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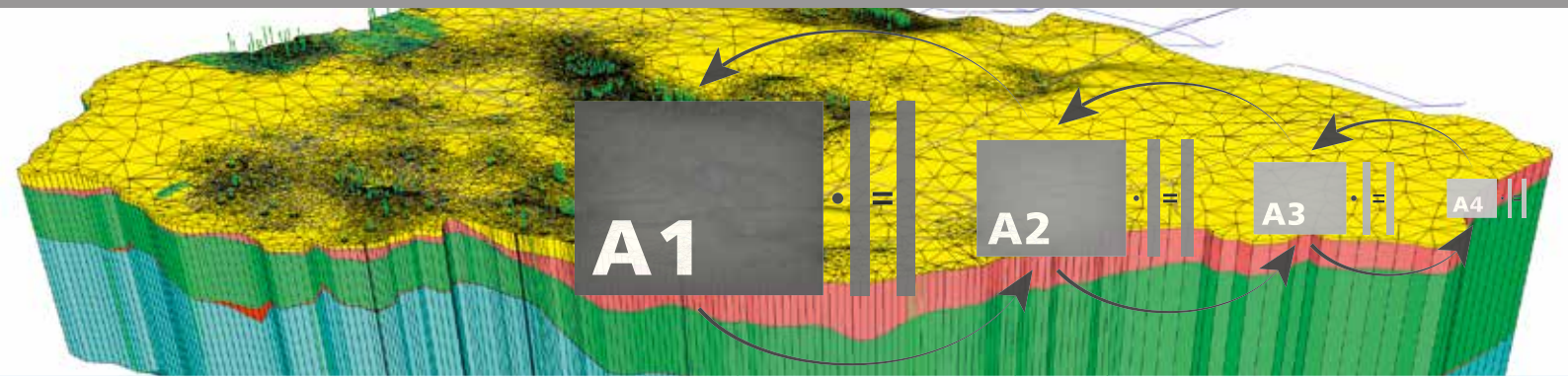

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ACCELERATING MODFLOW WITH THE ENHANCED SAMG LINEAR SOLVER SOFTWARE

SAMG Key Features:

- State-of-the-art AMG performance – applicable for all mesh types
- Optimized solver control including automated set-up re-use
- Support for parallel execution on multi-core computer systems and also multi-node systems

SAMG Advantages for MODFLOW:

- „Big Models“: Allows MODFLOW users to increase modeling accuracy (model sizes) but keep compute times managable
- Handles strongly heterogeneous systems (hydraulic conductivity), where standard solvers have problems

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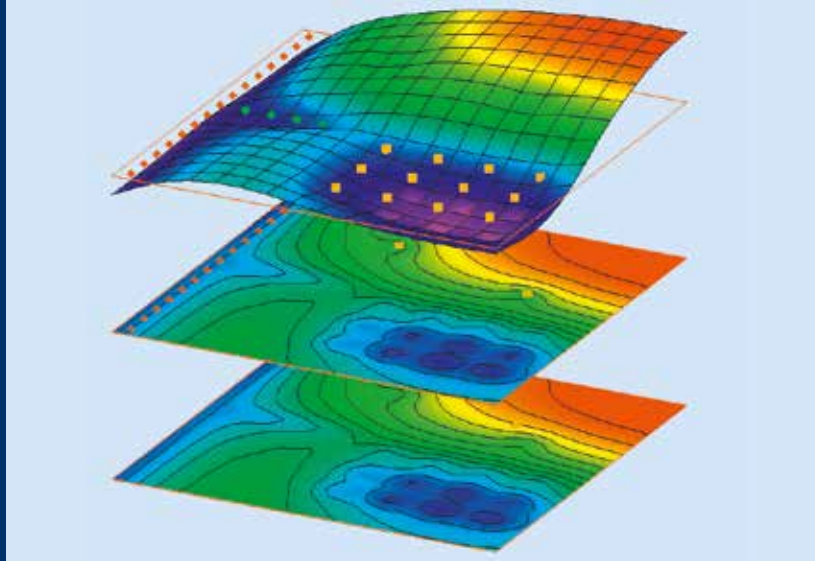


Commercial References

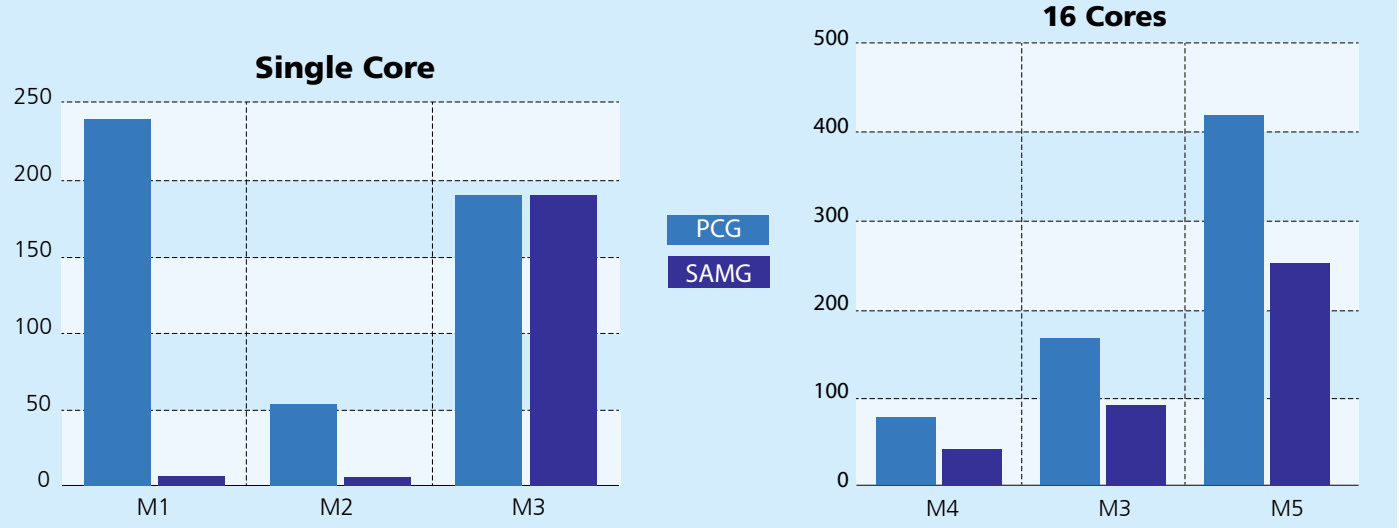
The following companies offer SAMG in their groundwater simulation software:

- **Aquaveo LLC**
- **DHI Water & Environment**
- **Environmental Simulations Inc.**
- **HydroGeoLogic Inc.**
- **Schlumberger Water Services**

SAMG

Algebraic Multigrid Methods for Systems

SAMG is a very efficient linear solver library based on algebraic multigrid (AMG), specifically developed for industrial applications. SAMG supports both serial and multi-core computations on single PC, workstations or compute nodes.



Models

M1 = problem2 from OFR 01-177 USGS, steady-state
M2 = problem5 from OFR 01-177 USGS, steady-state
M3 = benchmark model from SWS, transient
M4 = problem3 from OFR 01-177 USGS, transient
M5 = benchmark model from Aquaveo LLC, transient
(SWS = Schlumberger Water Services)
(USGS = U.S. Geological Survey)

The results show performance comparisons of MODFLOW models executed with the standard Pre-conditioned Conjugate Gradient solver (PCG) and with the SAMG software. For the steady-state models (M1-M2), the reduction in computing times through the use of SAMG is dramatic, even when using a single-core system. For transient models (M3-M5), the relative performance is greatly influenced by model characteristics, such as model size, time-step selection and nonlinearity. The single-core transient result illustrates the SAMG automatic solver control feature, which resorts to PCG selection when appropriate in terms of overall computing times. As clearly demonstrated by the transient results on the 16-core server, SAMG's multi-threading capability means that the potential of modern multi-core machines can be exploited and major reductions in compute times realized.

XSAMG

Auto-parallel SAMG for Clusters

The new XSAMG library exploits the parallelism offered by multiple nodes of a compute cluster by distributing linear systems across different nodes (based on MPI). Since this is done automatically, the calling simulation program itself does not have to be prepared for distributed computing.