

# PARALLEL GRID COMPUTING FOR LUBRICATION

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## Lubrication of Journal Bearings and Gears

- Surface areas in contact are very small
- Surfaces are rotating very quickly
- Resulting pressures are up to 2 or 3 GPa.
- Under such high pressures the surface will deform
- This is called elasto-hydrodynamic lubrication (EHL)

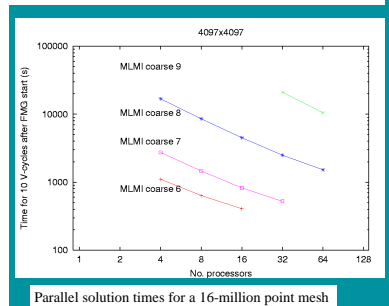


## Parallel Computing

- High resolution cases require many gigabytes of computational memory and vast CPU resources
- Global deformation makes it communication intensive.
- Large memory requirements mean distributed machine...
- ...therefore use MPI rather than shared memory
- Parallel multigrid for pressure solution
- Parallel Multilevel Multi-Integration for deformation

## Performance

- Speed-up excellent for like-for-like cases
- Coarsest MLMI grid limitations suggests using agglomeration
- Global memory requirements still limiting for very fine cases
- Record problem sizes have been solved



## Problem Solving Environments

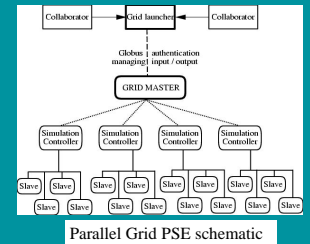
- Interaction with complex numerical software
- Experimentation with "What if...?" questions
- Powerful visualisation techniques available
- Computational steering to guide simulations
- Ease of use for e-Scientists – not just computer scientists

## Collaboration

- Often teams working on a project are geographically disparate, e.g. Utah and Leeds
- Sharing visualisation of a simulation is useful
- Very useful when combined with Access Grid
- Computational steering can now also be shared through generic libraries, such as gViz
- Different users can contribute their own expertise to guide a simulation

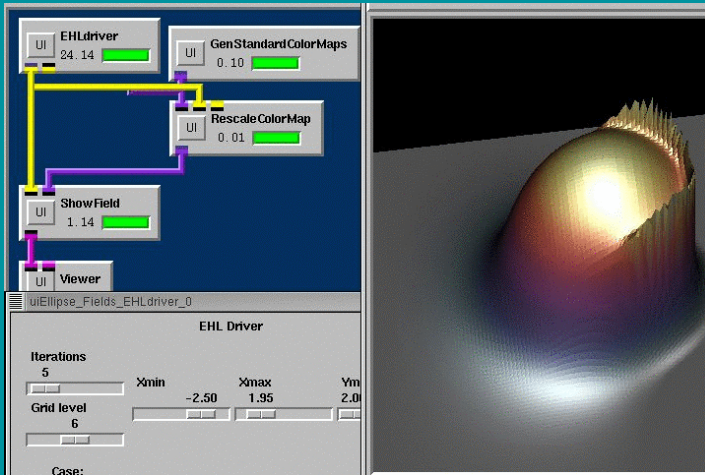
## EHL and the Grid

- The computational power needed exceeds most resources
- When running multiple simulations, such as optimisation, then the number of simulations are multiplied
- Each simulation may itself be run in parallel



## PSEs and the Grid

- Globus allows secure job launching onto a Grid machine
- Socket connections then formed between desktop PSE and Grid simulation using gViz
- Steering can still be done from the desktop, and visualisations returned
- Users can join whilst the simulation is running
- The users need not all use the same environment



EHL PSE 'Ellipse' running inside SCIRun. The numerical solver outputs solution profiles each timestep for visualisation

## Real Surface Roughness

- Asperities (dents, bumps) roll through contact
- Solutions are no longer smooth but have very steep features
- Very fine meshes needed for accurate calculation of friction

Measured rough surface profile (left) when applied to an EHL contact (right)

