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MPMD COUPLING OF SIERRA SD-ACOUSTICS AND SIERRA-SM

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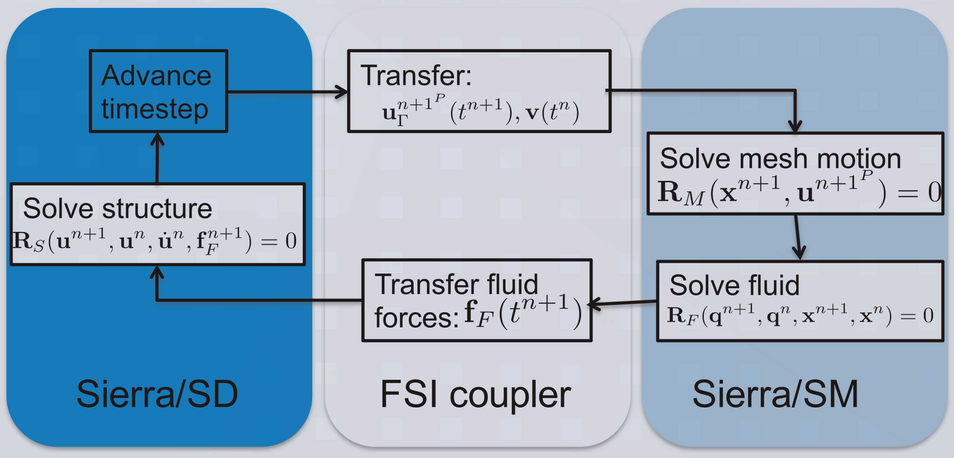
PROBLEM STATEMENT

To couple SD-Acoustics with SM in the time domain using the nemo coupler



Predictor: $\mathbf{u}_\Gamma^{n+1^P} = \mathbf{u}_\Gamma^n + \alpha_0 \Delta t \dot{\mathbf{u}}_\Gamma^n + \alpha_1 \Delta t \left(\dot{\mathbf{u}}_\Gamma^n - \dot{\mathbf{u}}_\Gamma^{n-1}\right)$

THEORY – GSS FSI

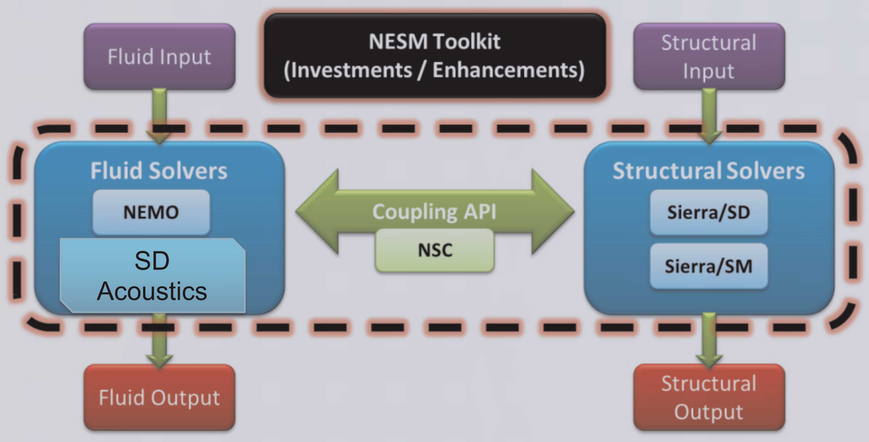
- Rewrite the matrix system with coupling terms on the RHS

$$\begin{bmatrix} M_s & 0 \\ 0 & M_a \end{bmatrix} \begin{bmatrix} \ddot{\mathbf{u}} \\ \ddot{\psi} \end{bmatrix} + \begin{bmatrix} C_s & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} \dot{\mathbf{u}} \\ \dot{\psi} \end{bmatrix} + \begin{bmatrix} K_s & 0 \\ 0 & K_a \end{bmatrix} \begin{bmatrix} \mathbf{u} \\ \psi \end{bmatrix} = \begin{bmatrix} \mathbf{f}_s \\ f_a \end{bmatrix} - \begin{bmatrix} 0 & C_{sa} \\ C_{as} & 0 \end{bmatrix} \begin{bmatrix} \dot{\mathbf{u}} \\ \dot{\psi} \end{bmatrix}$$

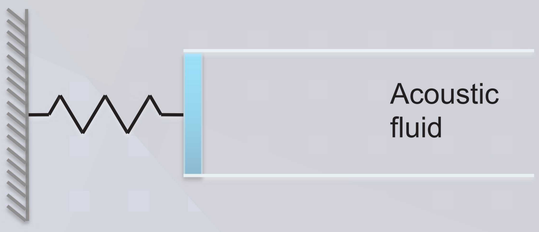
- Structure acceleration and acoustic pressure on RHS must be predicted
- Predictions not entirely independent of solution algorithm!
- Predict both: solve whole system in parallel
- Predict one: system is solved in serial
- Correctors: correct the load on one partition after the other has been solved

IMPLEMENTATION THROUGH NSC

- Leverage Existing SD and SM FSI Interfaces from Nemo Coupling
- All – to – All Communication



VERIFICATION: 1D ACOUSTIC PISTON



Goal: test loosely coupled algorithms to assess temporal accuracy

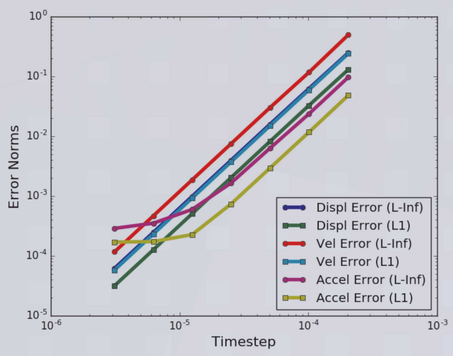
Structure displacement

$$u_s(t) = \mathrm{e}^{-dt}\left(a\cos\omega t + b\sin\omega t\right) + \nu(t-\beta)$$

Fluid solution

$$v_a(t) = \dot{u}_s(t - x/c_a)H(t - x/c_a)$$

$$p_a(t) = p_\infty + \rho_a c_a v_a(t)$$



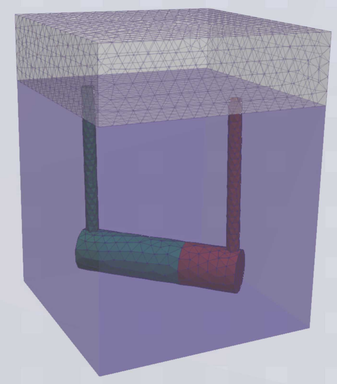
PERFORMANCE TEST

Acoustic domain

- 20,833 linear tetrahedra
- 4,455 DOFs

Structural domain

- 84,315 linear tetrahedra
- 46,230 DOFs



Loosely coupled:

- 1 acoustic processor, 1 structural processor: 2 mins, 13s
- 1 acoustic processor, 10 structural processors: 51s

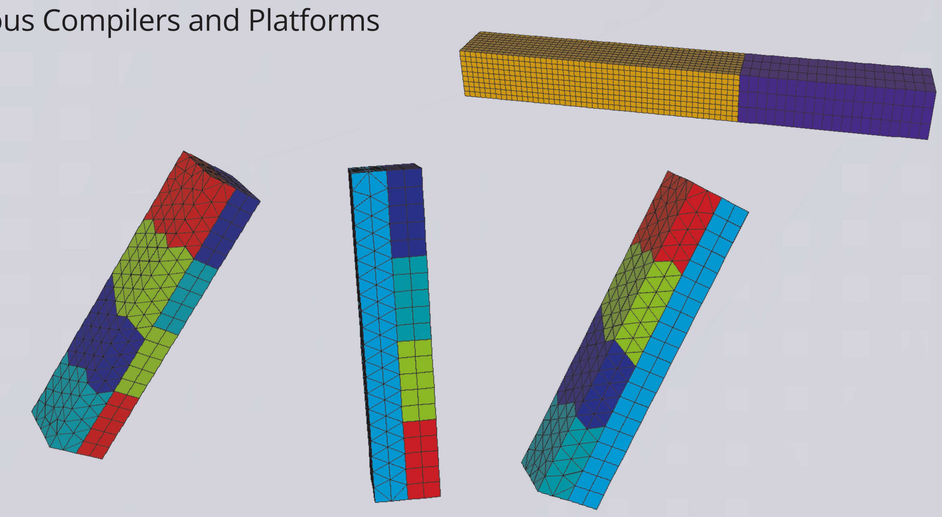
Tightly coupled:

- 1 processor: 2mins, 40 s
- 11 processors: 55s

Tightly coupled wins: ~same time, more accurate

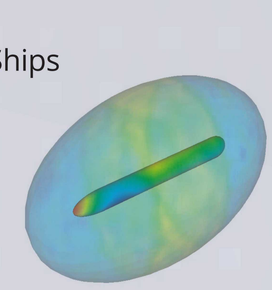
REGRESSION TESTING – ELEMENT TYPES, NONCONFORMING MESHES, PARALLEL CAPABILITY

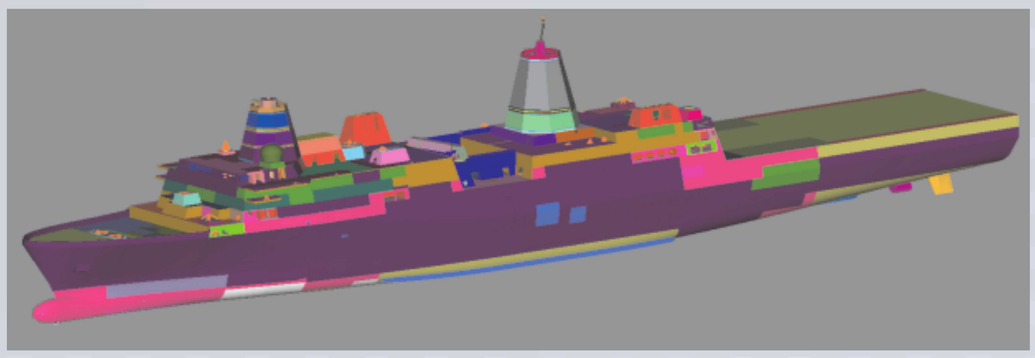
- Parallel – Parallel Support
- Nonconforming Meshes
- Supported Element Types
- Various Compilers and Platforms
- Software Quality Tests
- Infinite Elements
- Scattering Loads



APPLICATIONS

- NESM / CREATE – Ships
- Goodyear Noise Modeling
- Sandia Internal Applications





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