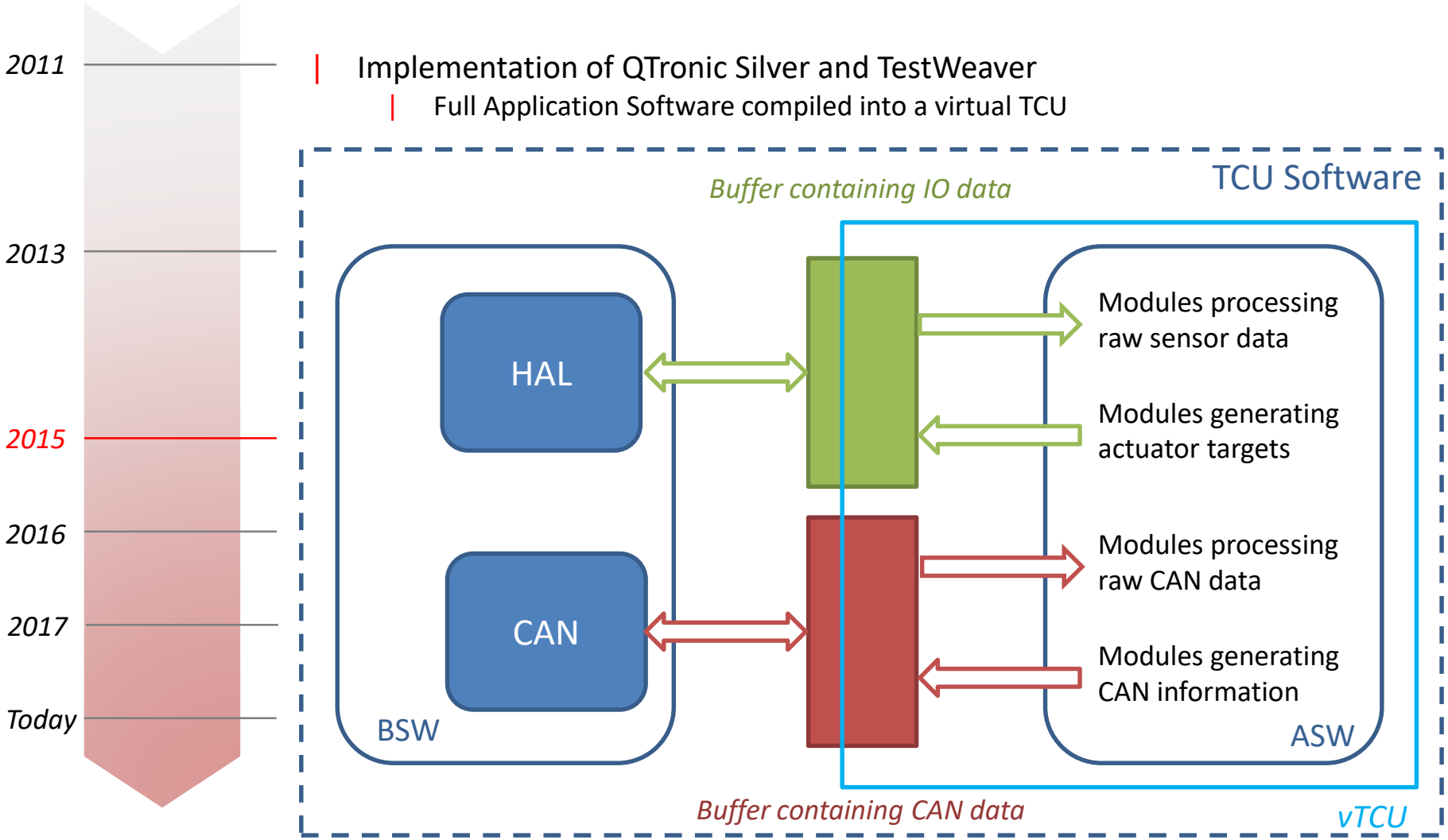
Performant Simulation Environment
Further steps towards SiL testing

2011
2013
2015
2016
2017
Today

- Implementation of QTronic Silver and TestWeaver
  - Testing of new algorithms without TCU HW needs



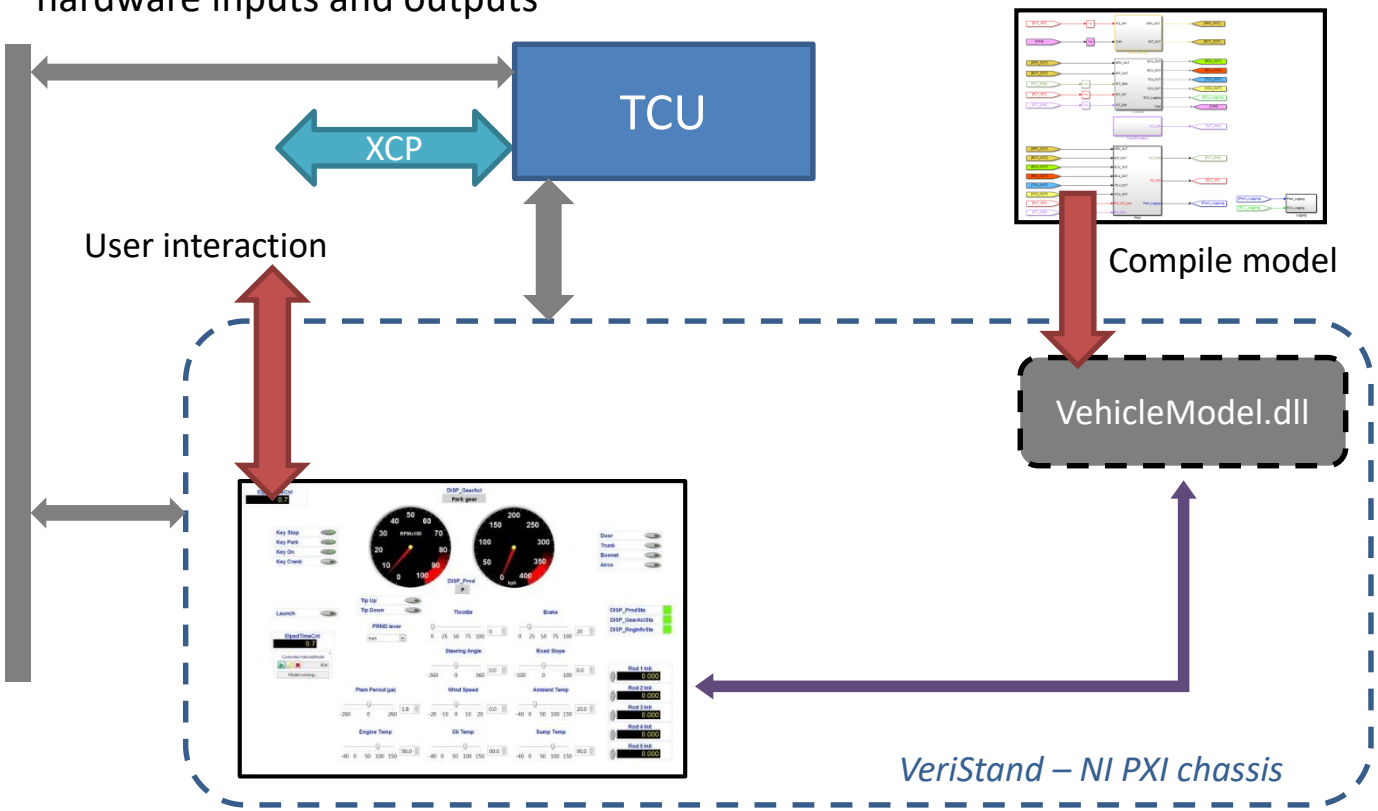
Performant Simulation Environment
Virtual TCU enables flexible ASW testing



Performant Simulation Environment
Extension of testing equipment with HiL

2011
2013
2015
2016
2017
Today

- Transition of PiL setup from Windows desktop to Real Time computer
- Development of HiL setup as an extension of PiL setup with hardware inputs and outputs



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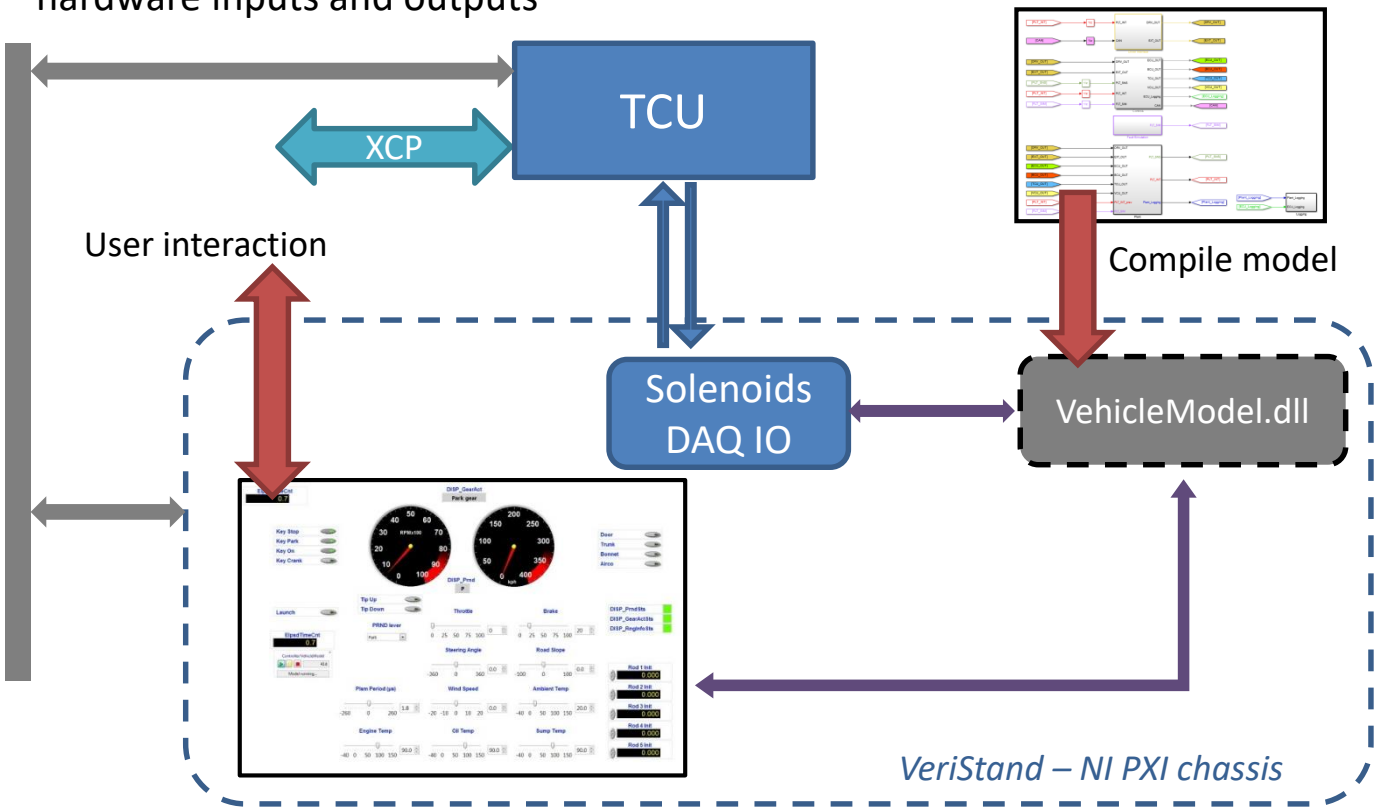


TestWeaver is used for regression testing and software release validation

2011

2013

2015

2016

2017

Today

Regression testing using TestWeaver

Weekly TestWeaver run

- Python scripts for regression
- Automatic script generation

Adp function	Adp result	Eol status check	online status check	reset to default status check	reset to default value check	Eol data check
23/07/2018 - rev 52642						
Percentage of Passed	100%	100%	100%	100%	94%	100%
M_ADPFCN_TQC_KP_CLU1:2					Failed	
30/07/2018 - rev 52961						
Percentage of Passed	100%	100%	100%	100%	94%	100%
M_ADPFCN_TQC_KP_CLU1:2					Failed	
09/08/2018 - rev 53273						
Percentage of Passed	100%	100%	100%	100%	94%	100%
M_ADPFCN_TQC_KP_CLU1:2					Failed	
20/08/2018 - rev 53415						
Percentage of Passed	90.3%	100.0%	100.0%	100.0%	94.3%	100.0%
M_ADPFCN_CPC_CURR_CLU1:2	Failed					
M_ADPFCN_CPC_PRL_CLU2	Failed					
M_ADPFCN_TQC_KP_CLU1:2					Failed	
27/08/2018 - rev 53752						
Percentage of Passed	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
3/09/2018 - rev 54256						
Percentage of Passed	59.4%	100.0%	100.0%	100.0%	94.3%	100.0%
10/09/2018 - rev 54589						
Percentage of Passed	58.6%	100.0%	100.0%	100.0%	94.3%	100.0%

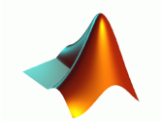
SW release TestWeaver run

- Regression test of diagnostic routines
- Release documentation

Performant Simulation Environment
Advantages of full virtual testing

2011

QTronic SIMULATION FOR ENGINEERING vTCU



VehicleModel

Silver environment for complete ASW testing and algorithm validation

2013

Parallel development of all components (short time to market)

- SW development needs to start before HW is finalized
- Limited availability of test vehicles

2015

OEMs want unique character and stand-out features

- Agile SW implementation and testing environment
- Confidence in new algorithms before vehicle testing

2016

- Possibility to explore new concepts and variants

2017

Today

Performant Simulation Environment
Advantages of full virtual testing

2011

QTronic SIMULATION FOR ENGINEERING vTCU

VehicleModel

Silver environment for complete ASW testing and algorithm validation

2013

Parallel development of all components (short time to market)

- \+ SW can be developed and tested on new configurations implemented in the VehicleModel
- \+ Silver environment available on each computer

2015

OEMs want unique character and stand-out features

2016

- \+ Immediate testing of the algorithm behavior by the SW developer

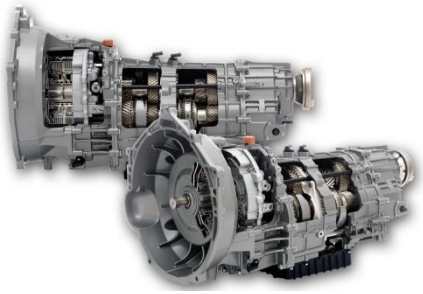
2017

- \+ Validation of new algorithms before release to minimize downtime and debugging

Today

- \+ Flexible and modular simulation environment

Proof Of Concept for new projects and algorithms

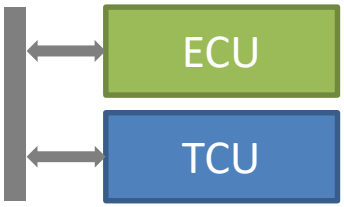


E-motor

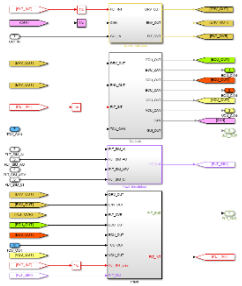
High performance Hybrid DCT

- Shadow shifting
- Flying starts
- Boosted driving

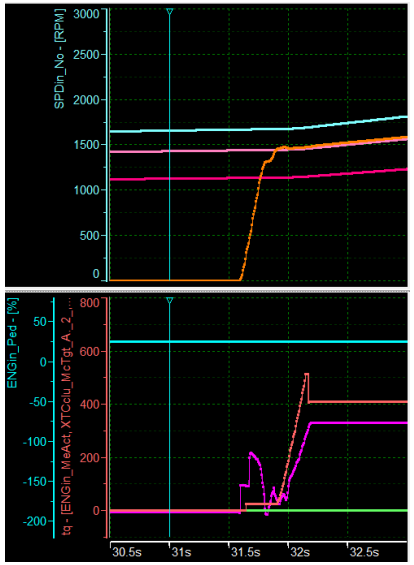
Interface definition



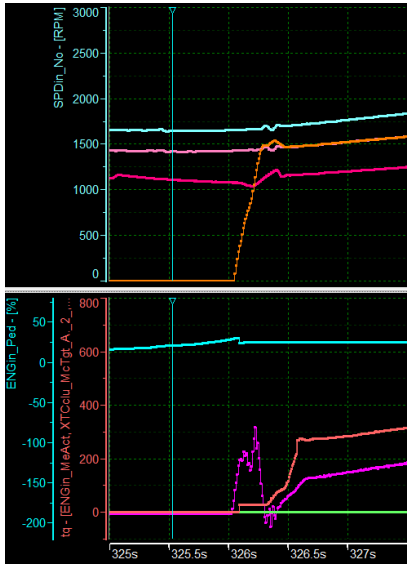
Simulation model update



Test algorithms by sharing simulation files with OEM



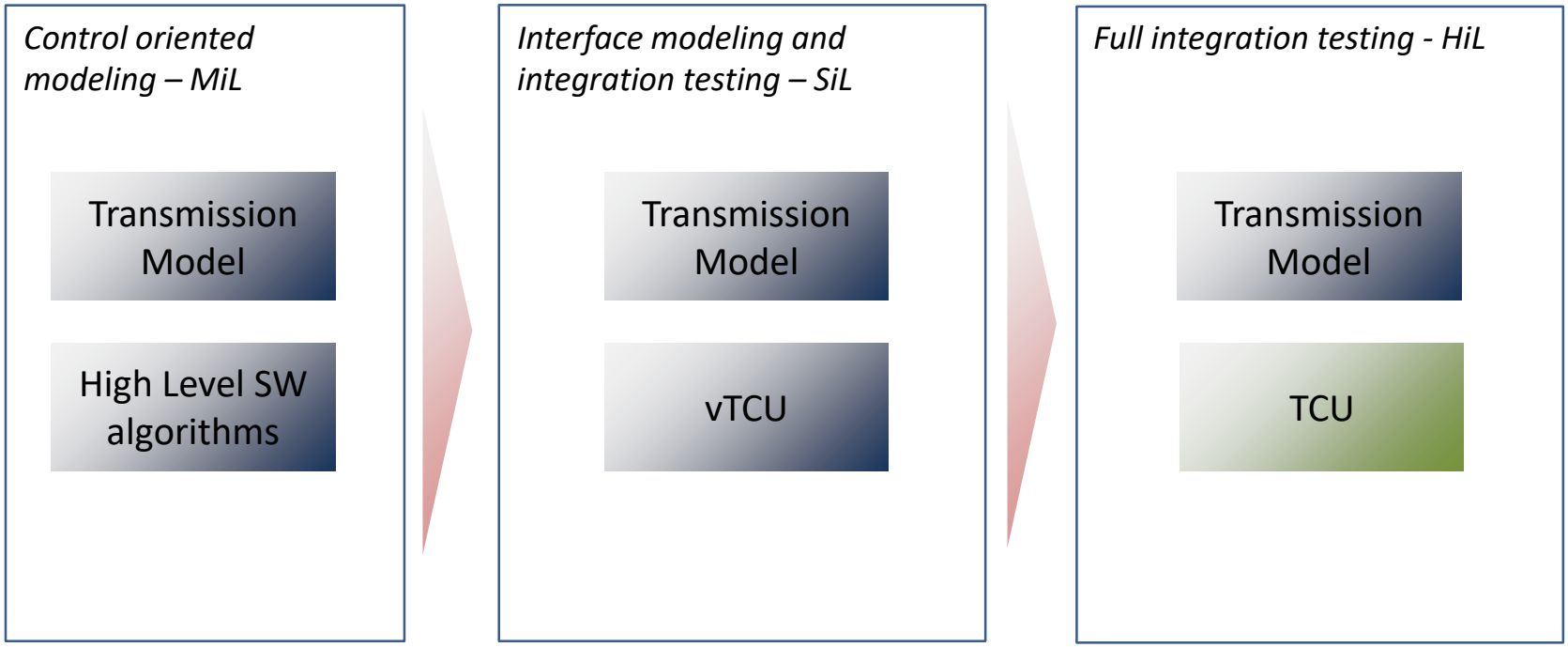
Successful testing on the first prototype vehicle



Tremec has developed State of the Art simulation and testing capabilities

Multiple methods for simulation to enable virtual SW development

- Modular simulation components that can be protected and shared
- Support for different testing methods and toolchains



Questions

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