



Redefining Realism & Efficiency: Volvo Cars' Driving Simulator Journey Using Adams

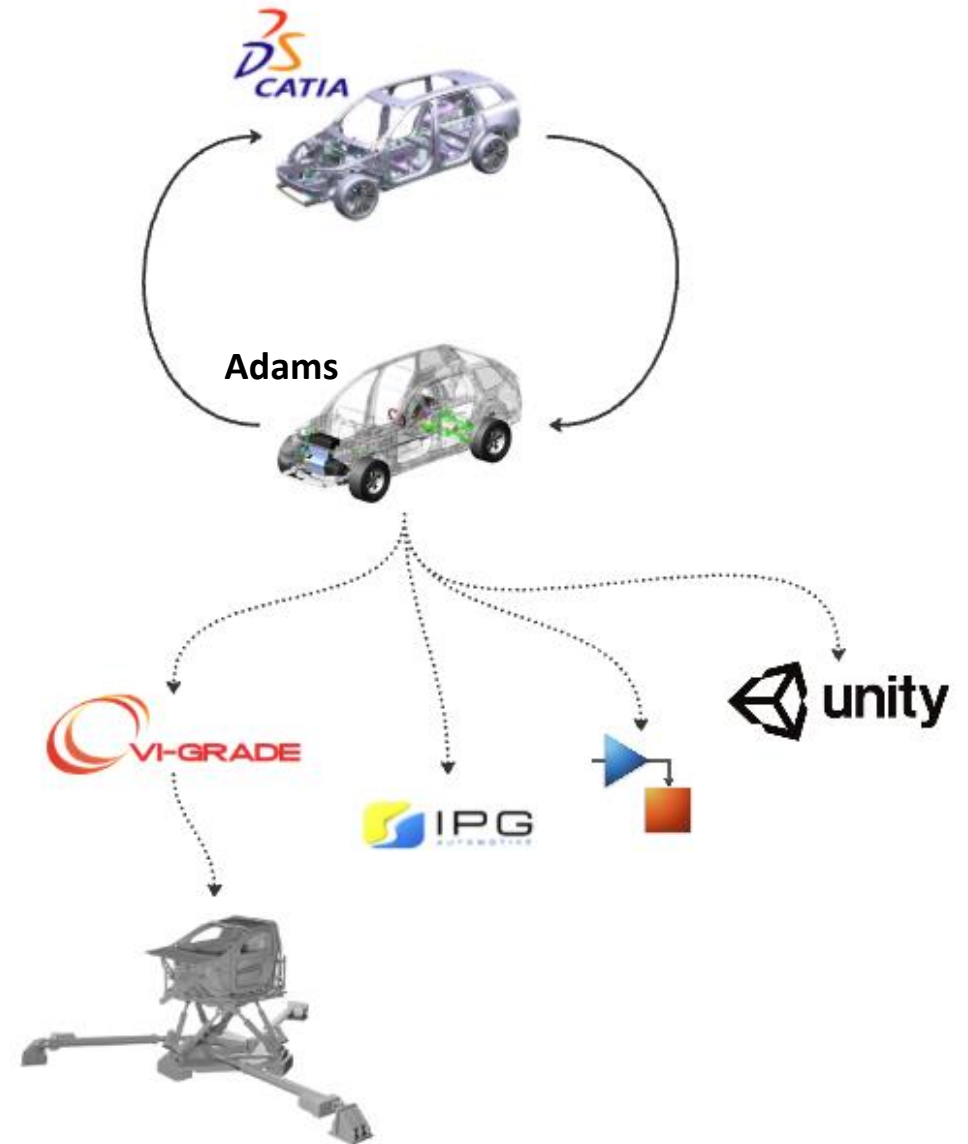
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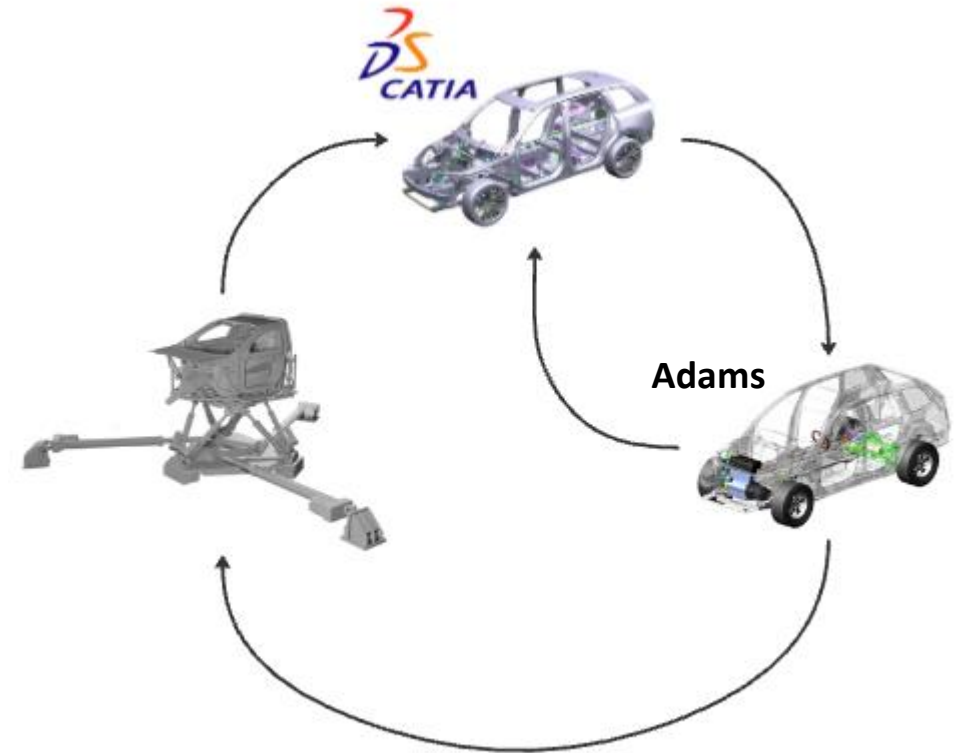
Legacy

- Adams Car is the main Multi Body Dynamics simulation software at Volvo Cars - primarily used in the fields of vehicle dynamics, durability and powertrain dynamics.
- Adams Car acts as “high-fidelity master model” for other vehicle simulation software used in other domains.
- VI-CarRealTime has a native connection with Adams Car and has been the real-time standard for many years.
- Volvo Cars uses the VI-Grade “turnkey” product solution in the DiM150 since 2014.



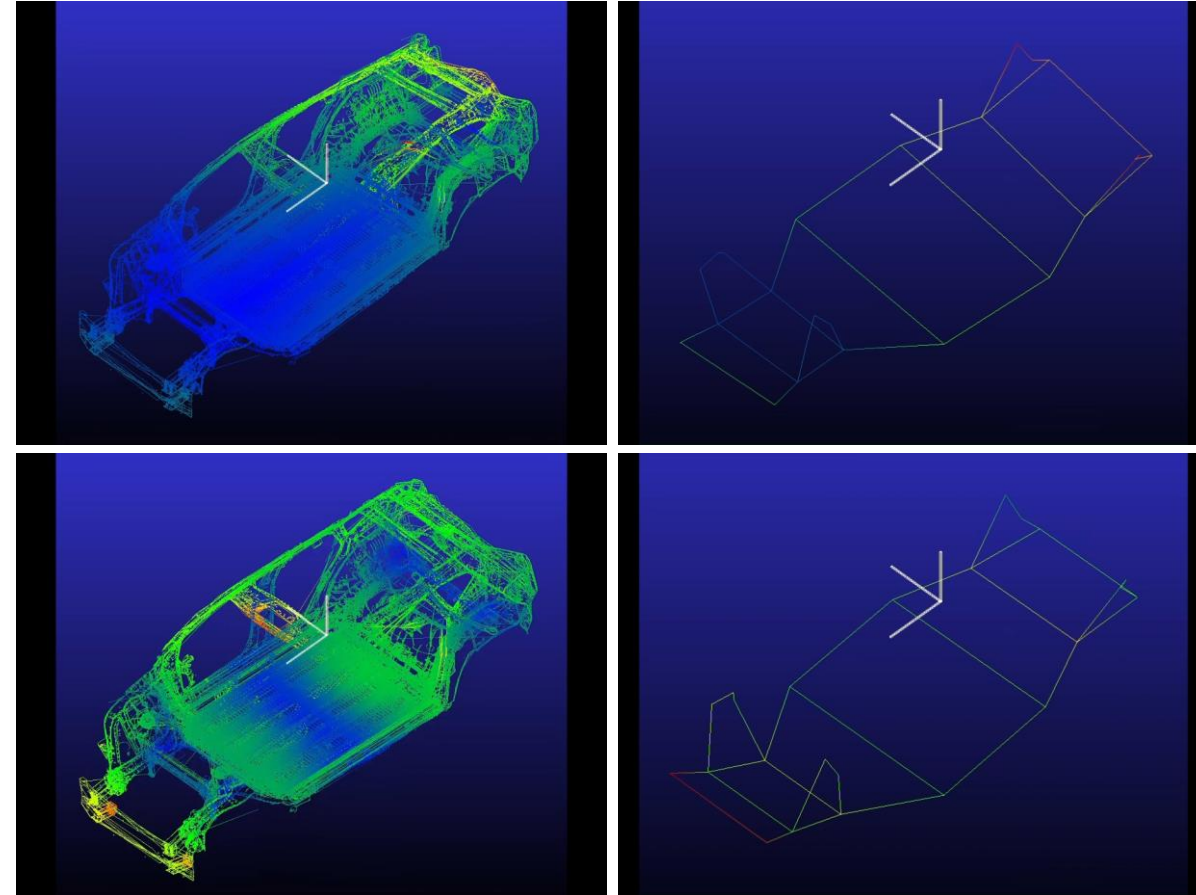
Motivation for Adams Real Time

- Faster iterations of drivable simulator models.
- Eliminate error prone “export” step.
- Use same model as analysed by other teams.
- Subjective verification is a great model quality check.
- Talk same language (e.g. hardpoint coordinates) as design engineers and tuning engineers.
- More accurate time evolution of component states.



Requirements

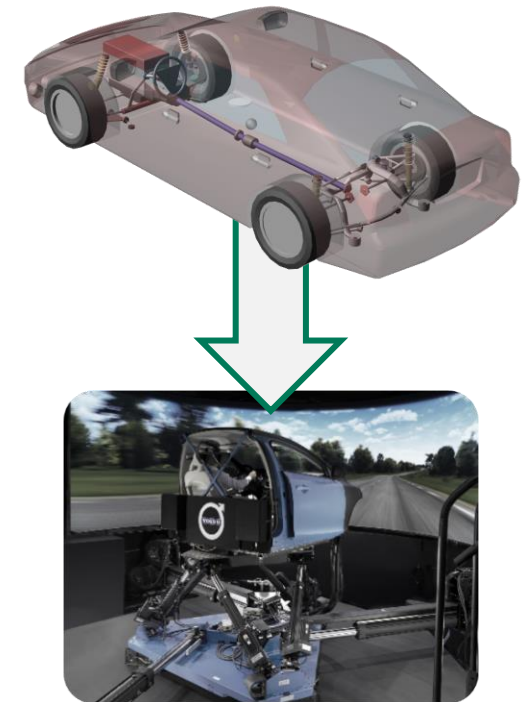
- Real-time @ 1kHz.
- Cosimulation with controllers.
- Balanced trade-off between fidelity and real-time performance.
- Generic modal reduction method for components.



Multibody dynamics (MBD) and real-time simulation

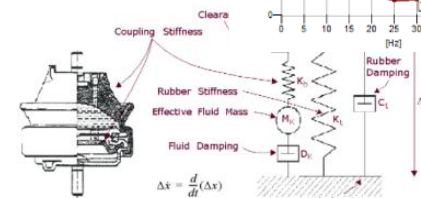
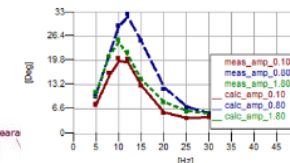
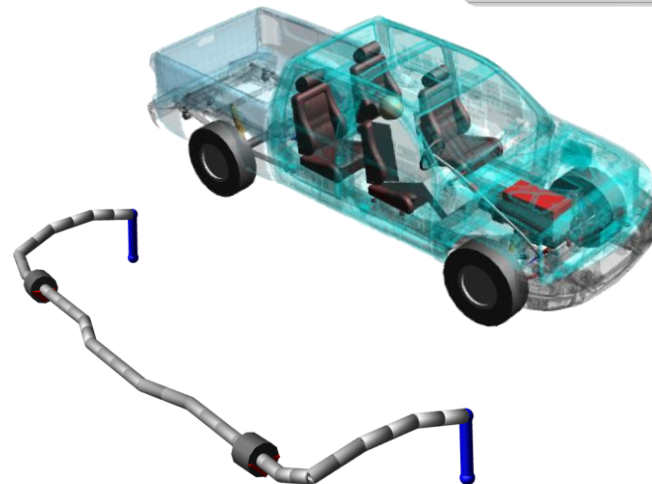
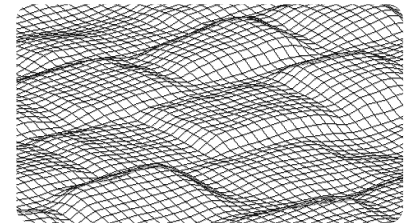
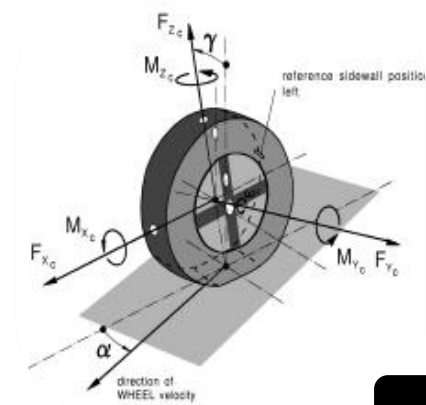
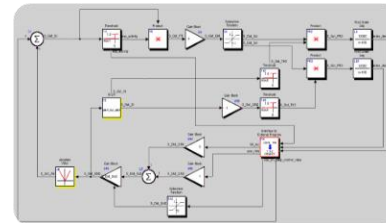
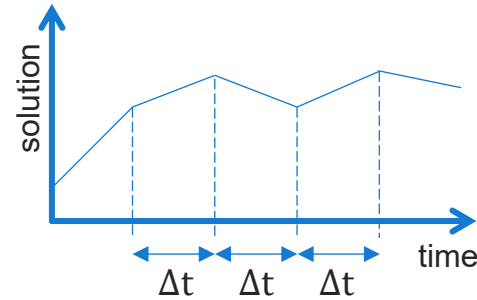
- MBD is famous for its high level of detail and accuracy
- Can it be real-time capable?
- Motivation:
 - No conversion → Faster and reliable workflow
 - No reduction → Higher fidelity models
 - Use existing models, and existing integrators
 - Available for wide range of models, not only automotive

$$\begin{cases} M\ddot{\xi} + \dot{M}\dot{\xi} - \frac{1}{2} \left[\frac{\partial M}{\partial \xi} \dot{\xi} \right]^T \dot{\xi} + K\xi + f_g + D\dot{\xi} + \left[\frac{\partial \Psi}{\partial \xi} \right]^T \lambda = Q \\ \Psi = 0 \end{cases}$$



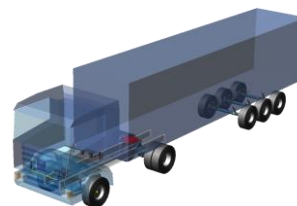
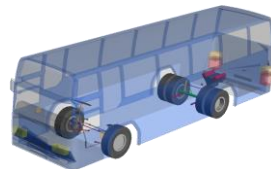
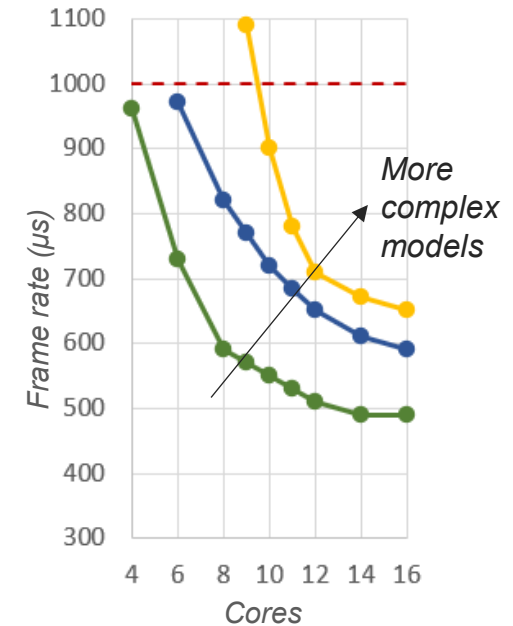
What determines real-time capability of an MBD model?

- Time step size?
- Number of degrees of freedom?
- Component complexity?
- Type of component?
- Flexible bodies?
- Tires?
- Roads?
- Hardware?



State-of-the-art realtime simulation with Adams

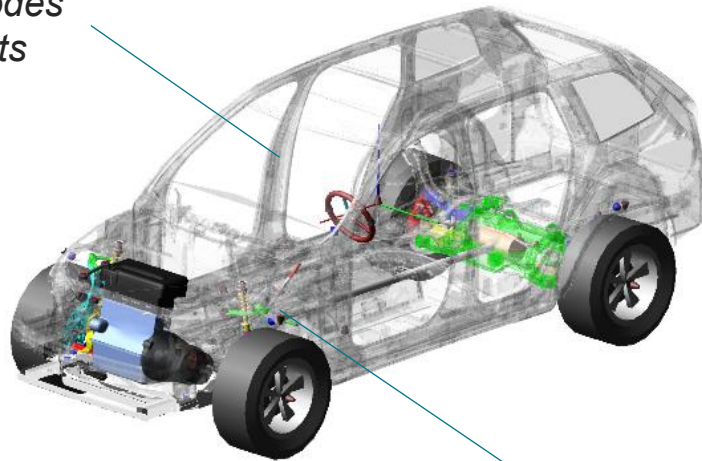
- Solver:
 - Same solver for offline and online simulations
 - No reduction of the equations of motion
 - Large vehicle models scale to 16 cores, and beyond
 - Advanced tire models running on dedicated cores
 - Generally faster solver – and more robust solver
 - Computationally faster components
- Workflow:
 - No model conversion, Adams is used directly in simulator
 - Using FMI standard to package the model
 - Integration with controllers



Real-life case

- Volvo Cars model
 - 820 degrees of freedom in total
 - AutoHawk32: Adams runs on 16 cores @ 3.6GHz
 - Frame rate: 896 μ s

*Flexible body (body-in-grey)
144 active modes
28 attachments*



*Steering control system FMU
Connected via SimWB*

Visit our booth for a test drive!

- Volvo model with CCD dampers
- Flexible car body
- Electric powertrain, dual motors
- Steering system as external FMU
- IDIADA test track



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