ASHOK LEYLAND

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Development and Deployment of Virtual Test Systems

An enabler to faster and efficient vehicle development

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Vehicle Dynamics Attribute Engineering

Ashok Leyland Product Development

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24 April | Hyderabad
26 April | Pune

Contents

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Objective

- Develop and deploy the methodology of virtual testing for vehicle dynamics.
- The new system to be parametric, capable to predict key parameters of interest to vehicle dynamics analyses.
- Adept in sustainable utilization through the life cycle of vehicle and enable optimization & automated testing.

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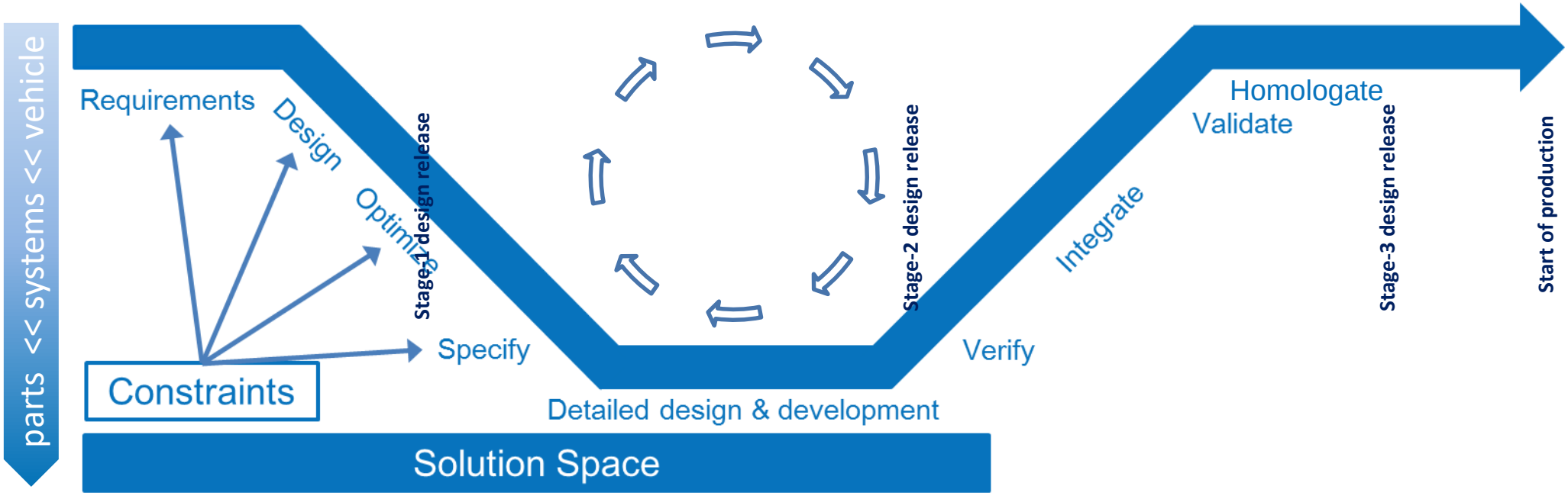
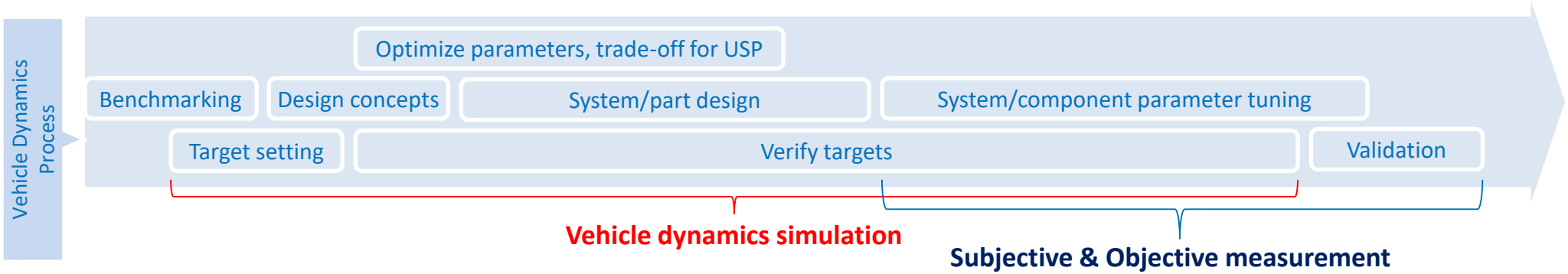
Vehicle development and engineering the vehicle dynamics - process





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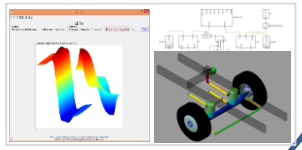
Vehicle dynamics simulation process

Vehicle data

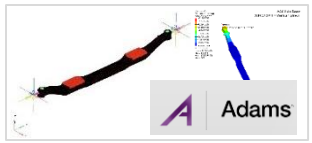
Vehicle model

trucksim MECHANICAL SIMULATION

Models/Methods



Part/system data



Tests and Maneuvers

- Ride Tests
- Handling Tests
- Transient Response Tests
- Stability Tests …

Safety

Vehicle characteristics -

Feel & Response

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Overview of testing for vehicle dynamics simulation and its inputs

- Apart from development and tuning tests of vehicle, specific rig tests of vehicle and its systems are needed for useful vehicle dynamic simulations.
- Traditionally this tests are done with huge special purpose machines.
- A complete physical vehicle is loaded on the machine. Depending on the type of machine either all the tires or vehicle chassis are fixed to ground.
- Depending on the type of fixing(tires or chassis), 3-directional load and torque is applied in defined sequences.
- Forces, moments and deflections are measured at various points in the vehicle and vehicle systems to generate required parameters.

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An effective TruckSIM model needs to have significant parameters for useful results

Axle dive: Dive table
No Caster Change

Axle X movement: Longitudinal Movement
No movement (R = 0)

Axle Y movement - jounce: Lateral Movement
No movement

Axle Y movement - roll: Lateral Movement
Roll Center: 53 mm Below Axle

Compliance Coefficients

	Left	Right	
Toe vs Fx:	0	0	deg/N
Steer vs Fy:	0	0	deg/N
Steer vs Mz:	0	0	deg/(N-m)
Camber vs Fx:	0	0	deg/N
Inclination vs Fy:	0	0	deg/N
Inclination vs Mz:	0	0	deg/(N-m)

Axle longitudinal vs Fx	0	mm/N
Axle lateral vs Fy	0	mm/N

Kinematic Properties

Nominal steering gear ratio: xx deg/deg

Speed Effect: Steer Gain vs. Speed
Always Steered

Define steer angles in vehicle coordinates

Left Wheel Kinematics: Steering kinematics
Left Wheel, 5 m Wheelbase

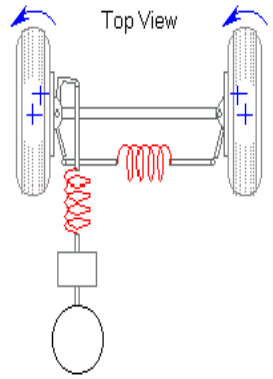
Right Wheel Kinematics: Steering kinematics
Right Wheel, 5 m Wheelbase

Ground-Friction Low-Speed Steer Torque

Left Side: Parking Torque
Zero

Right Side: Parking Torque
Zero

Steering Compliance

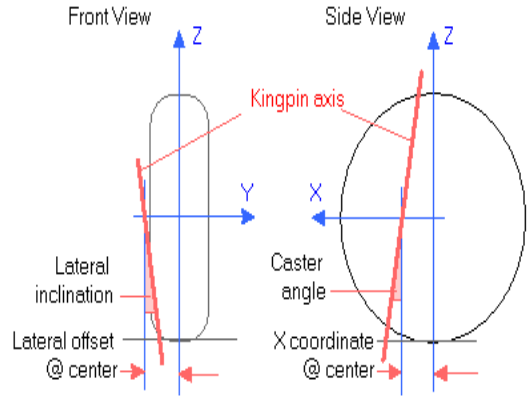


Steer left wheel

Tie rod compliance: right-wheel steer relative to left wheel due to right-wheel kingpin moment: xx deg/N-m

Steering column compliance: steer of both wheels due to kingpin moments on both wheels: xx deg/N-m

Kingpin Geometry



Axle Interactions

Axle wrap compliance:	xx	deg/N-m
Ratio: steer / wrap:	xx	deg/deg
Wheel steer vs. axle jounce:	xx	deg/mm

	Left	Right	
Lateral offset @ center:	xx	xx	mm
Lateral inclination:	xx	xx	deg
X coordinate @ center:	xx	xx	mm
Caster angle:	xx	xx	deg

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Status quo and challenges

- Specialized vehicle dynamics test rigs for heavy trucks and buses are rare, globally.
- Building specialized rig (for vehicle dynamics parameter measurement) for heavy commercial vehicle is economically unviable due to huge capital, time and less than optimum facility utilization for single OEM.
- Commercial virtual test systems specifically for truck & bus configurations are not yet mature.
- Multibody simulations with existing commercial tools need expertise, detailed vehicle model and relatively more time apart from computationally expensive.
- There is need for seamless integration of virtual test system simulation and truckSIM simulations for faster throughput.
- Current scenario of vehicle development demands hundreds of vehicle configurations to be designed to deliver preset vehicle dynamics performance target.
- In upfront simulations and design tuning, the importance of correct parameters input can’t be overstated.

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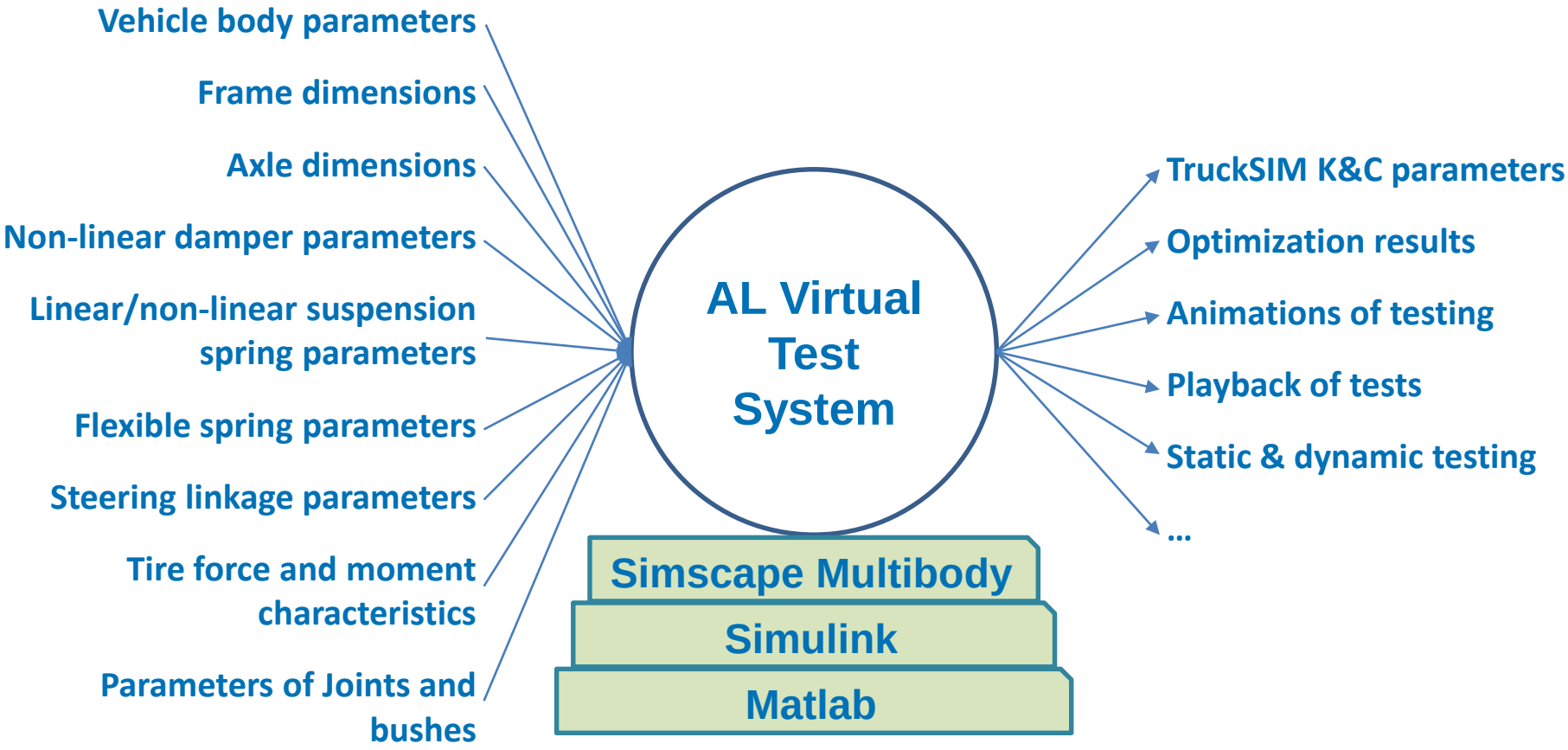
Approach to virtual test system

- Physical modelling using simscape ‘Multibody’ methodology is made use for the development of virtual test system.



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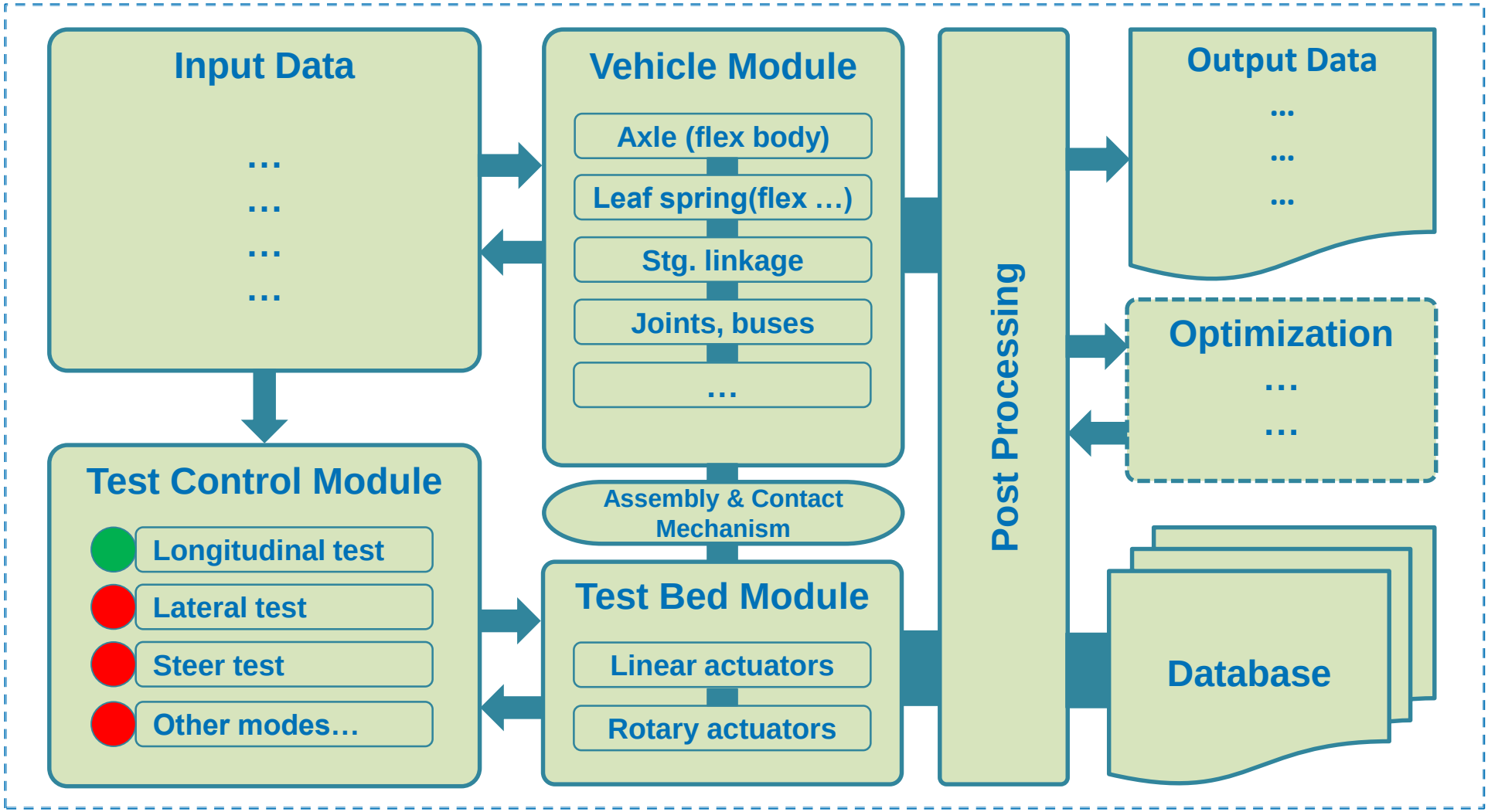
Virtual test system workflow



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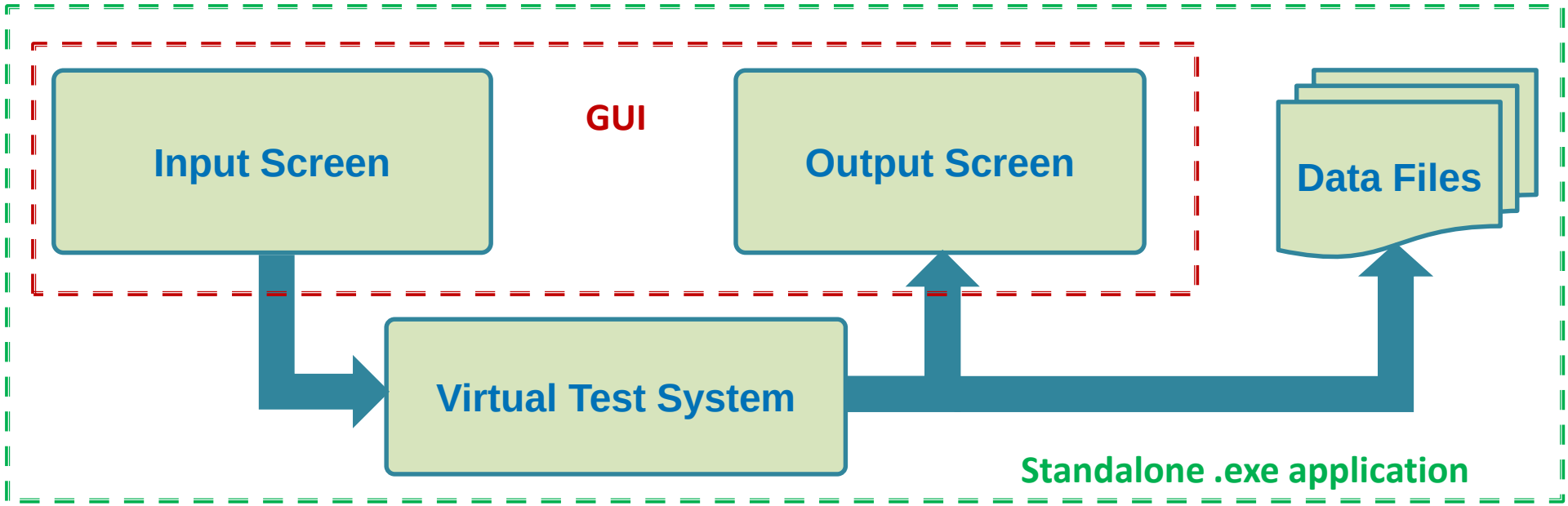
Deployment to user group

- Virtual test system developed in simscape toolboxes are being converted to standalone executables with suitable GUI using MATLAB and Simulink coder tool boxes.
- Such standalone .exe files installed in different user PCs enable various pre-defined tests be performed by vehicle dynamics engineers.
- Thus, wide use of virtual test system by domain engineers for various vehicle projects result in effective upfront engineering.



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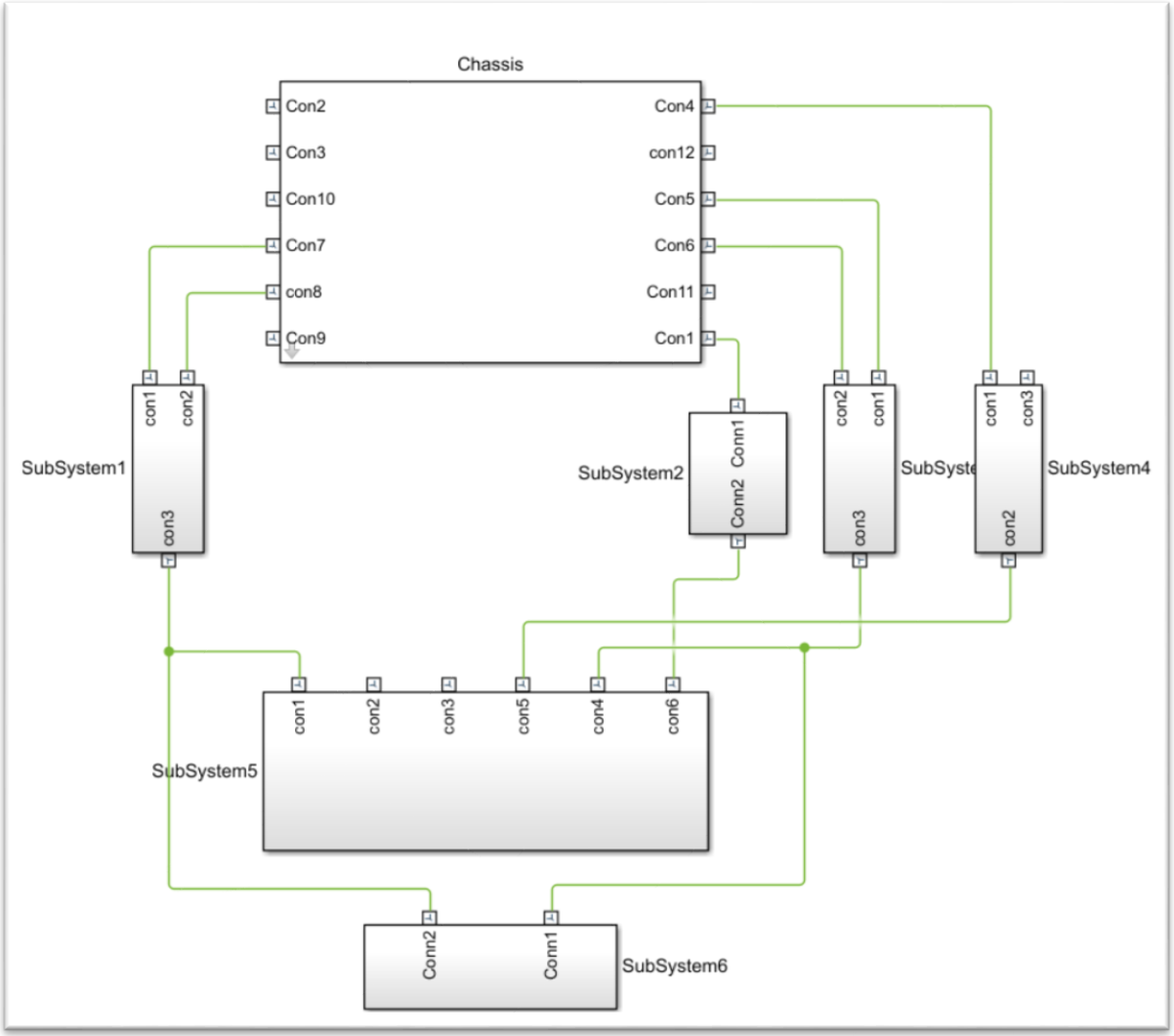
The solution: Virtual test system by simscape multibody



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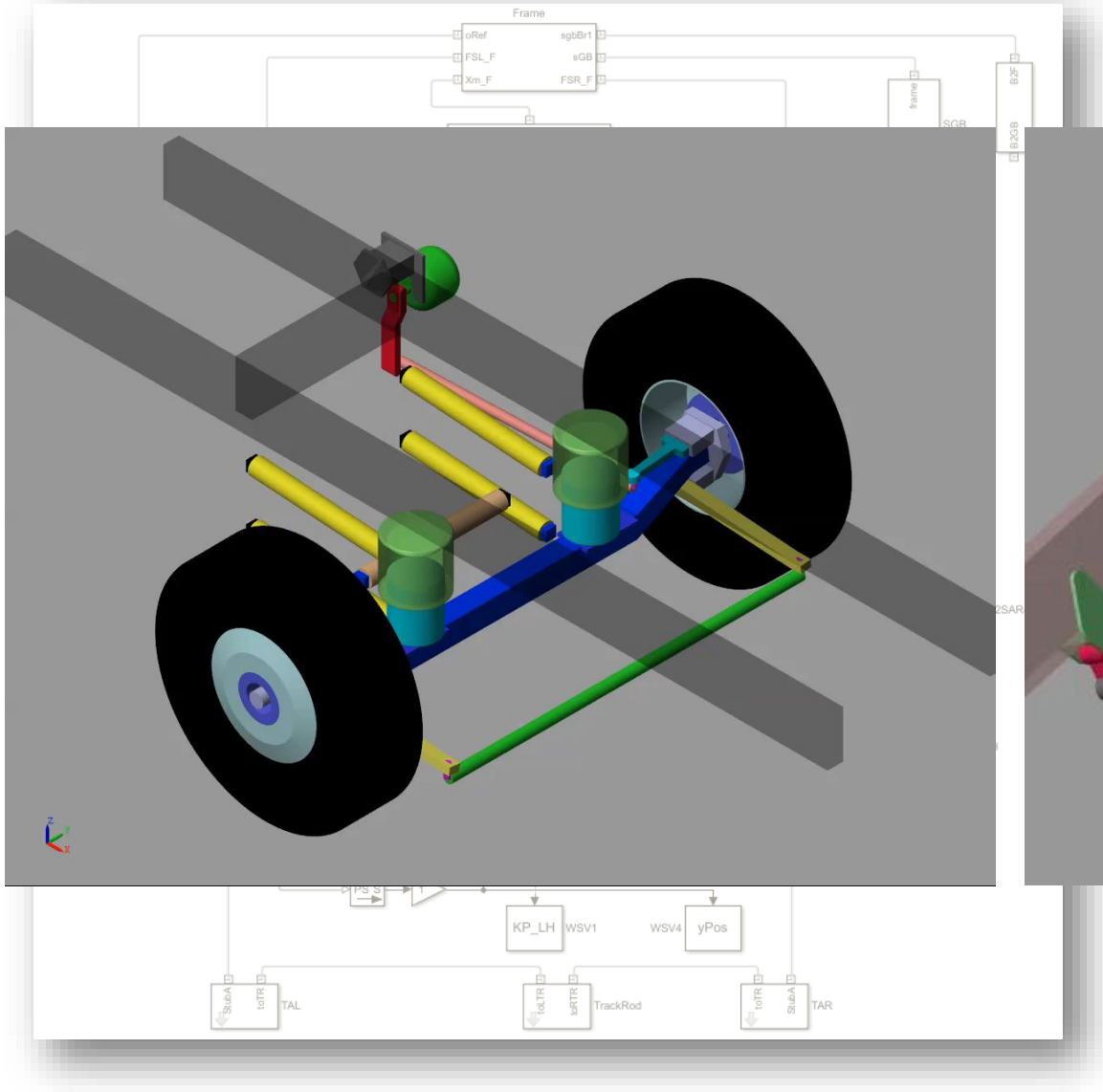
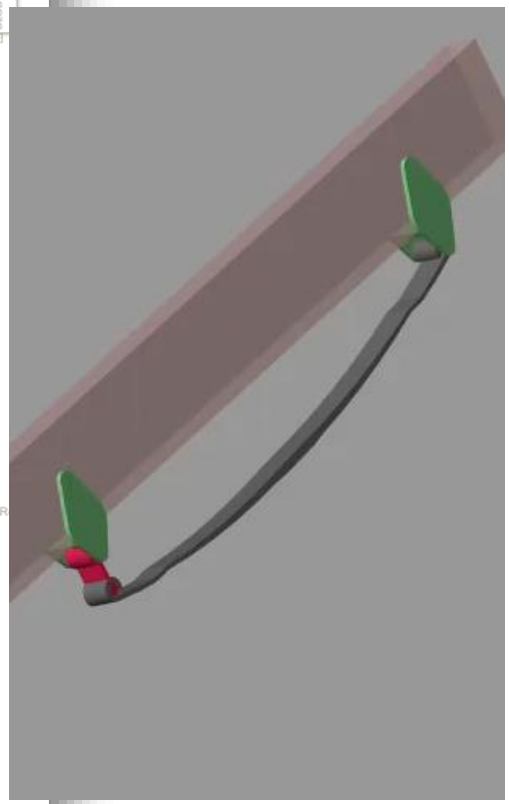
The solution: Virtual testing by simscape multibody…

Features

- ✓ **Parametric model & less no. inputs**
- ✓ **Design optimization**
- ✓ **Scalable (2Axle, 3Axle, 4Axle, 5Axle trucks & buses…)**
- ✓ **Variants in minutes**
- ✓ **Models inertia, joint friction, stiffness…**
- ✓ **Highly customizable**
- ✓ **100% In-house (No-license fee)**





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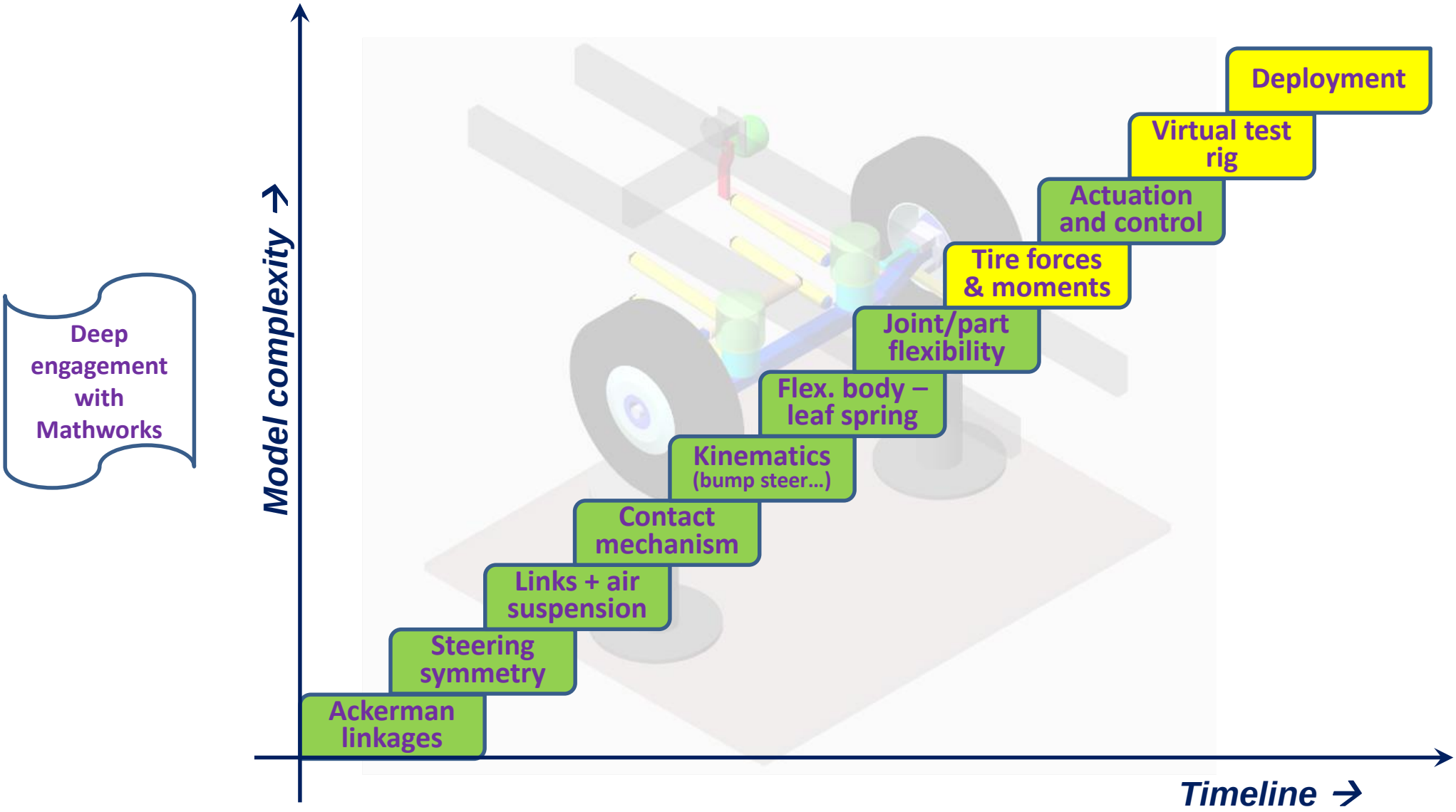
The solution:….Modular virtual testing system delivering needs of system design



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The benefits

- No capital investment, faster throughput
- Analyze hundreds of vehicle configurations otherwise not feasible
- Effective target cascading and efficient target verification
- Aids what-if: throughout the development life - concept to production.
- Effective optimization and co-simulation
- Enables virtual testing of futuristic products/technologies.
- Results in effective trouble shooting of issues and possible solutions matrix.

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Thank you!

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