Modern Computing

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Taking the Lead with Computational Speed

High performance computer models in Dutch business

Affiliation

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  http://www.3tu.nl/ami/en/
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  http://www.cse.tudelft.nl/

Contents

- Case studies
- Smart algorithms
- Future computers
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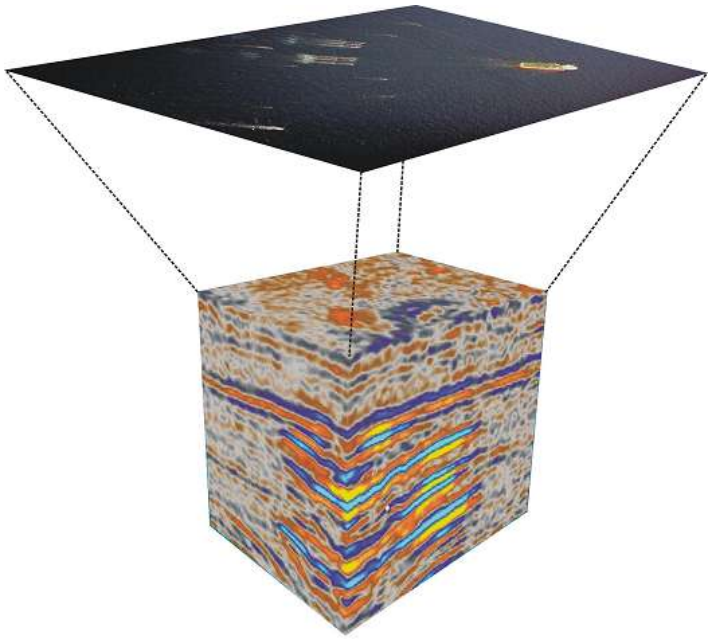
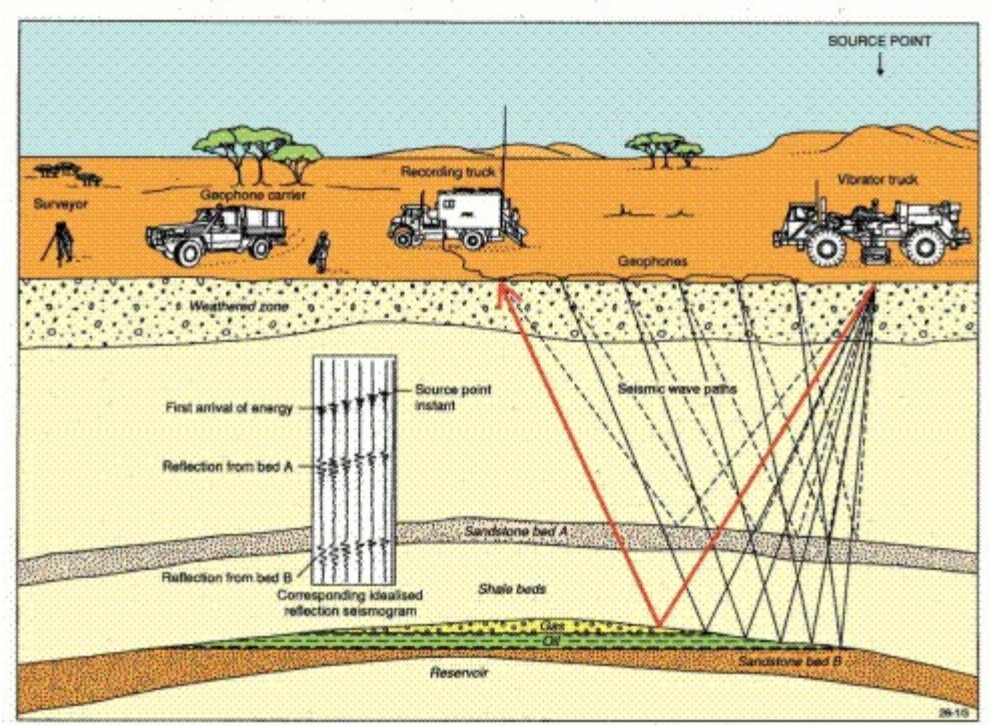
Seismic simulations

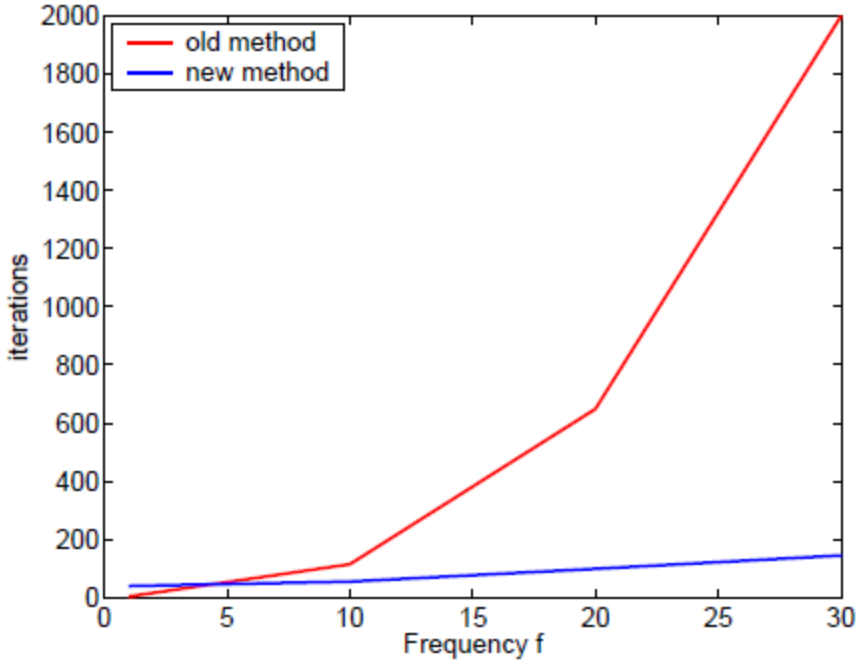


Offshore

On land



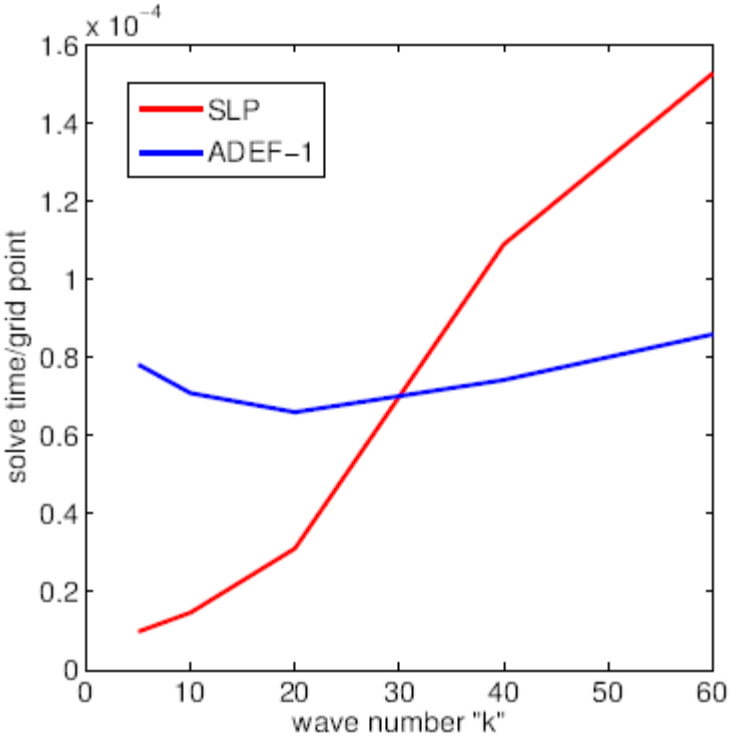
Solution 2005



Y.A. Erlangga and C.W. Oosterlee and C. Vuik
A Novel Multigrid Based Preconditioner For Heterogeneous Helmholtz Problems
SIAM J. Sci. Comput.,27, pp. 1471-1492, 2006

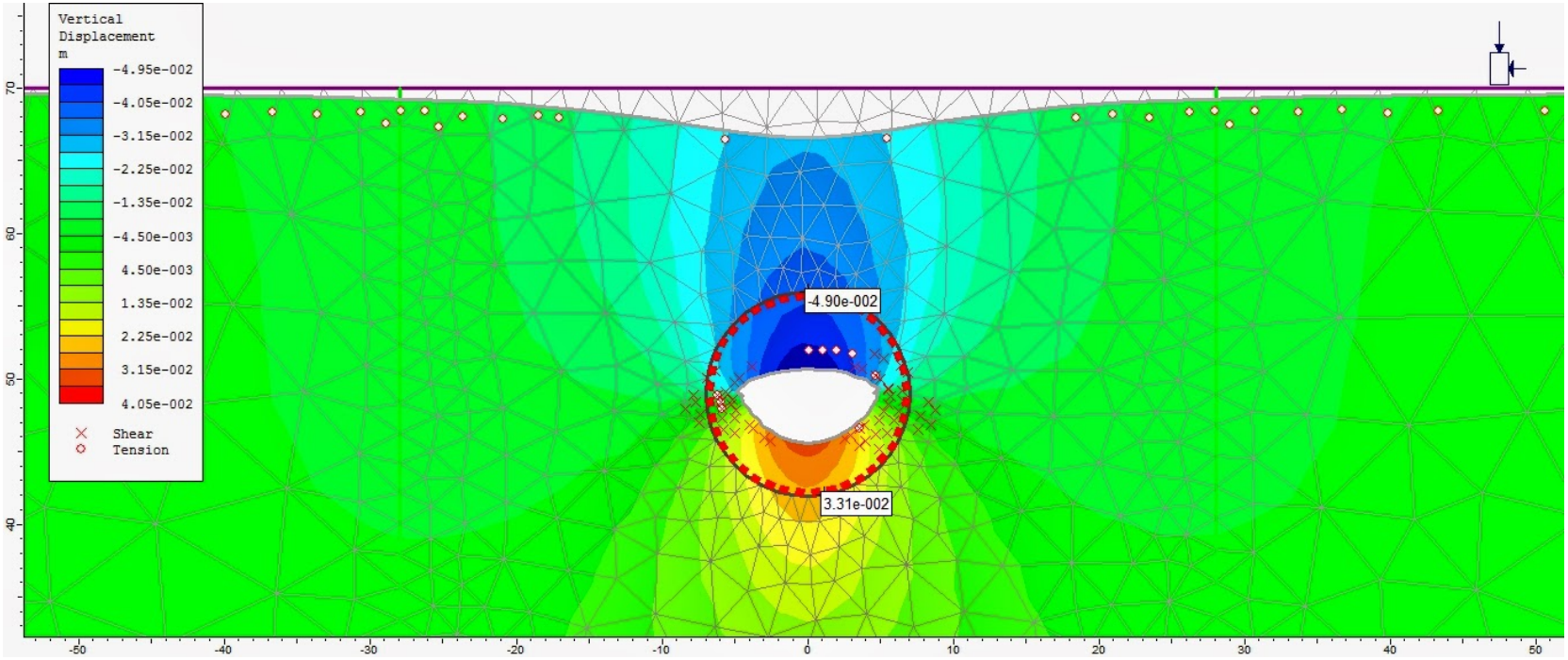
ISI Emerging Research Front Paper, 2010

Solution 2015



A.H. Sheikh and D. Lahaye and C. Vuik
On the convergence of shifted Laplace preconditioner combined with multilevel deflation
Numerical Linear Algebra with Applications, 20, pp. 645-662, 2013

Geomechanic simulation



Parallel solver

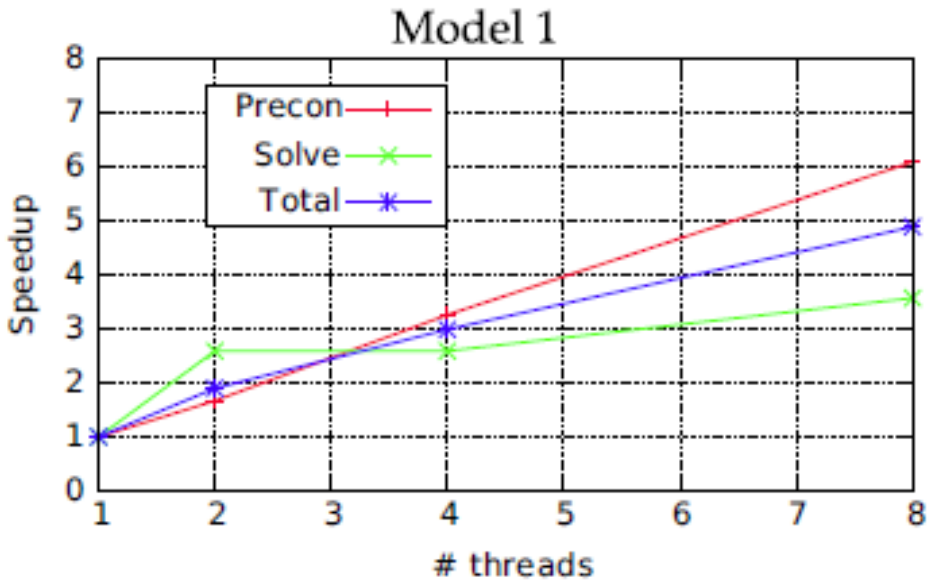


Fig. 5 The parallel speedup obtained for the two models. The curve labeled "Precon" depicts the parallel speedup of the preconditioner. The curve labeled "Solve" depicts the parallel speedup of the solver,

Parallel solver

Solver	# Threads	Precon [s]	Solve [s]	# Iter
PARDISO	8	200	25	1
Original	1	320	130	140
New	1	140	75	134
	2	84	29	80
	4	43	29	111
	8	23	21	113

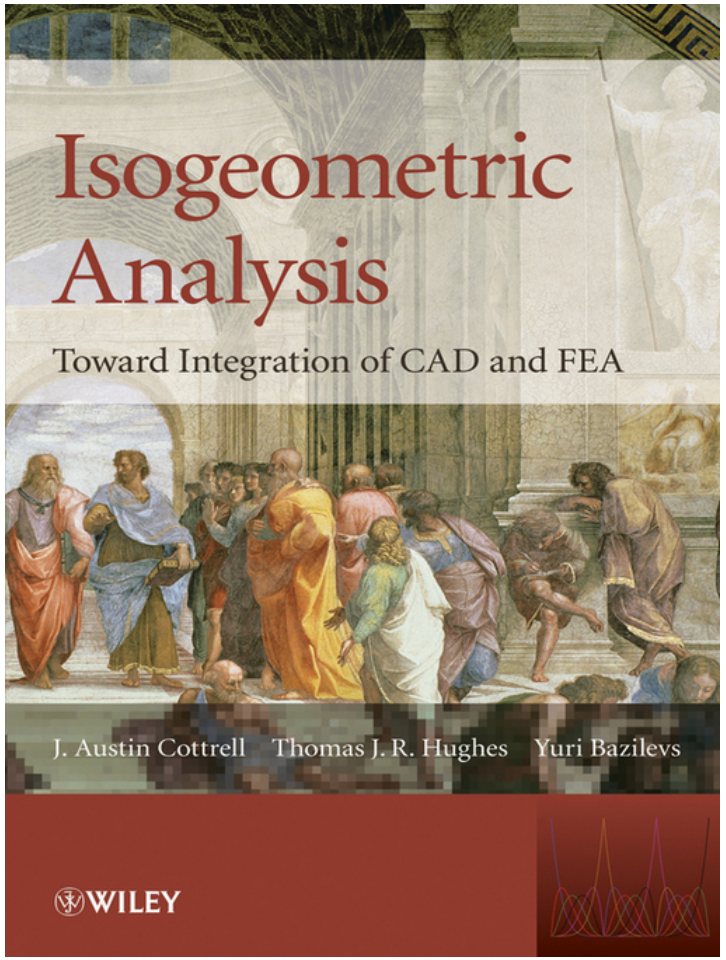
F.J. Lingen and P.G. Bonnier and R.B.J. Brinkgreve and M.B. van Gijzen and C. Vuik
A parallel linear solver exploiting the physical properties of the underlying mechanical problem Computational Geosciences, 1, pp. 1-1, 2014

Smart algorithms

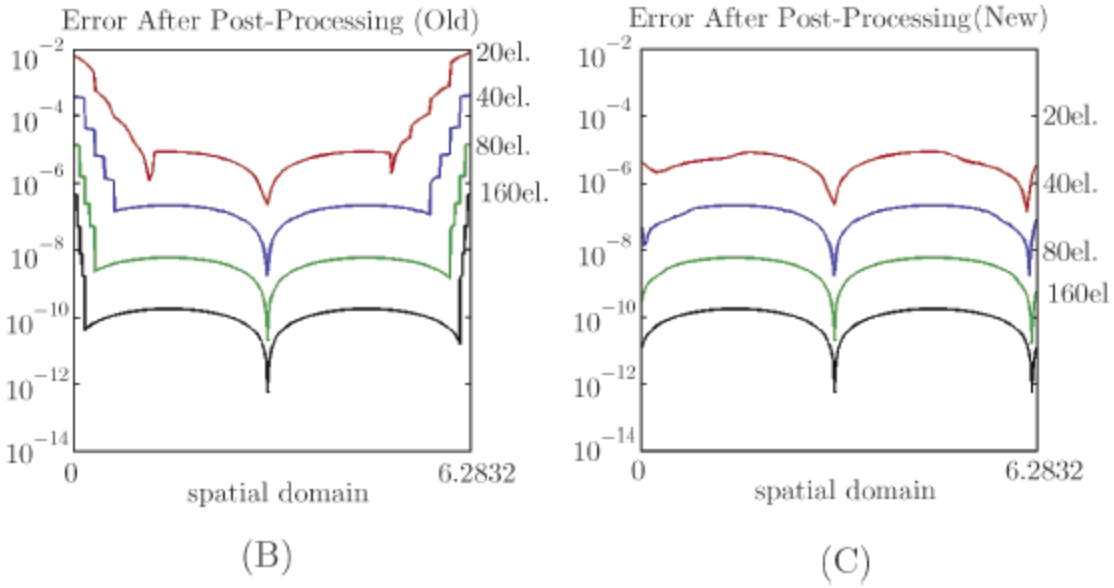
- Flexible
- Adaptive
- Robust
- Parallel
- Accuracy
- Physics-based

Discretization methods

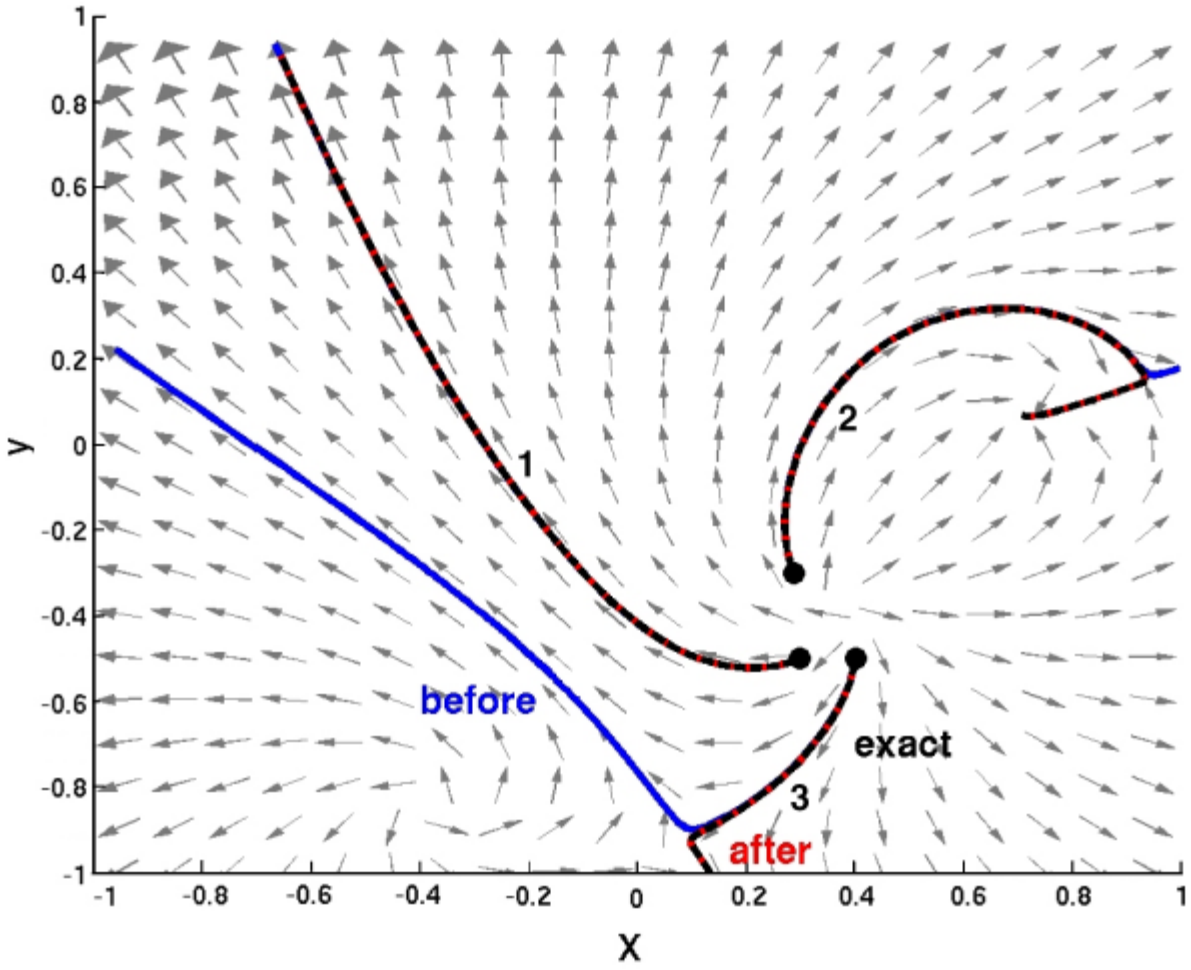
- FDM
- FEM
- FVM
- DG
- isoGEO FEM



Discretization method



Discretization method



Seismic solver

- Bad result for standard solvers
- Preconditioner based on damped equations
- Multigrid suitable for damped equations
- Near-null space remains a problem
- Deflation solves this problem

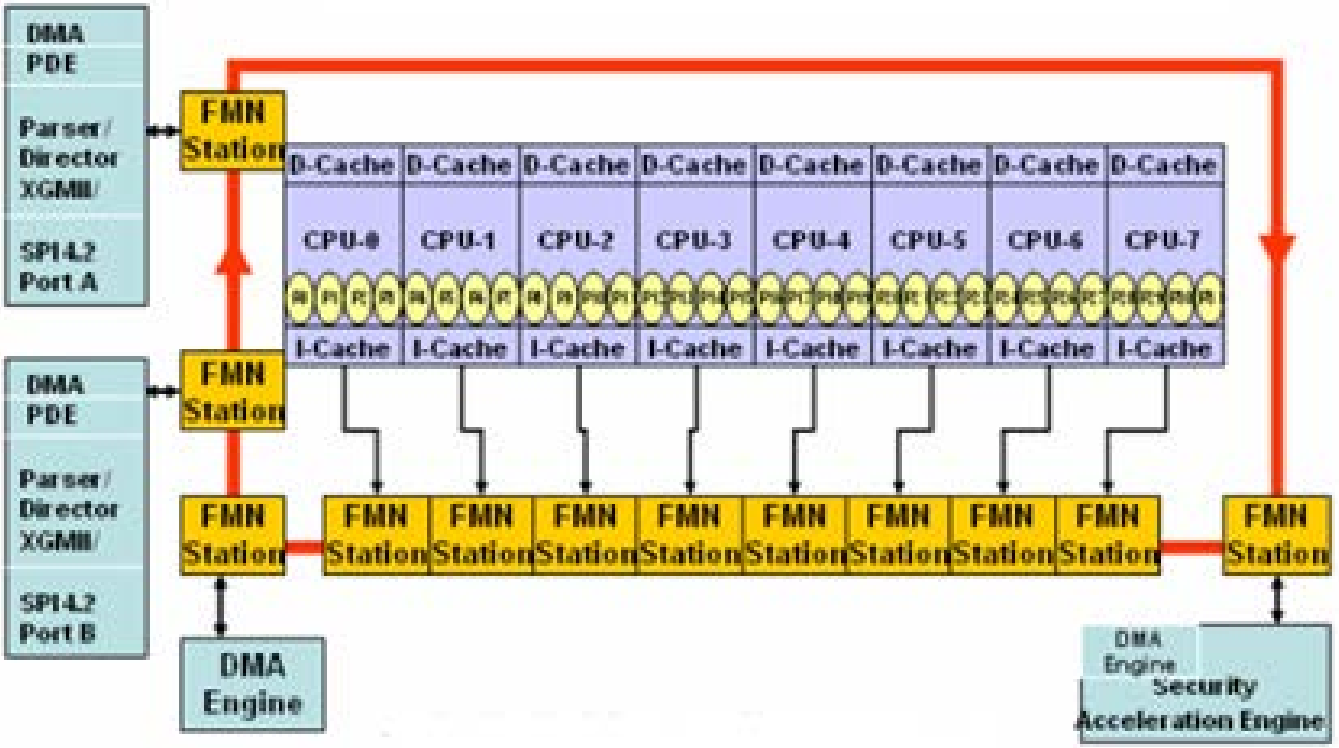
Geomechanic solver

- Fast sequential solver
- Standard parallelization fails
- First physics-based decomposition
- Domain decomposition
- Deflation
- Fast multi-core implementation

Future computers

- Slow increase in speed
- Double / single precision
- Parallel coarse / fine
- Memory bound
- Data movement
- Power requirements
- Heat problem

Multi core


DMA
PDE
Parser/
Director
XGMII/
SPI4.2
Port A
DMA
PDE
Parser/
Director
XGMII/
SPI4.2
Port B
FMN
Station
FMN
Station
FMN
Station
FMN
Station
FMN
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FMN
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FMN
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FMN
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FMN
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CPU-0
CPU-1
CPU-2
CPU-3
CPU-4
CPU-5
CPU-6
CPU-7
I-Cache
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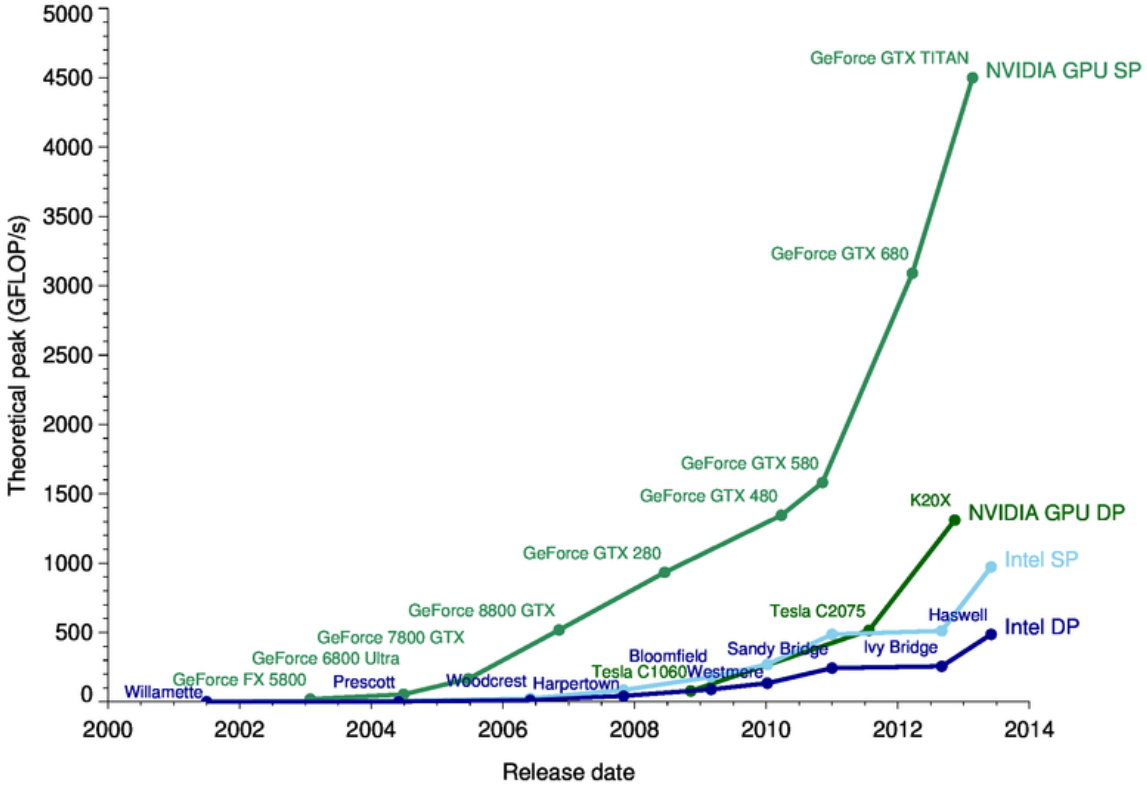
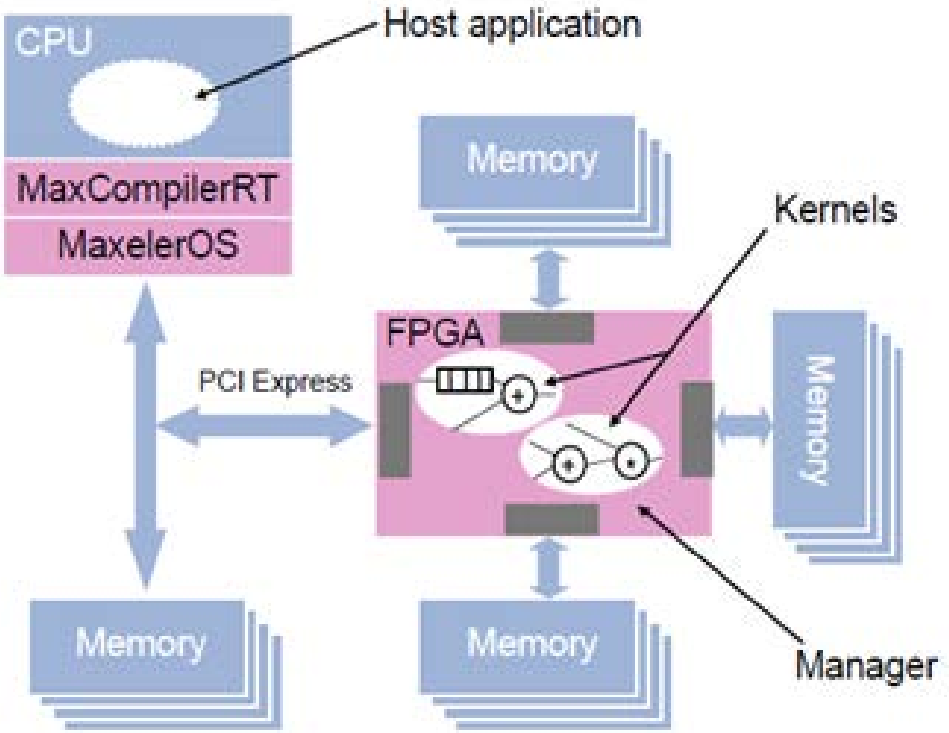
DMA
Engine
DMA
Engine
Security
Acceleration Engine

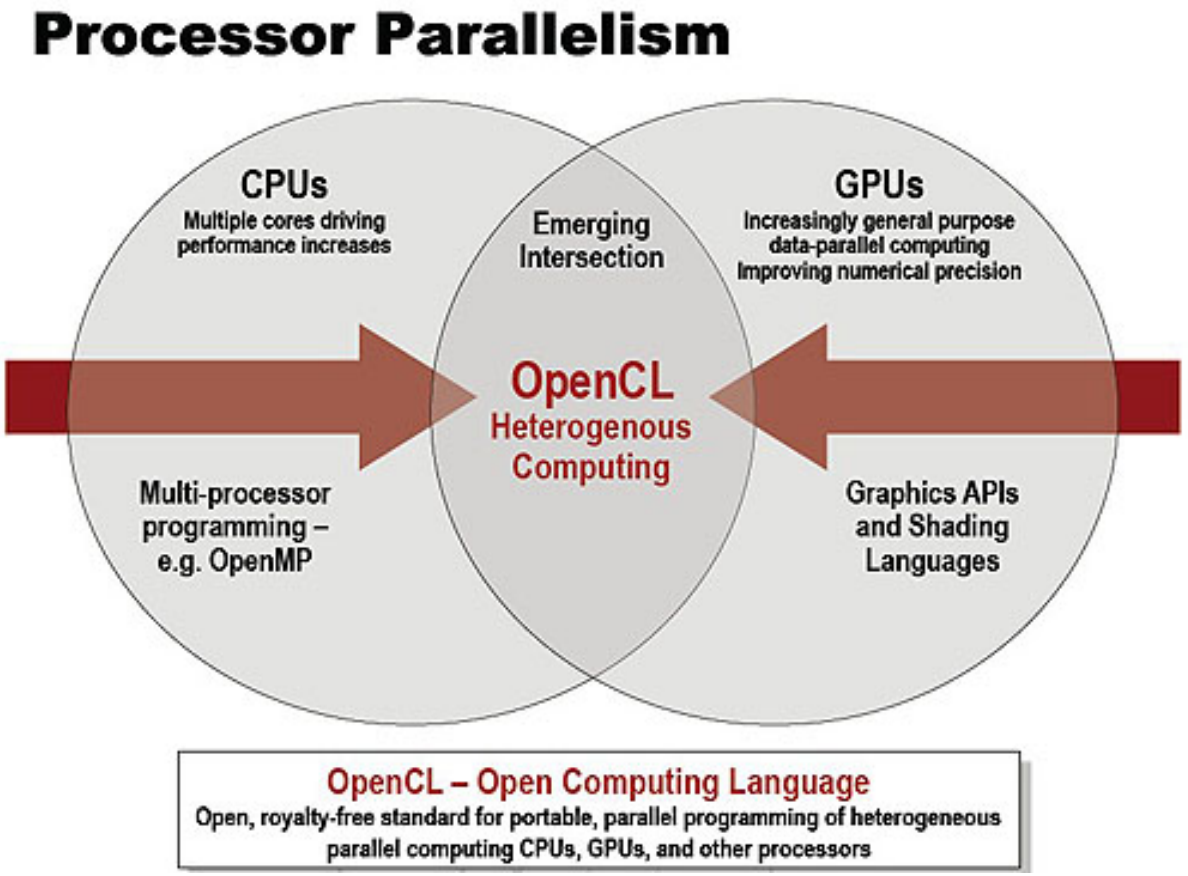
GPU


Theoretical peak (GFLOP/s)
Release date
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2000
2002
2004
2006
2008
2010
2012
2014
GeForce GTX TITAN
NVIDIA GPU SP
GeForce GTX 680
GeForce GTX 580
GeForce GTX 480
GeForce GTX 280
GeForce 8800 GTX
GeForce 7800 GTX
GeForce 6800 Ultra
GeForce FX 5800
Willamette
Prescott
Woodcrest
Harpertown
Bloomfield
Tesla C1060
Westmere
Sandy Bridge
Ivy Bridge
Haswell
Tesla C2075
K20X
NVIDIA GPU DP
Intel SP
Intel DP

FPGA


CPU
Host application
MaxCompilerRT
MaxelerOS
Memory
Kernels
FPGA
PCI Express
Memory
Memory
Memory
Manager

Parallel coarse / fine



Discussion