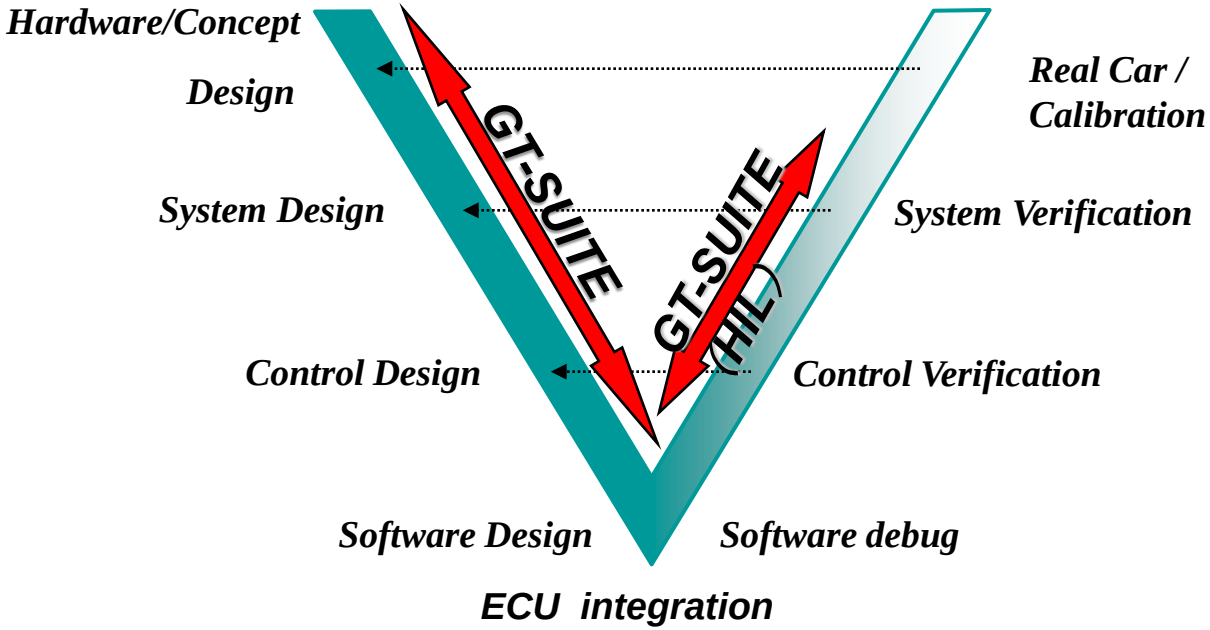
ICSC 2013
IDAJ CAE Solution Conference
New Value in CAE & CFD Industry

GT-SUITE
MBDプロセスでのGT-SUITEの活用

GT-SUITE trials for the HILS application

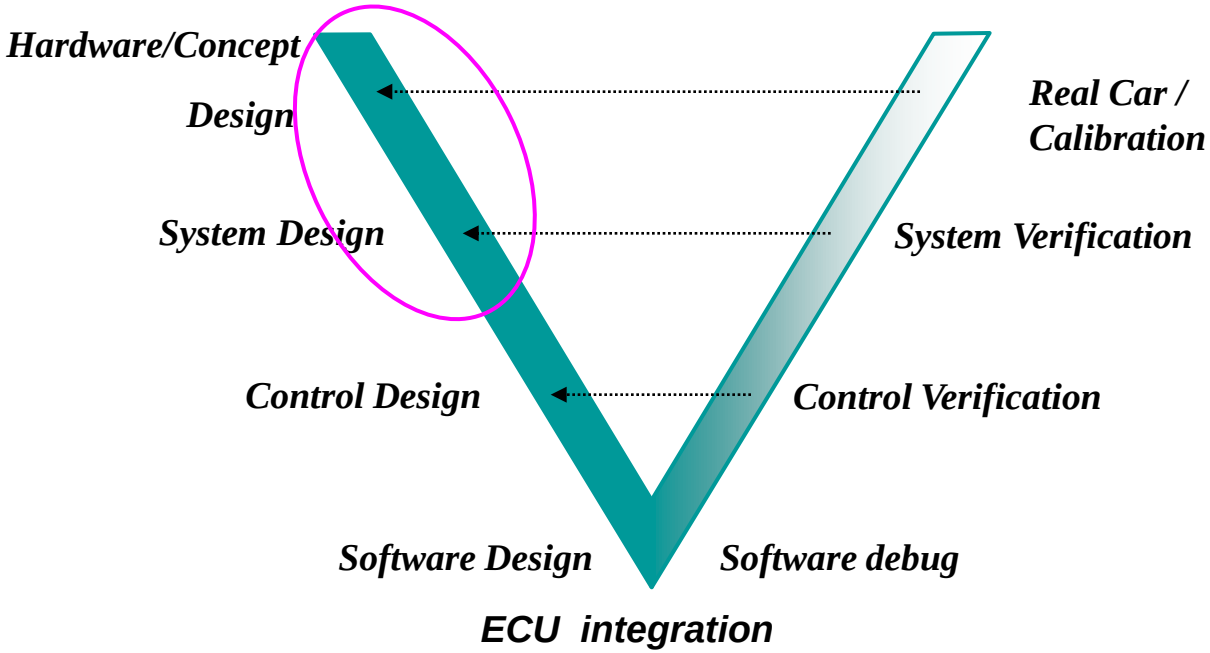
IDAJ co.,Ltd.
Tomomi Ejima

Coverage



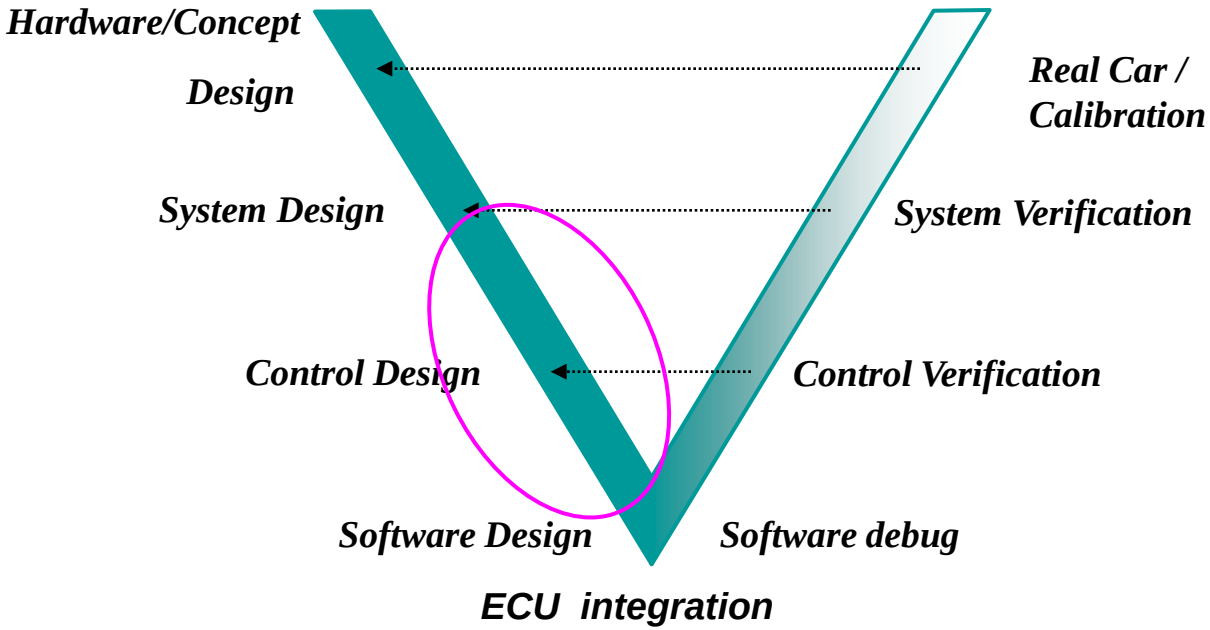
Cover area1

- For early design phase
- Physical and high accuracy model simulation



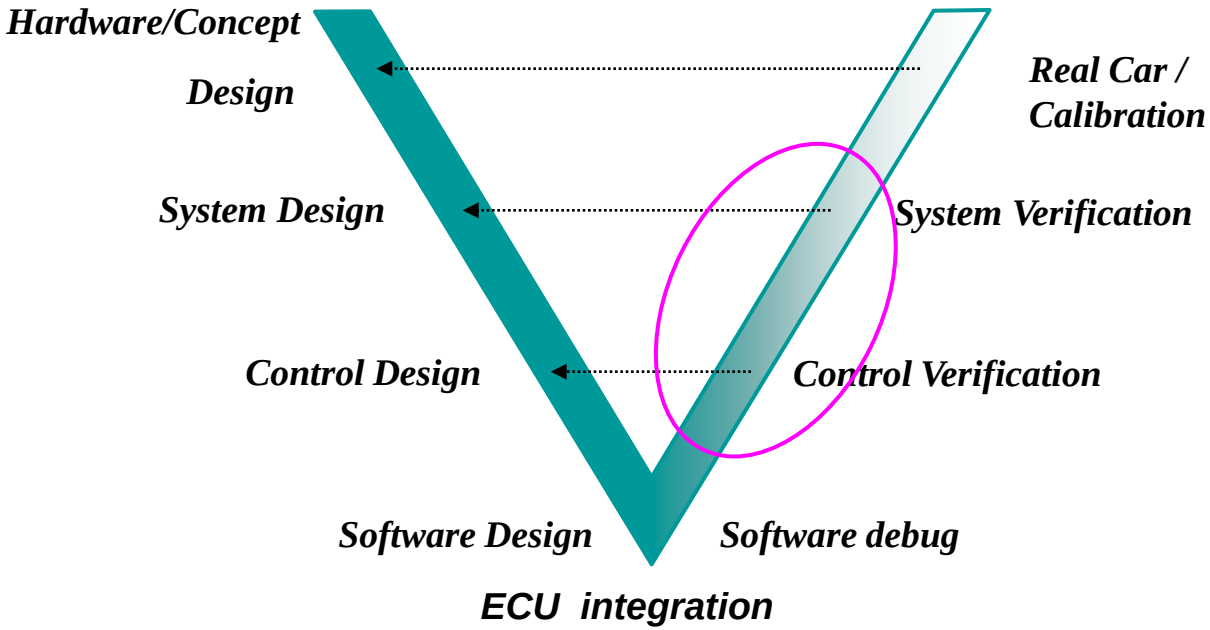
Cover area2

- For late design phase
- Fast running simulation for software design

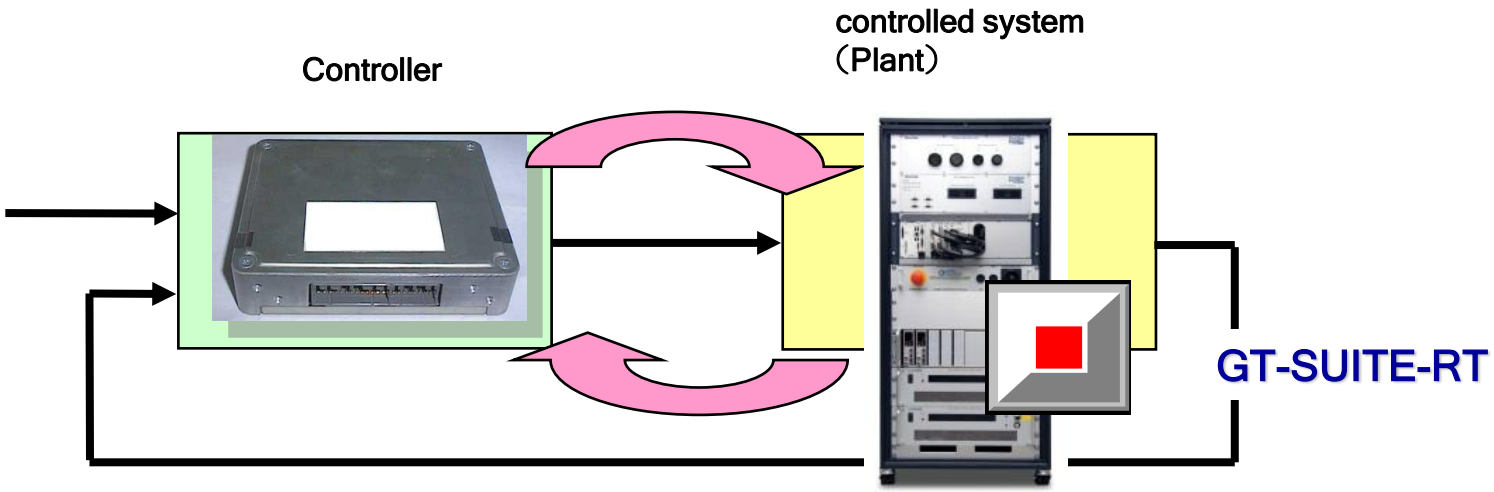


Cover area3

- For verification phase
- Real time capability for HILS



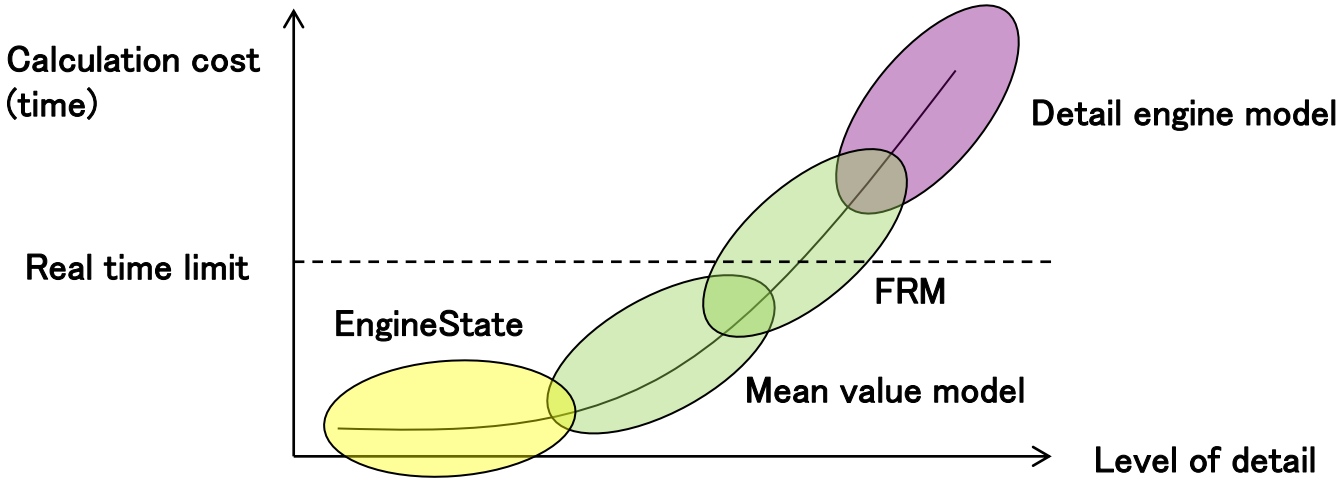
What is HILS?



Supported HILS vendor in Japan
dSPACE, ETAS, NI, AandD, Concurrent

Benefit

- Physical base simulation
  - 1D Navier–Stokes equation , Continuity equation, Energy equation
  - Mechanical motion equation
  - Detail chemical reaction , etc
- Transient action（fluid transport delay, turbo lag , etc）
- Capability for modeling various level of detail



Trial 1 : Diesel Engine Model

4-cylinder diesel example

Smoke control logic

EGR and EGR cooler (EGR percent of ～35%)

Variable geometry turbine

VGT rack control (target boost control)

Inter cooler

Air box

DOC and DPF

Muffler

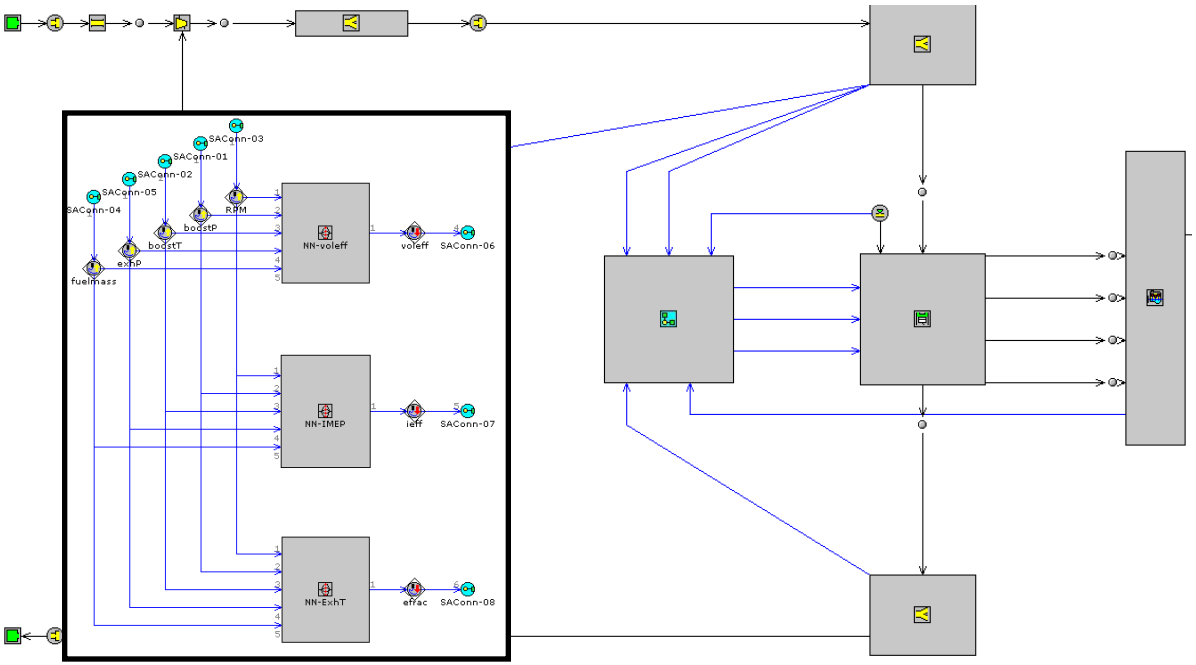
ETAS LABCAR

Mean value model

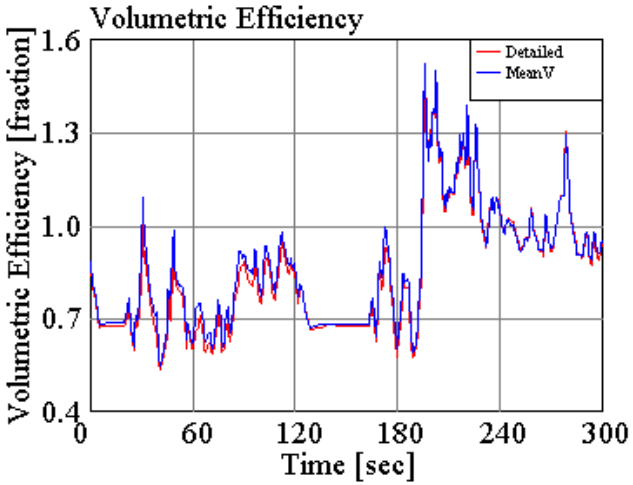
Mean value model

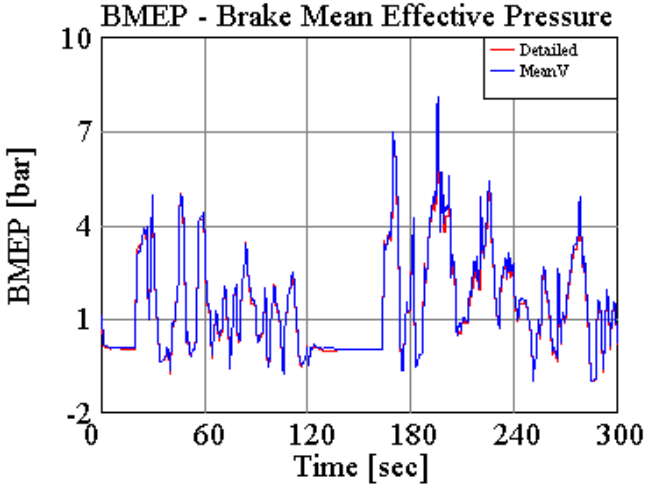
Model reduction

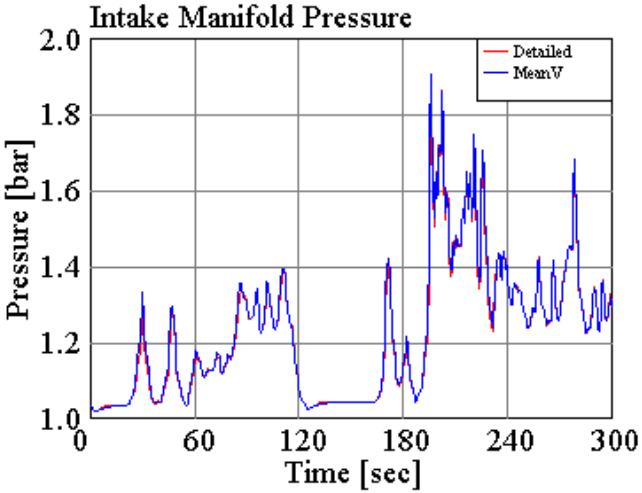
Keep accuracy by neural network

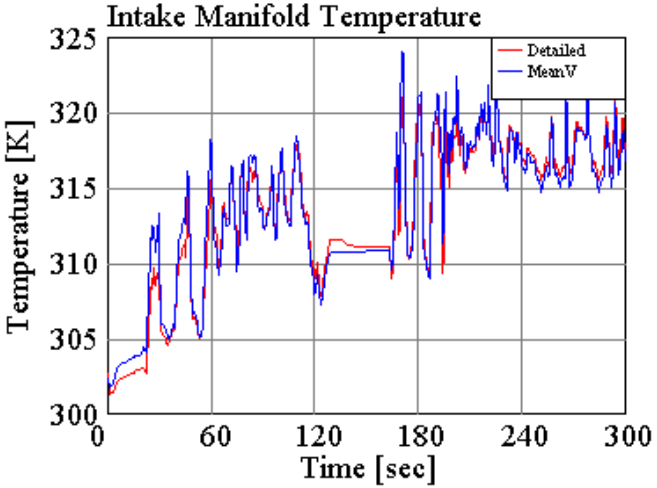


Results

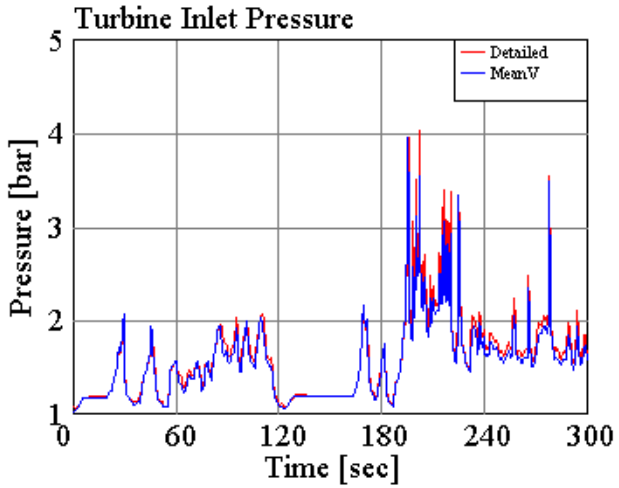


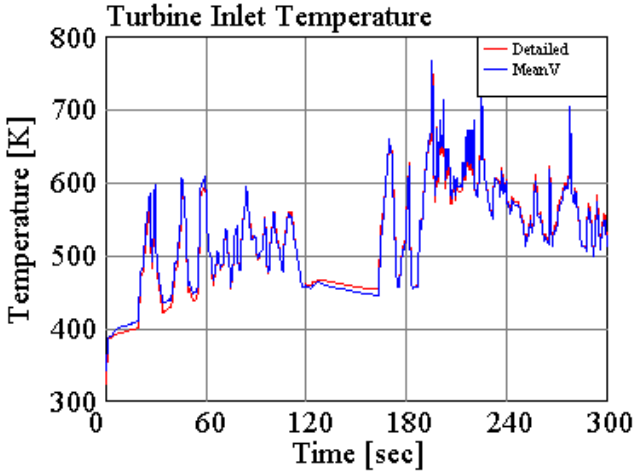


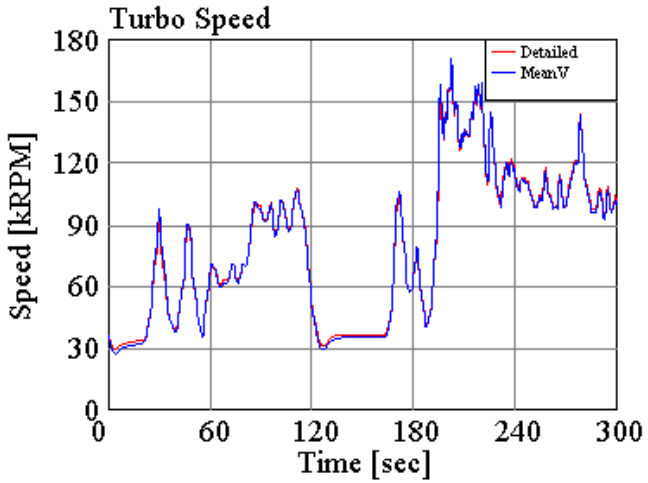


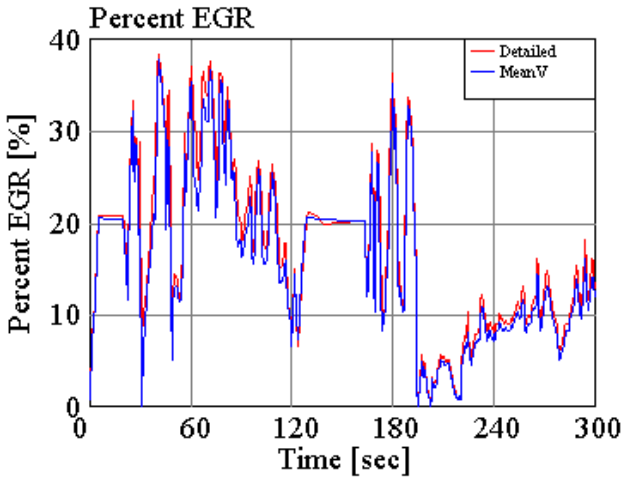


Results









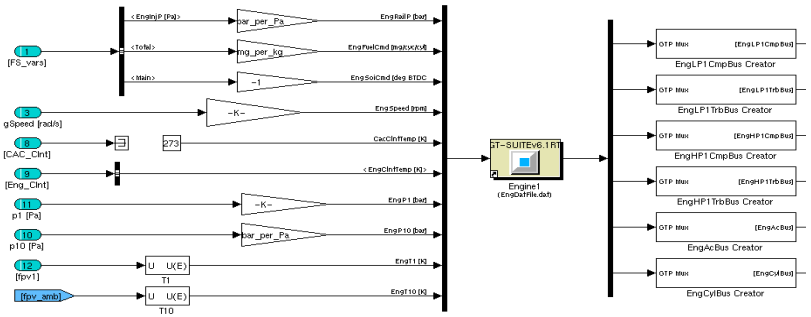
Integration

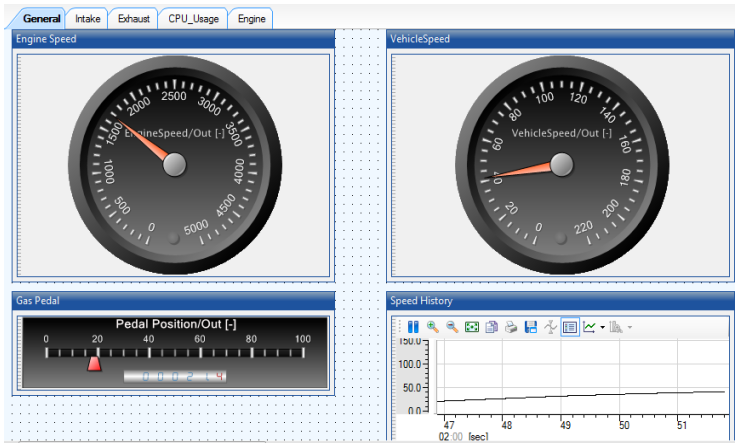
Design in LABCAR

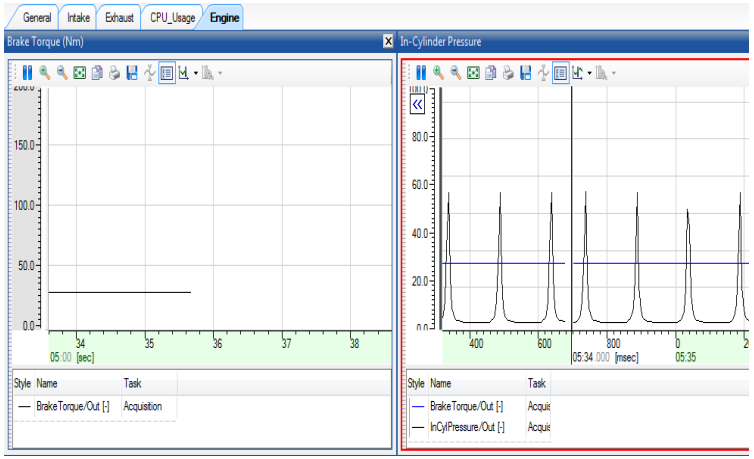
Download to RTPC and Real Time Calculation

Sampling frequency

: 1ms





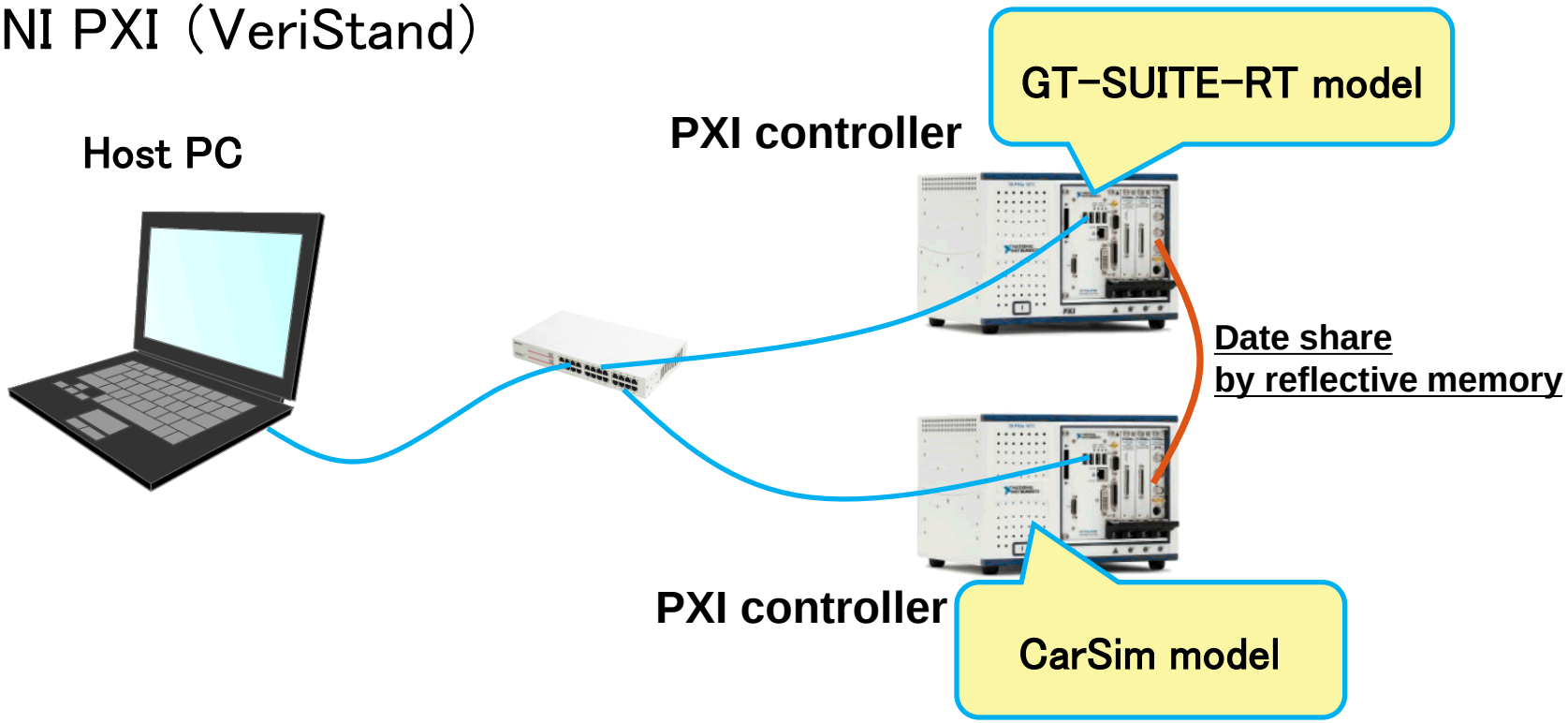


Trial 2 : Coupling between GT-SUITE and CarSim on HILS

Engine model : GT-SUITE-RT

Vehicle model : CarSim

NI PXI (VeriStand)

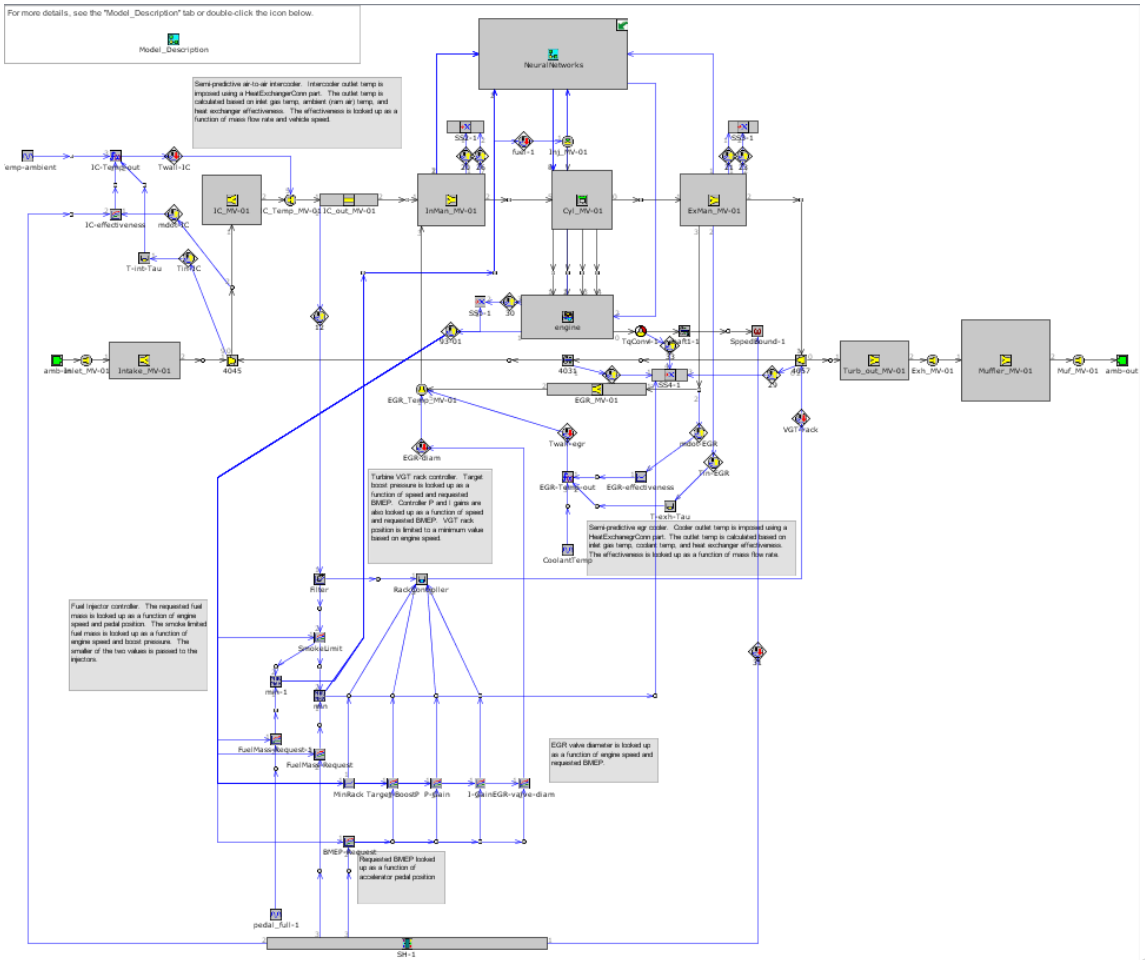


GT-SUITE model

Engine + Torque Convertor

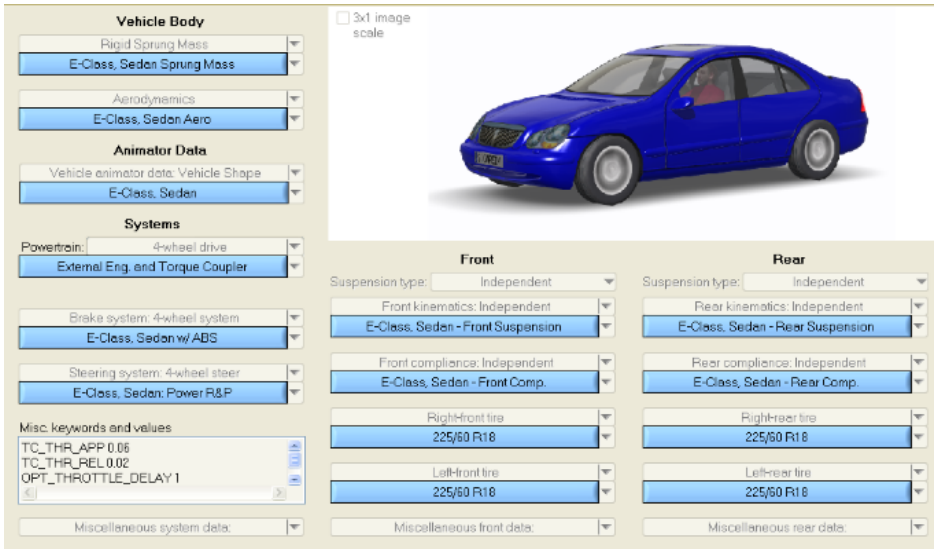
- Diesel engine
- 3.2L
- Turbo（VGT control）
- EGR valve control

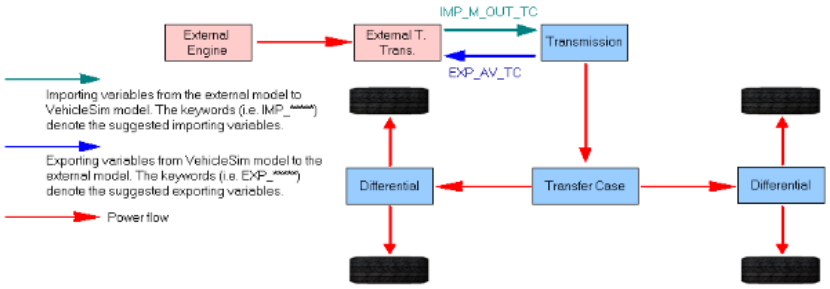
Mean Value Model



CarSim model

- Vehicle model(E-Class Seden, 7AT)





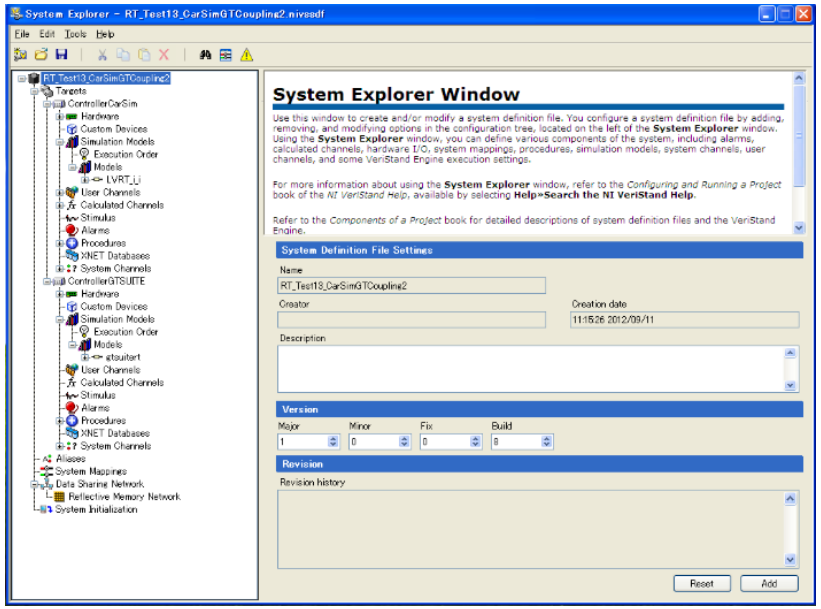
HILS coupling with VeriStand

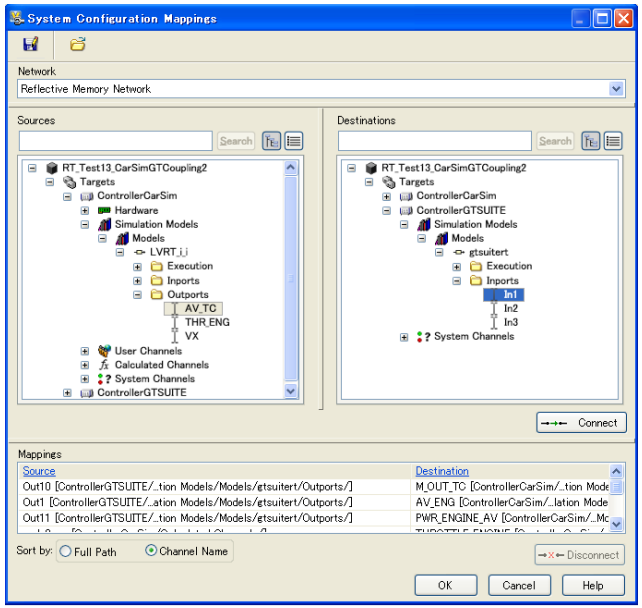
Data share between two HILS target by reflective memory

Trade physical values for each other

- CarSim → GT-SUITE : Engine Speed
- GT-SUITE → CarSim : Torque

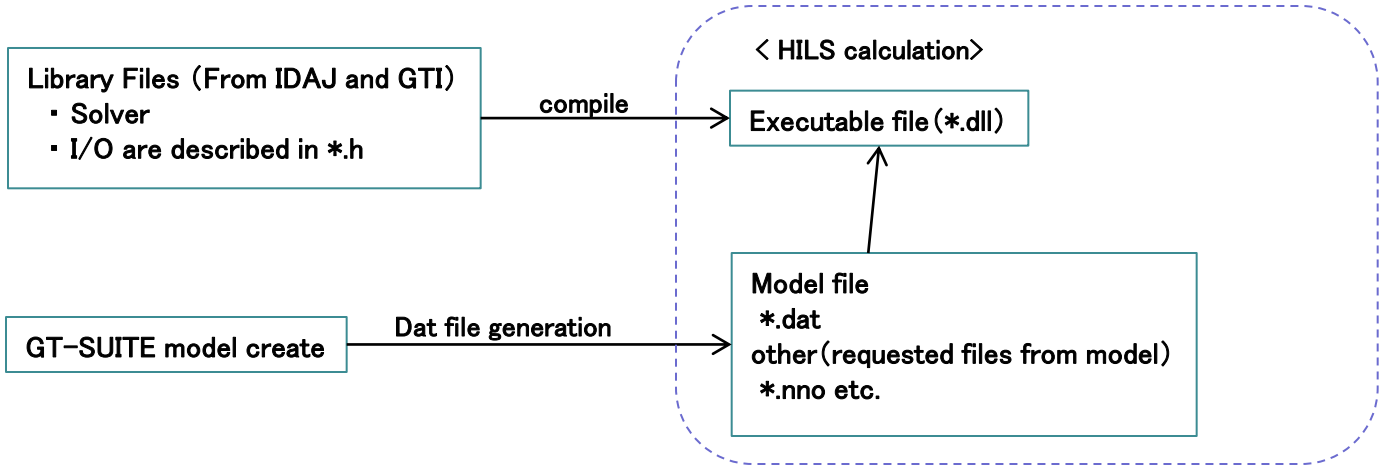
- User should consider each models coverage and traded data



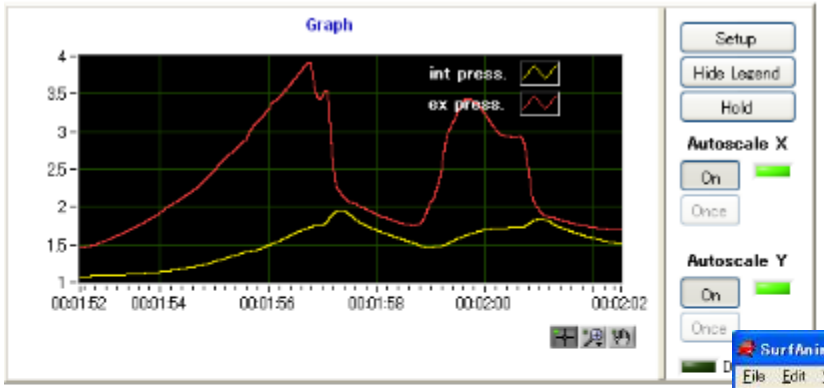


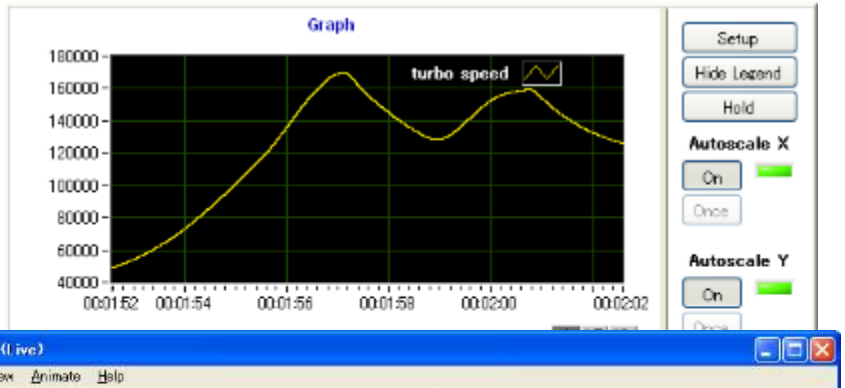
Integration on VeriStand

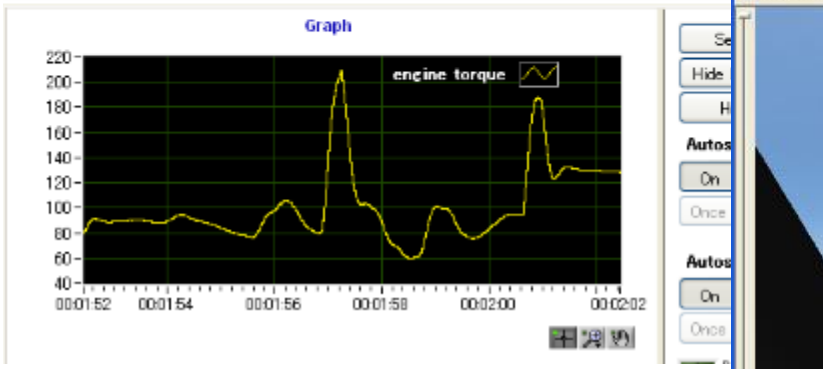
- Download a executable file (*.dll) to PXI
  - Inputs and outputs are described in header file (*.h)
  - Compile with Visual Studio
- Model file : *.dat file (generated from GT-ISE)
- It is handled as input file for *.dll
- *.dll is handled as a model file on VeriStand System Explorer



example





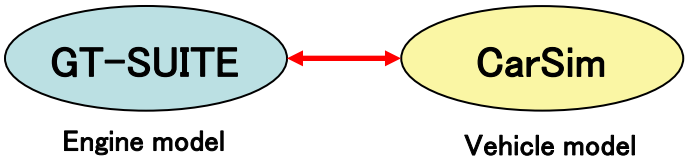


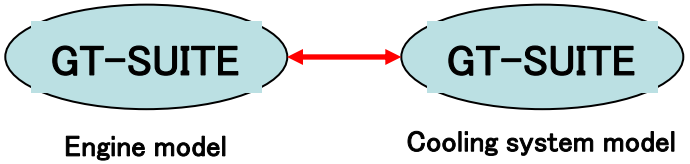
Sampling Frequency

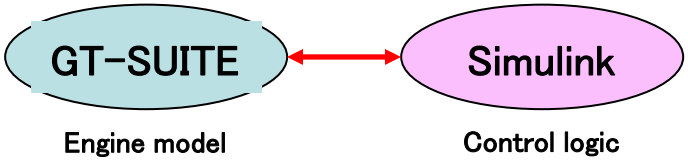
: 1ms

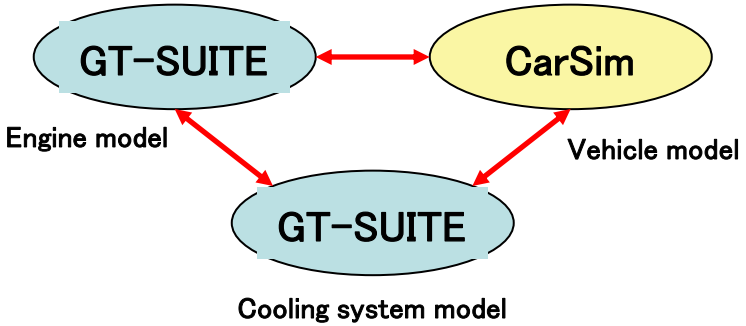
benefit

- GT-SUITE can solve the behavior of engine exactly
  - For example : Turbo lag, Fluid trans, fluid transport delay, engine control etc.
- CarSim can solve the behavior of vehicle and graphic animation
- Any combination models



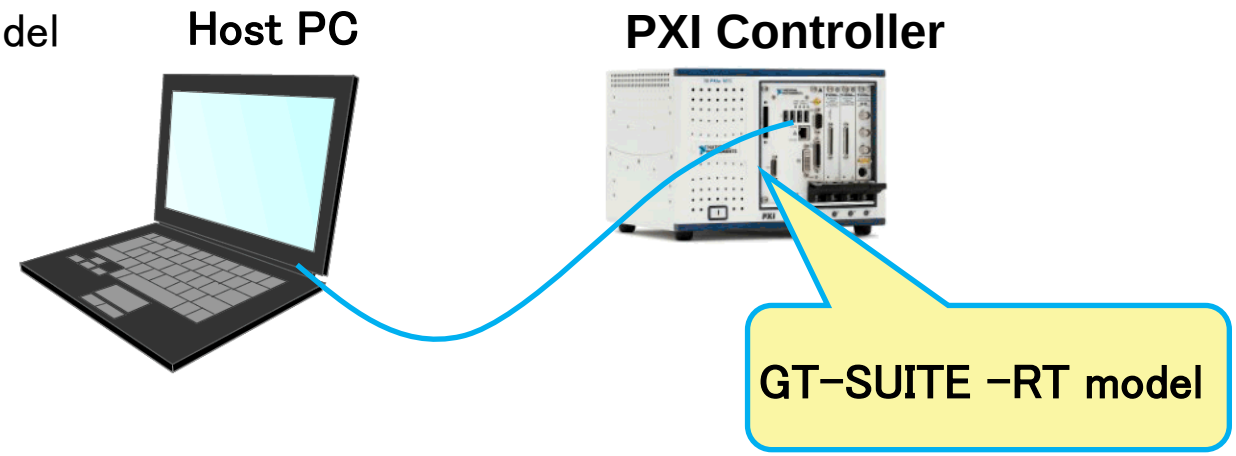






Trial 3 High frequency simulation

- 1 cylinder engine model
  - Reproduce pulsation and Instantaneous torque
- High frequency sampling ～0.5ms
- 2 Case
  - FRM
  - Mean value model
- NI PXI



FRM

Refined reduction

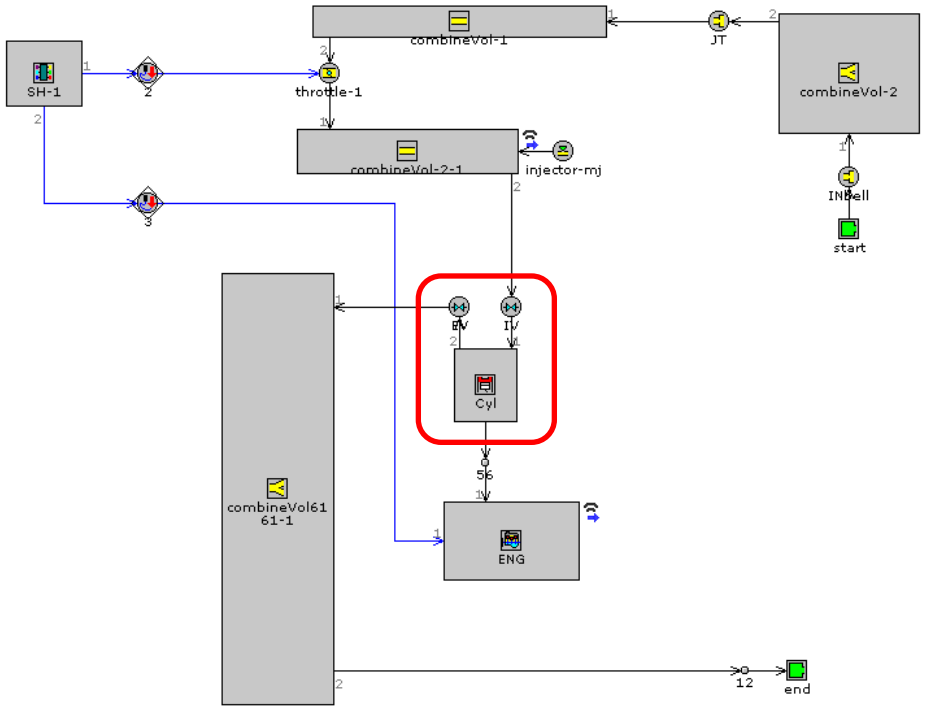
- For cost and accuracy

Input and Output signals

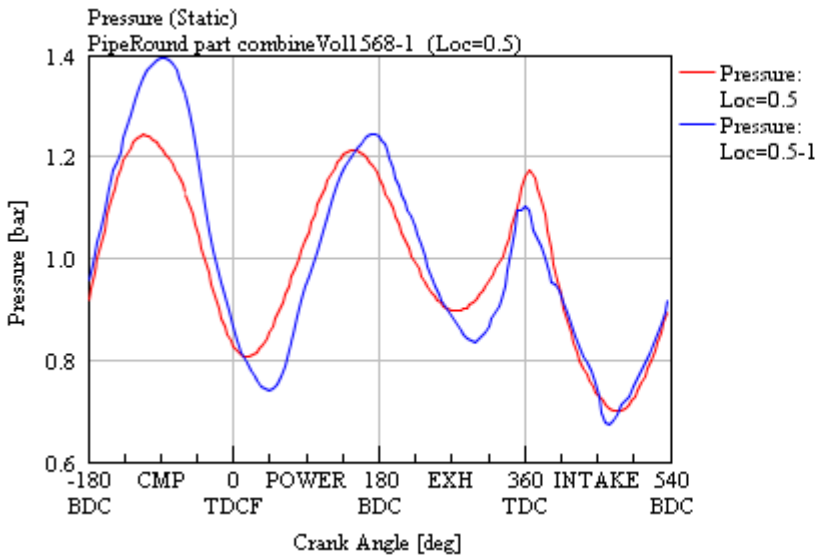
- Inputs from external
  - Throttle angle
  - Engine speed
- Outputs to external
  - Instantaneous torque
  - Instantaneous intake pressure

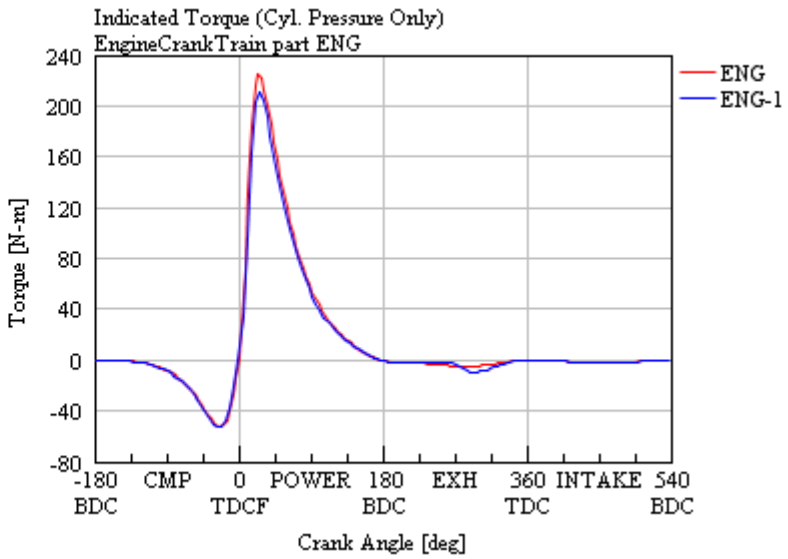
Detail calculation in cylinder

- Keep intake and exhaust values
- Piston motion
- Burn rate
- In-cylinder pressure
- In-cylinder temperature etc.



Results





Real Time Capability with sampling frequency 0.5ms

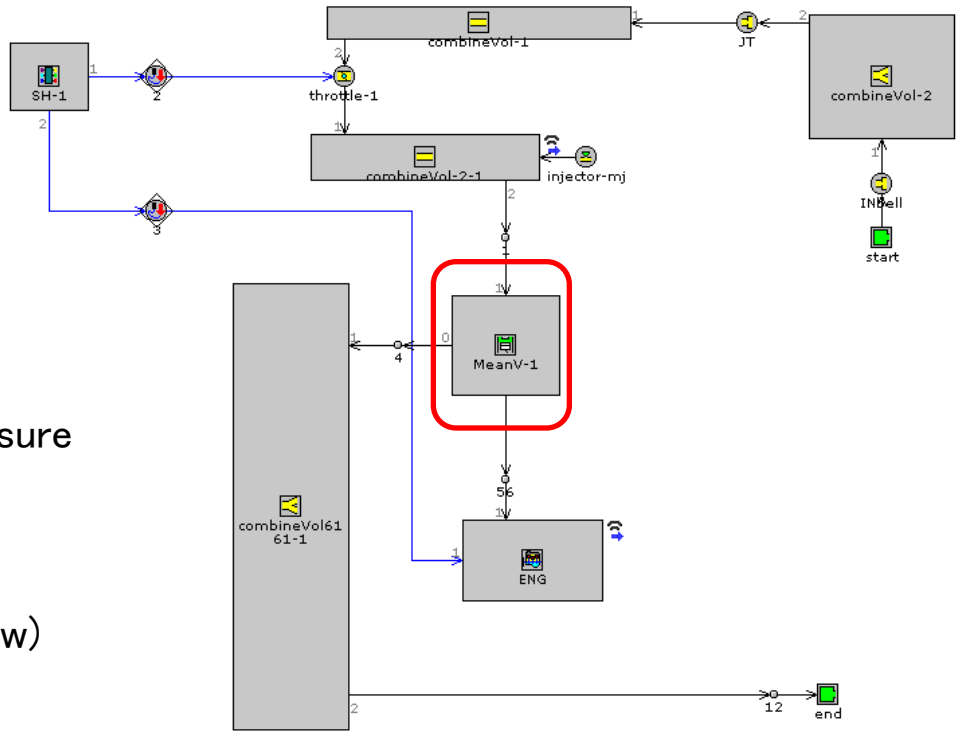
Mean Value Model

Input and Output signals

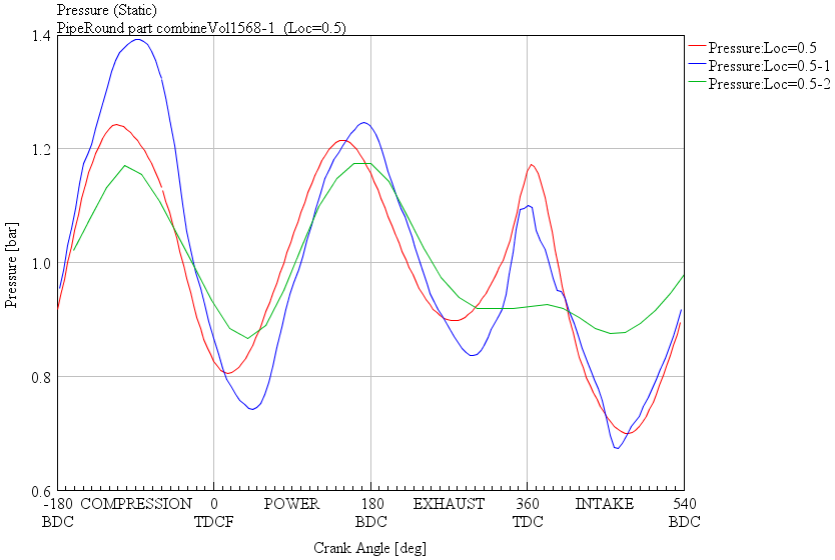
- Inputs from external
  - Throttle angle
  - Engine speed
- Outputs to external
  - Instantaneous torque
  - Instantaneous intake pressure

Mean value model

- Pulsation feature (unsteady flow)



Results



※ Instantaneous torque calculation
：not supported yet

Real Time Capability with sampling frequency 0.2ms
Supported multiple cylinder model

Conclusion

Coverage of the development process (V-process)

Capability for modeling various level of detail

Real Time Capability on HILS

HILS Trials

- Engine model (Mean value model) 1ms
- HILS coupling of GT-SUITE and CarSim
- FRM 0.5ms, Mean Value Model 0.2ms

GT-SUITE provide a method of reduction for high accuracy and real time calculation