Applications of Desktop Simulator in Vehicle Development Process for best NVH Characteristics

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Introduction/Background

- Desktop Simulator Acquisition.
- Models Levels Creation to support ongoing and Upcoming Vehicle Programs
  - Level 1 Models
  - Level 2 Models
  - Level 3 Models
- Usage of DTS Models
- Examples

DTS Has given voice to every NVH Plots/Curve we generate.

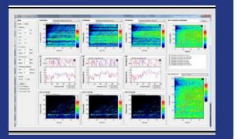
NVH Driving Simulator (DTS)

Pre-Concept	Concept	Design & Prototype		Launch Readiness
Free Drive Vehicle Model	NVH Target Setting & Cascading	NVH Design Decisions	NVH Enabler Development	Refine/Debug Prototypes
Level 1 & 2	Level 3	Level 3	Level 3	Level 3

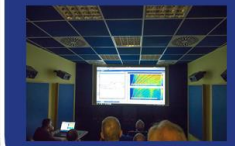
DTS NVH Simulator

Cost Savings

Target setting and deployment *with direct feedback through objects modifications, source and transfer functions modification.*

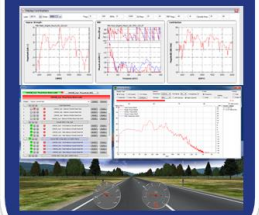


Sound Quality decision *of Vehicle NVH performance in the SONIA room through clinic tests and comparing different vehicle models*



Troubleshooting and what-if analysis *Understand what are really the main issues for the customer*

Hybrid modelling *Combining test data and CAE results*



Record once playback forever

Multi-evaluation tests

Find and improve "only" the main paths

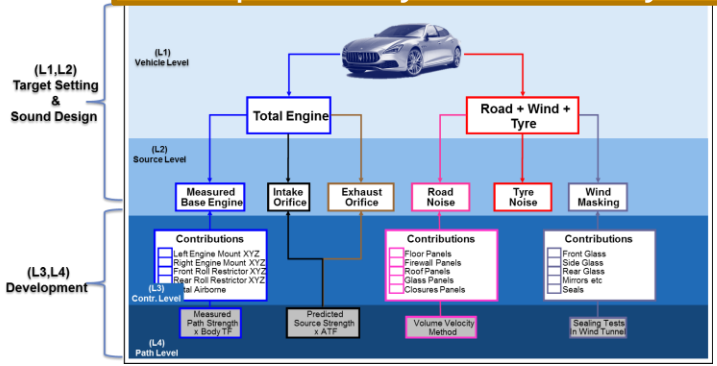
Test the virtual solutions before the physical test

Database sharing between regions

Drive Vehicles from other regions

Drive Vehicles with sound from supplier (ex. Exhaust)

DTS Model complexity could be adapted to any kind of activity



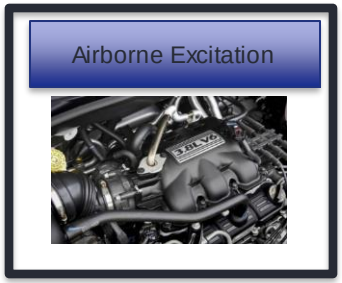
- Level 1: Benchmarking
- Level 2: Road and Wind Noise Masking Noise Generation
- Level 3: Trouble Shooting; What-if Analysis; Target Cascading; Powertrain Swap

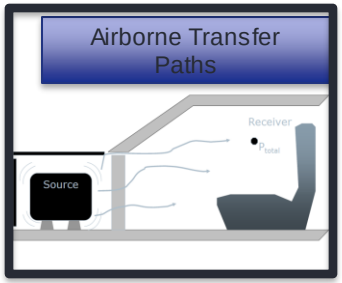
DTS Level 3 Models

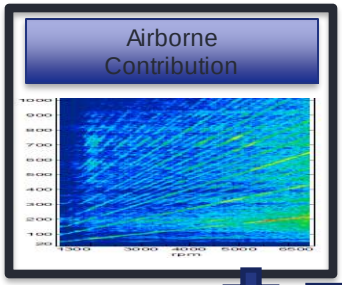
Source

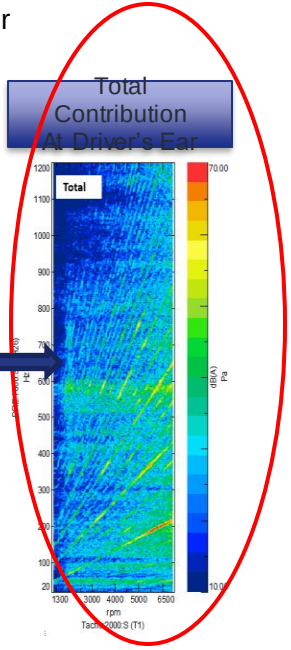
Path

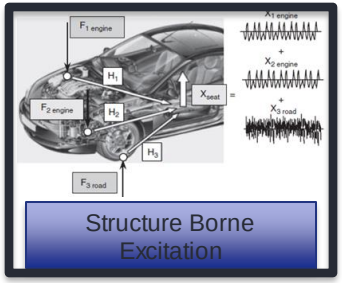
Receiver

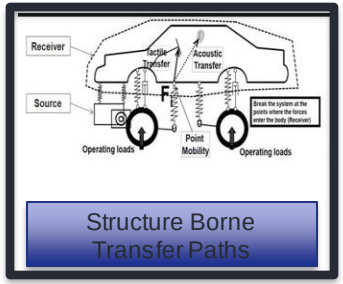


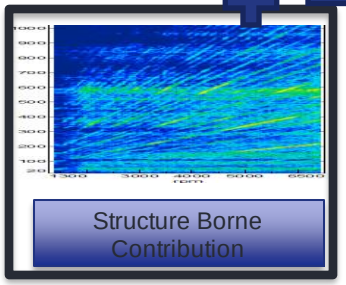






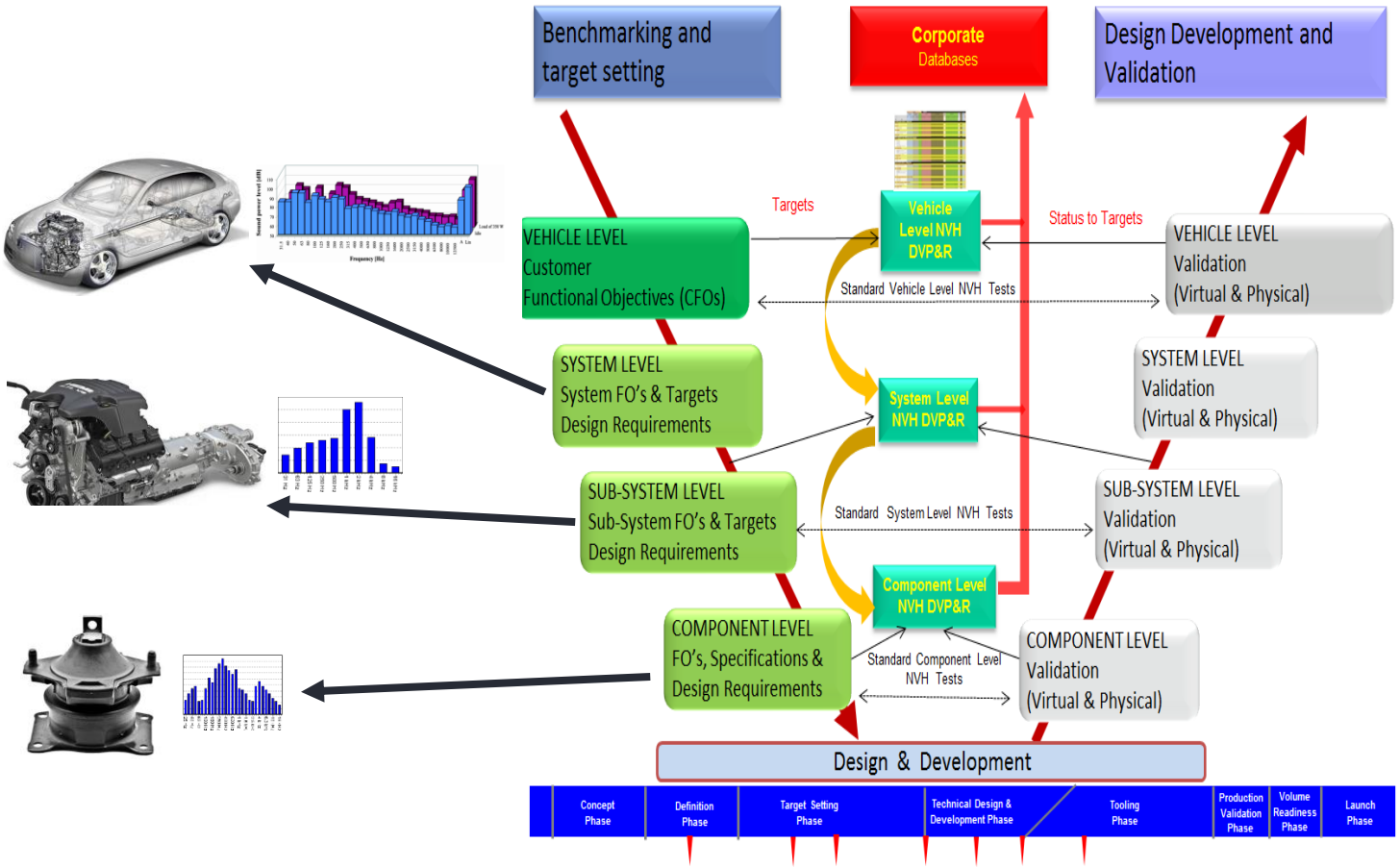




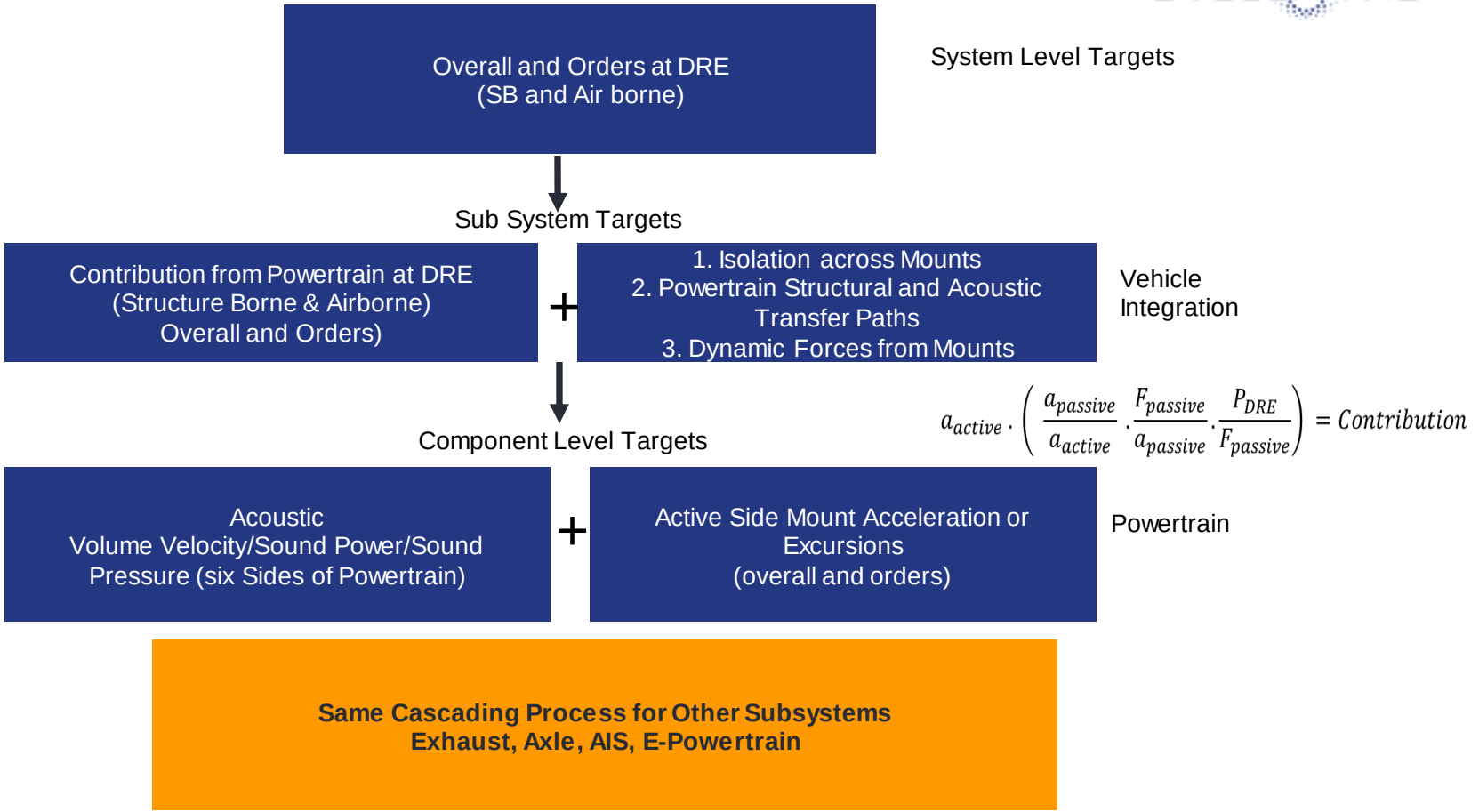


Time-domain calculations allow for the playback of model predictions using DTS,perform listening studies and further data analysis and NVH Target Cascading from System to subsystem and to Component.

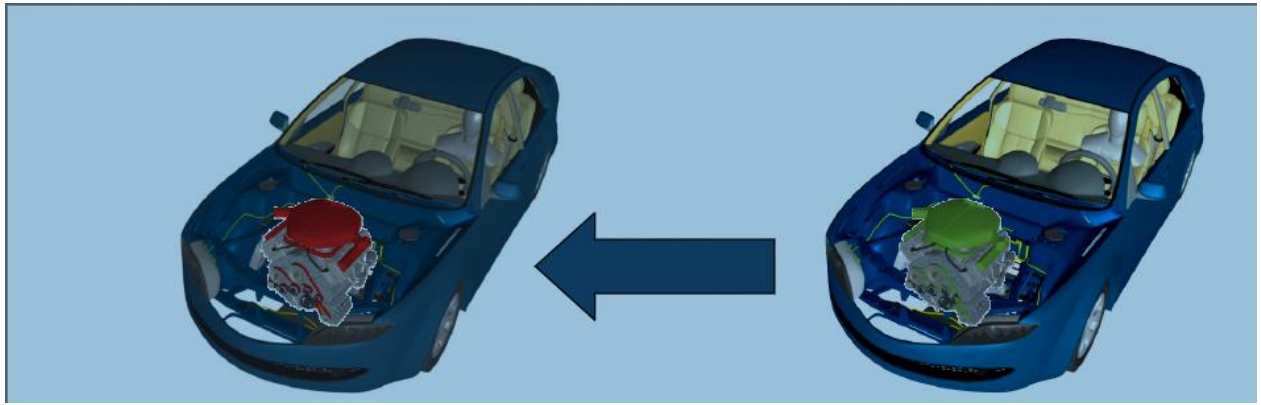
NVH Target Cascading Process (DTS Model 3)



Target Cascading Powertrain System, Subsystem, Component



Powertrain Swap using DTS level 3 Models



- Mostly used for Upcoming Vehicle Programs.
- Target Vehicles: Path
- Source: Intended Powertrain
- Prediction at Receiver

Project # 1: EDM Noise performance

Request:

Simulate EDM noise in existing DTS Vehicle Model and perform a listening sessions.

Tasks Performed:

- Existing DTS model was used to include EDM Orders. The EDM model was added using CAE predicted orders. The demo was performed along with Road and wind noise using most recent calibrations.
- Later, Test based orders were used instead of CAE data to simulate the NVH performance.
- Using this model, we simulated modulation phenomena of orders being closed to each other.

Result:

- DTS Model revealed that EDM noise was not completely masked with Engine, Road and Wind Noise.
- Optimal EDM order separation for minimal modulation.

Usage:

- Design considerations in modulation avoidance.
- Correlation activity for powertrain CAE.
- Improvements to EDM orders for acceptable levels.

Project # 2: Powertrain Mount Bracket Design Evaluations Using DTS Level 3 Model

Request:

Upcoming Vehicle program's ICE PT mount brackets are not meeting dynamic stiffness targets. Simulate effect of **five designs** developed by CAE using a Level 3 Model.

Tasks Performed:

- A Powertrain swap analysis was carried out using intended Vehicle with intended powertrain to create Level 3 DTS Model.
- Mount Backets Accelerations were simulated for all five designs using ratios provided by CAE analysis.
- Analysis was run (Multiple iterations) and contributions at Receiver Microphones from all three mounts were evaluated.
- Results were simulated in DTS and sound annualization sessions were done to the project teams.

Result:

- Simulations show that Design # 1 is worst design. Design # 5 is best design.
- This result has been verified by listening sessions.

Usage:

- The results was used to pursue usage of Design # 5 as opposed to Design # 1.

Project # 3: DTS Model to assess EDM Problematic Orders.

Request:
Create a DTS Model to simulate the Upcoming Vehicle program's Two orders which are not meeting NVH Targets.

Tasks Performed:
- A Target Vehicle's Level 2 model was used to develop the DTS model for this study (Masking; road and wind).
- EDMs Problematic orders were Modeled using Test Data & Target Vehicle's Acoustic Transfer Paths.
- Results were simulated in DTS and sound annualization sessions were done to the project teams.

Result:
- Organized Several Listening sessions to demonstrate the contributions from EDM orders.
- Consensus of the team was that order which is not meeting the target would pose an issue.
- Performed what if study on the DTS model to show new target level for the problematic order.
- Evaluated Reduction in sound Level for acceptable level.

Usage:
Powertrain Performance group will use this information to make necessary changes to either source or transfer function for acceptable level.

Project 4: DTS Model to assess effect of Snorkel noise contribution at Receiver Microphone.

Request:

Create a DTS Model to simulate the effect of snorkel location change in upcoming vehicle Program.

Tasks Performed:

- Intended Powertrain swap was carried out in a Target vehicle.
- Contributions at Driver's right ear was evaluated from Snorkel. Overall, orders of contributions were shared with the team.
- Acoustic Transfer path was measured from new locations
- Evaluated the contributions Change due to snorkel location Change at Receiver.

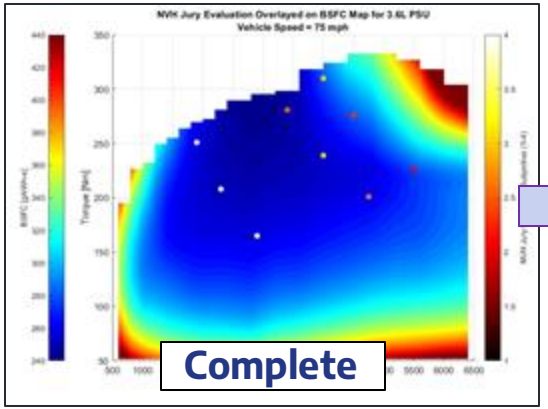
Result:

- Snorkel contribution change at Receiver was moderate.

Usage:

- Analysis is being used to reexamine snorkel noise location and make necessary design alterations to be acceptable according to program requirements.

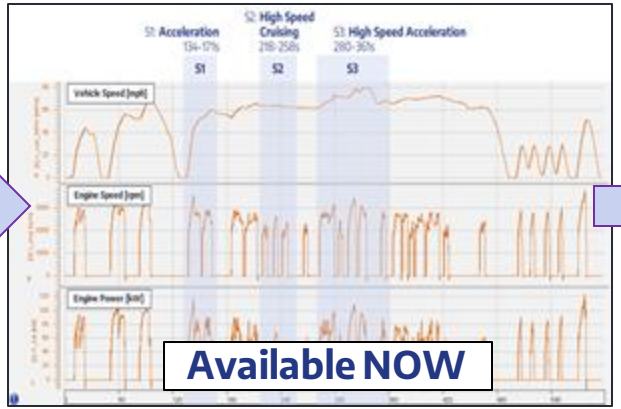
Steady State Speed/Load Points



Complete

- Enablers
- Engine speed / load
- Background noise

Passenger Seat Evaluation



Available NOW

- Specific time traces from US06 profile
- Selected engine operation strategies

Driver Seat Evaluation

NVH Simulator

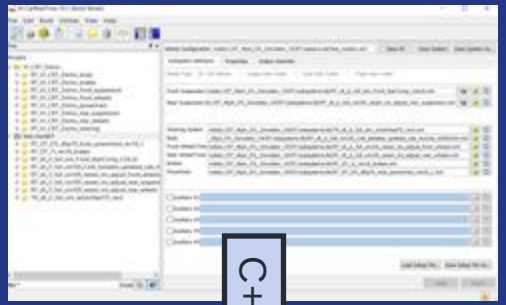
In Development

- Driver input (pedal)
- Integrated vehicle model (VI-CarRealTime)
- Integrated control system (ISS)
- Selected engine operation strategies

NVH Simulator – VI-CarRealTime Interface using DTS Plugin: Future State

STELLANTIS

VI-CarRealTime Vehicle Model



C++ API

Standalone Executable VI-CarRealTime Vehicle Model (Engine+Trans+Vehicle) (Vi-CarRealTime Solver)

(Communication with NVH Simulator at fixed time interval)

- Input/output signals shown are specified for 1st version of testing interface script
- Full list of DTS plugin interface input/output signals are available.

DTS Plugin

UDP Network Communication

Engine RPM | Engine Torque | Vehicle Speed | Gear

Steering Angle | Throttle | Brake

NVH Simulator

Questions