WHAT STARTS HERE CHANGES THE WORLD
THE UNIVERSITY OF TEXAS AT AUSTIN

DDDAS Project Update

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Outline

- **Hybrid OpenMP/MPI Paradigm**

- **Code Demonstration**

  Data Transfer , Filtering, Visualization

- **Computations**

  Optimization window

OpenMP/MPI Paradigm

- **Computer Architecture at TACC is cluster of SMP nodes**

  Lonestar: 4 processors per compute nodes

- **Profiling shows linear solve time $\approx$ constant as increase processors for a given problem size**

- **Large number of processors communication between MPI tasks dominates solve time**

- **OpenMP Offers a way to avoid communication overhead**

  no communication between OpenMP threads, but Fork/Join overhead very expensive

OpenMP/MPI Paradigm

Sheet1

petsc to hp3d	1	2.59E-002	1.09E-001
assemble fnc	2	1.35E 001	1.14E 000
assemble jac	3	1.62E-001	9.10E-001
eval objective	4	6.17E-003	2.39E-002
elemfnc setup	5	3.17E-002	4.25E-002
elemfncsumfact	6	4.89E-002	4.74E-002
elemfnc bndry	7	2.37E 002	4.21E 002
elemjac setup	8	2.32E-002	5.19E-002
elemjacsumfact	9	9.98E-002	1.69E-001
elemjac bndry	10	2.52E-002	2.89E-002
elem tmp	11	1.87E 002	8.23E 002
VecMDot	12	7.30E-002	3.98E-002
VecNorm	13	5.33E-002	2.03E-001
VecScale	14	3.61E-004	1.50E-001
VecCopy	15	9.66E-005	2.80E-004
VecSet	16	8.41E 004	1.89E 003
VecAXPY	17	5.36E-005	1.13E-004
VecWAXPY	18	7.22E-005	1.61E-004
VecMAXPY	19	2.49E-003	4.81E-003
VecAssemblyBegin	20	6.11E-002	7.83E-001
VecAssemblyEnd	21	3.17E-004	1.53E-001
VecScatterBegin	22	6.55E-003	3.43E-003
VecScatterEnd	23	3.63E-002	1.04E-003
VecNormalize	24	4.85E-002	4.83E-002
MatMult	25	4.34E 002	2.94E 002
MatSolve	26	1.08E-002	3.29E-002
MatLUFactorNum	27	4.66E-003	2.24E-002
MatAssemblyBegin	28	4.12E-002	5.49E-001
MatAssemblyEnd	29	1.94E-002	3.83E-002
MatZeroEntries	30	6.16E 004	2.02E 003
SNESSolve	31	4.78E-001	2.63E-000
SNESLineSearch	32	1.19E-001	1.09E-000
SNESFunctionEval	33	1.62E-001	1.73E-000
SNESJacobianEval	34	1.91E 001	1.29E 000
KSPGMRESOrthog	35	7.44E-002	4.31E-002
KSPSetup	36	2.74E-005	4.08E-005
KSPSolve	37	1.41E-001	1.41E-001
PCSetUp	38	4.83E-003	2.27E-002
PCSetUpOnBlocks	39	4.76E 003	2.26E 002
PCApply	40	1.37E-002	3.66E-002
TaoAppObjective	41	1.90E-001	2.68E-000

Time for fork/join .1sec

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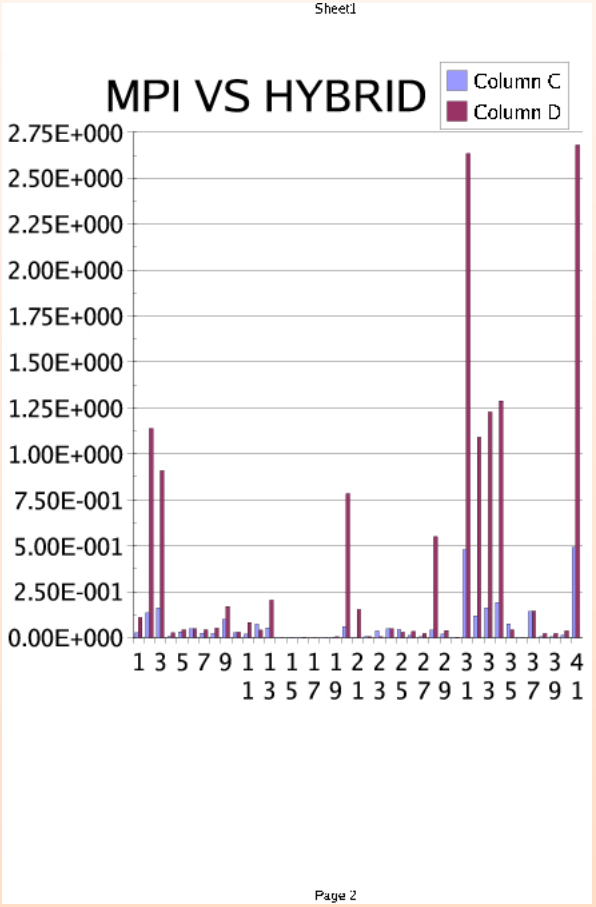
Sheet1



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Code Demonstration

- **Data Transfer scripts written in Python**

- **Bottleneck was writing to disk**

  Solution: collect onto one processor, collect into one buffer then write visualization files to disk

- **Computations**

  Optimization window

Computations

- **Optimization window**

  TWO groups of processors: 1st group is constantly calibrating and sending the calibrated parameters to 2nd group of processors. 2nd group constanly solving optimal control problem given calibrated data.

- **Time constraint resrictions imposed by real time calculation allow only a handful of objective function/gradient evaluations**

  Quasi Newton Methods taking too many iterations

  Steepest descent guarantees objective function decrease