



*The Role of the NVH Full Vehicle Simulator in JLR's
Early Engineering Validation Workstreams.*

Gavin Stout 25/4/23



01 Presentation objectives

- What is the primary role of the FVS at JLR?
- Where does the FVS fit into the product Lifecycle at JLR?
- An example of model build process in a Battery Electric Vehicle application.
- What are the key pre-requisites in transitioning the FVS to become integral to the NVH Department?



Section 1

What is the primary role of the FVS at JLR?



FVS High Level Build Discretisation

Two fundamental bookends to the model build process:

Test-Track Benchmark Model:

1

- Generally reserved for benchmarking vehicles that are to be used as comparators/references against which to compare detailed models.
- Alternatively built using data from mature prototypes for Road and Wind noise contributions as well as full vehicle customer level correlation data.
- Depending on acquisition requirements, car will need to follow the relevant instrumentation procedure (standard vs multiple coherence).
- If competitor benchmark, additional overhead of performance model creation is necessary.
- A standard benchmark model will take 3-4 days to instrument and measure, followed by 2-3 weeks to build the noise & vibration model and performance model.
- Head and Siemens acquisition systems can be used to measure but HBK/VI-Grade Data preparation software is necessary for the preparation of simulator compatible data.

Discrete System Source-Path-Receiver Model:

2

- Principally engineering program focussed although a benchmark TPA could also be used to build this level of model.
- Individual system contributions built from the ground up through the combination of source strengths for multiple load-cases and transfer functions from corresponding forcing locations.
- Facilitates the design maturation process allowing target system forcing and body sensitivity to be replaced by both CAE generated and measured equivalents.
- Highly data greedy and requires careful consideration of source and path assumptions for correct data coupling with the final build conducted either in Matlab Toolbox, CAE Auditor software, or manually in NVH Simulator software
- Depending on quality and format of source data, a complete vehicle model can take between 2 days to 2 weeks to build (Matlab). Iterations of specific design changes can be turned around in 1 – 24 hrs depending on method and application.
- Usually aimed to be controlled via Simulink performance model although NVH Simulator internal performance model can be requested from Powertrain colleagues.



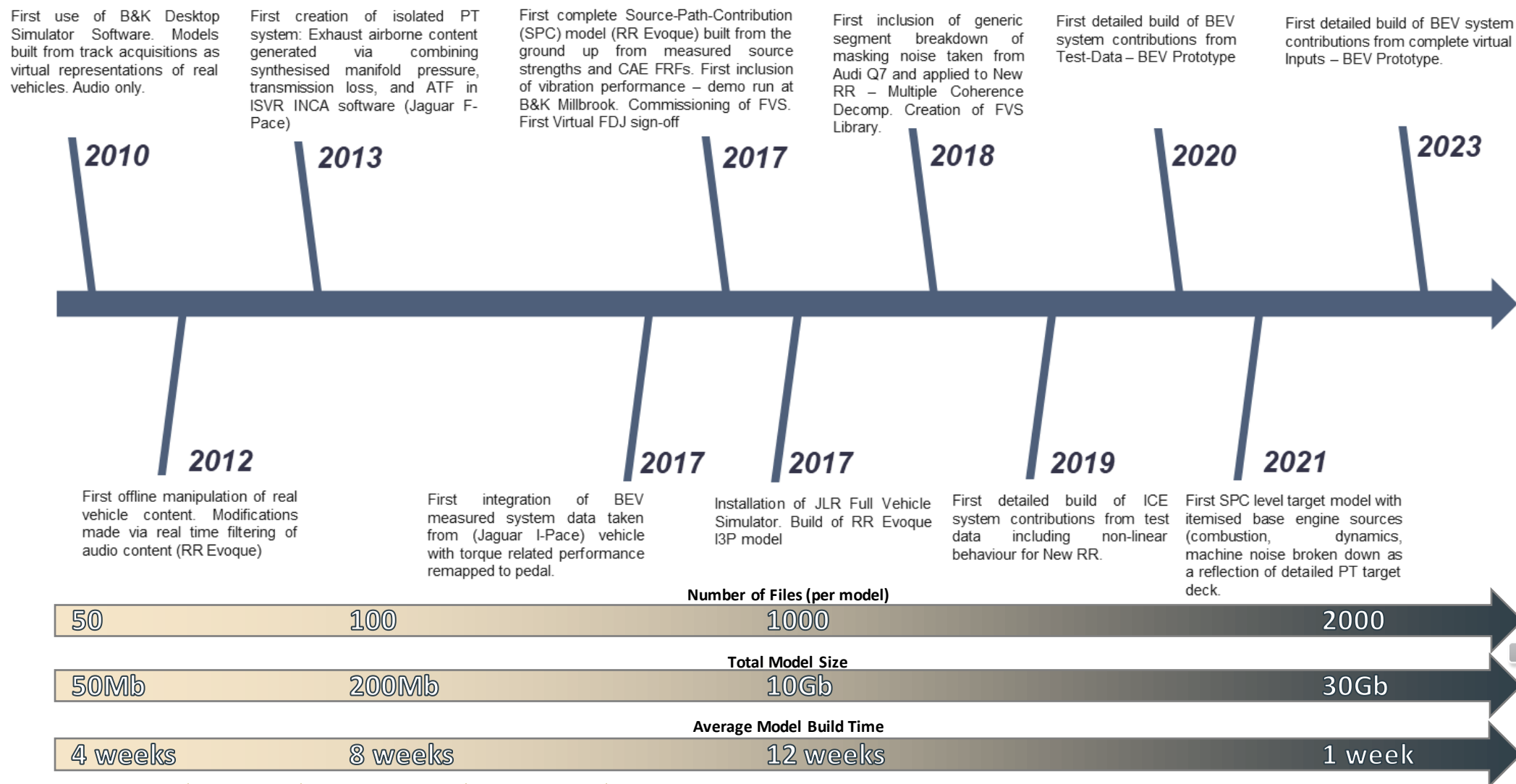
Primary Description and Application

The Full Vehicle Simulator, and the processes which generate the data that feed it, are built on the foundations of Non-linear Transfer Path Analysis, translating the detailed breakdown of complex multi-source noise and vibration excitation and presenting it in an elementary context which enables the clear assessment of customer level impact.

- Confirmation and validation of NVH Targets: Vehicle, System, and Component
- Customer level interaction with NVH Data
- Provides a completely repeatable driving experience resulting in consistent subjective evaluation
- Supports the iterative comparison and validation of design concepts.
- Supports instantaneous back to back assessment of multiple vehicles and configurations
- Process of building models provides deeper insight into vehicle NVH performance ahead of detailed contribution analysis.
- Solves the problem of having no physical properties prior to Engineering Pens Down.



Evolution of NVH Vehicle Simulation Process

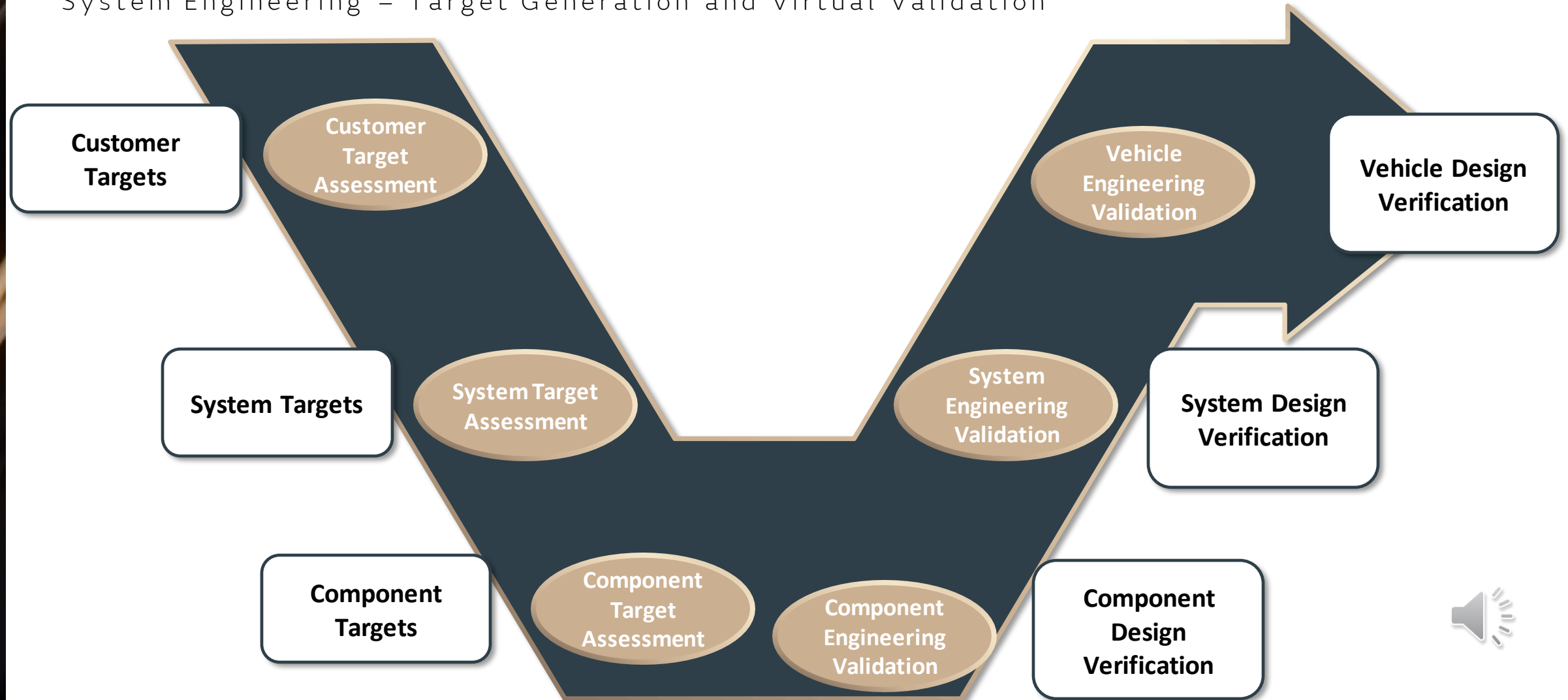


Section 2

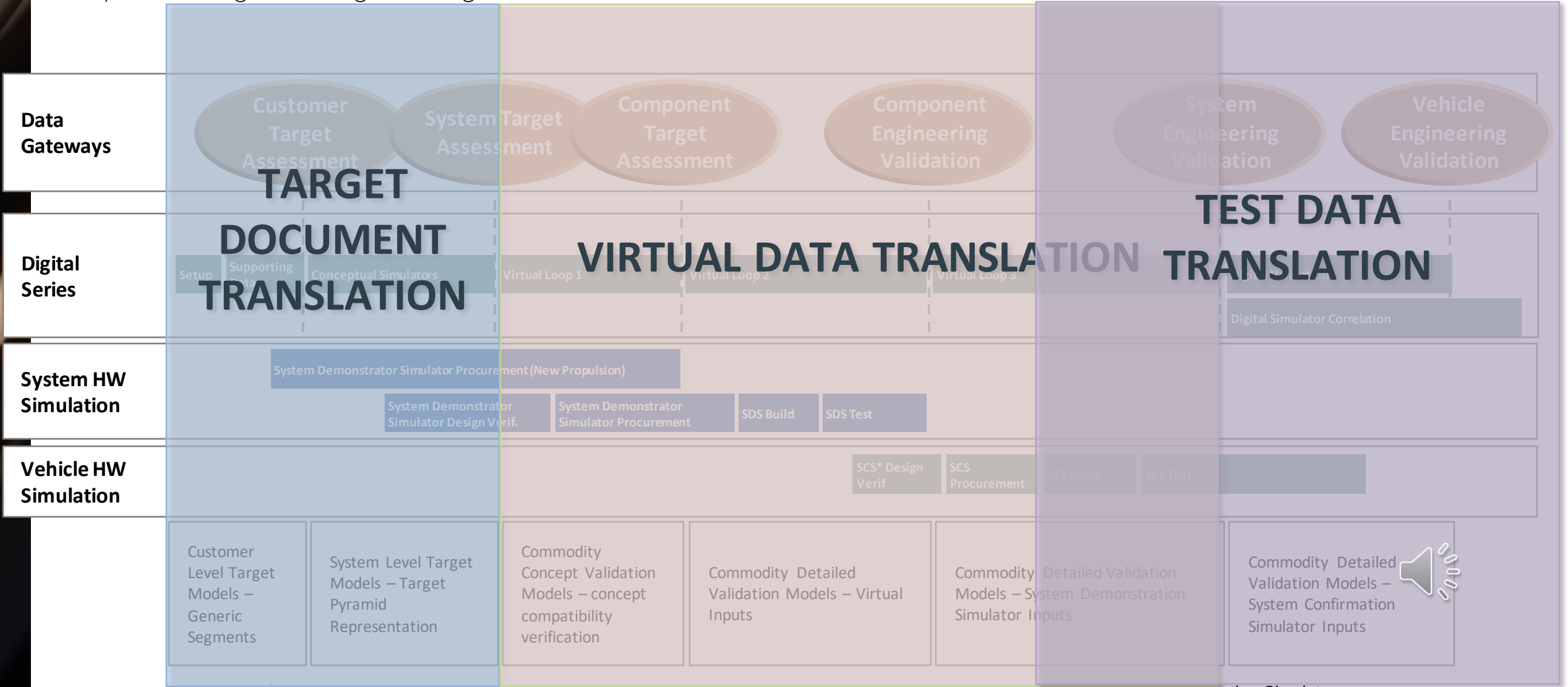
Where does the FVS fit into the product Lifecycle at JLR?



System Engineering – Target Generation and Virtual Validation



System Engineering – Target Generation and Virtual Validation

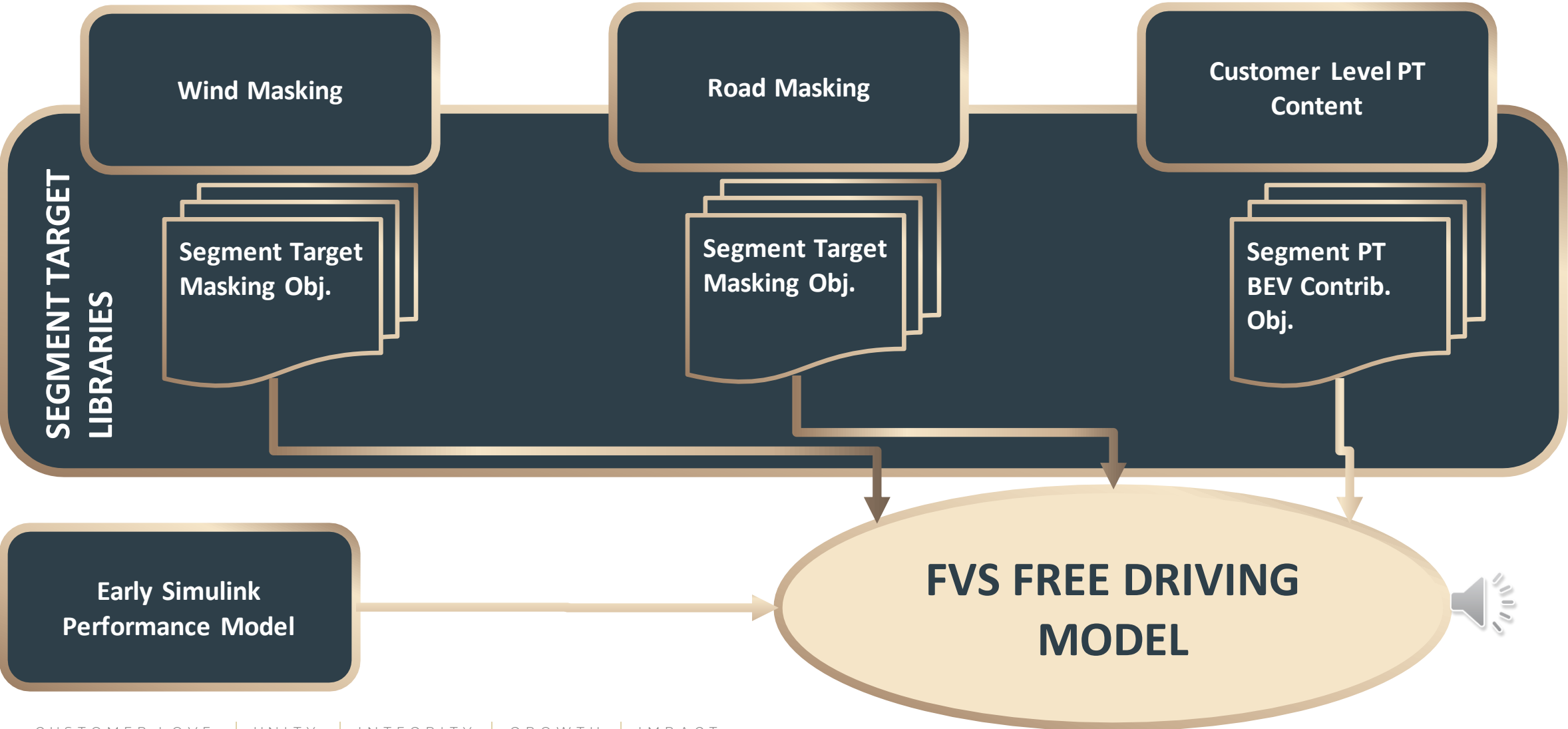


Section 3

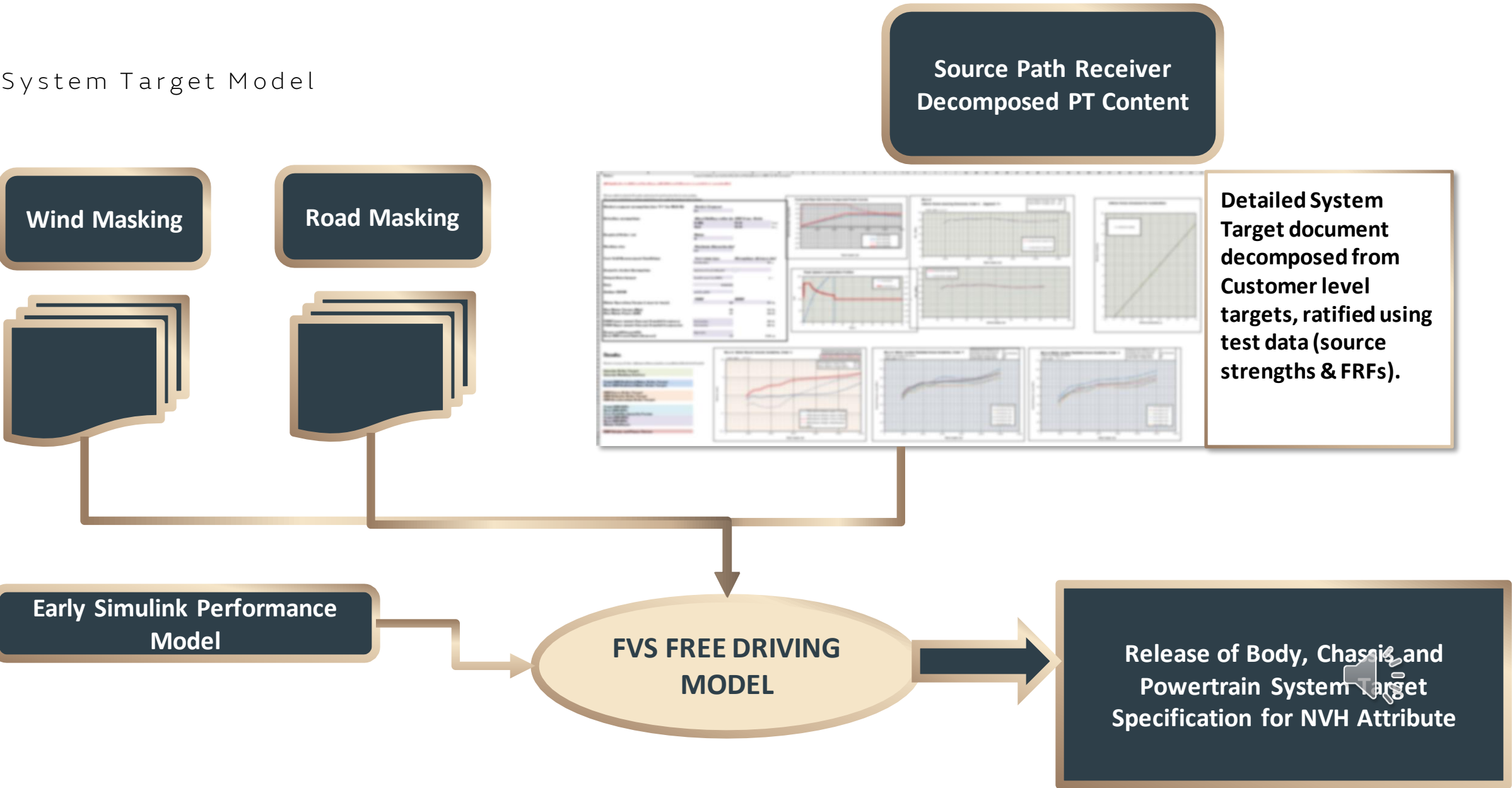
Example of Discrete Model Build for BEV Application



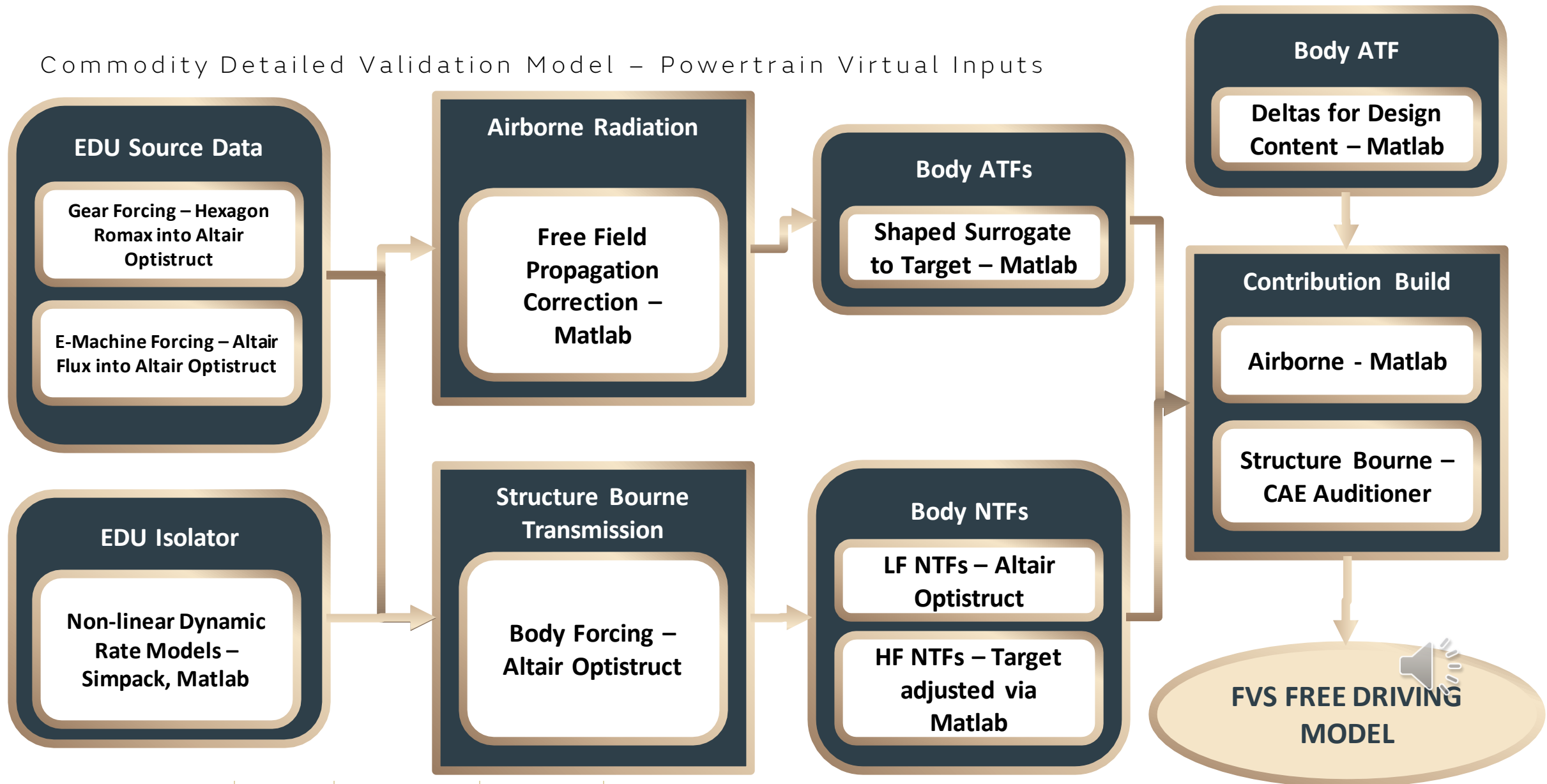
Customer/Contribution Level Target Model



System Target Model



Commodity Detailed Validation Model – Powertrain Virtual Inputs



Section 4

- What are the key pre-requisites in transitioning the FVS to become integral to the NVH Department?



What are the key pre-requisites in transitioning the FVS to become integral to the NVH Department?

JAGUAR LAND ROVER

- Invested confidence from the Leadership Team
 - Benchmarking (experience of known vehicles)
 - Correlation
 - Process repetition
 - Time
- Reduce the model build time
 - Intra-departmental DOFID convention
 - Homogenised Datasets – Target, Virtual, and Test (translation tools)
 - Develop an external toolkit to Automate (speed and consistency)
 - Simulink Integration
- Results optimised for correct forum
 - Free Driving models where time allows
 - Fixed Driving models for quick communication
 - Quick extraction of results vs target for Issue Identification and Formalised Engineering Validation



Gavin Stout

Powertrain Sound Quality Subject Matter Expert

Mobile: (+44)7469038981

gstout@jaguarlandrover.com

