

ANSYS 2002 CONFERENCE

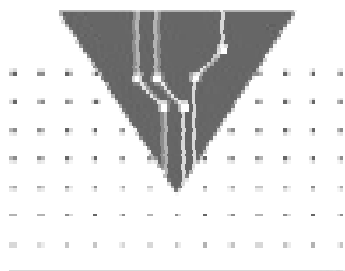
C.A. Evolution

CUSTOMIZE YOUR WORLD

Evaluation of the Distributed Domain Solver

Dave O'Neal, University of Illinois, and Sam Murgie, ANSYS Inc.

Objectives



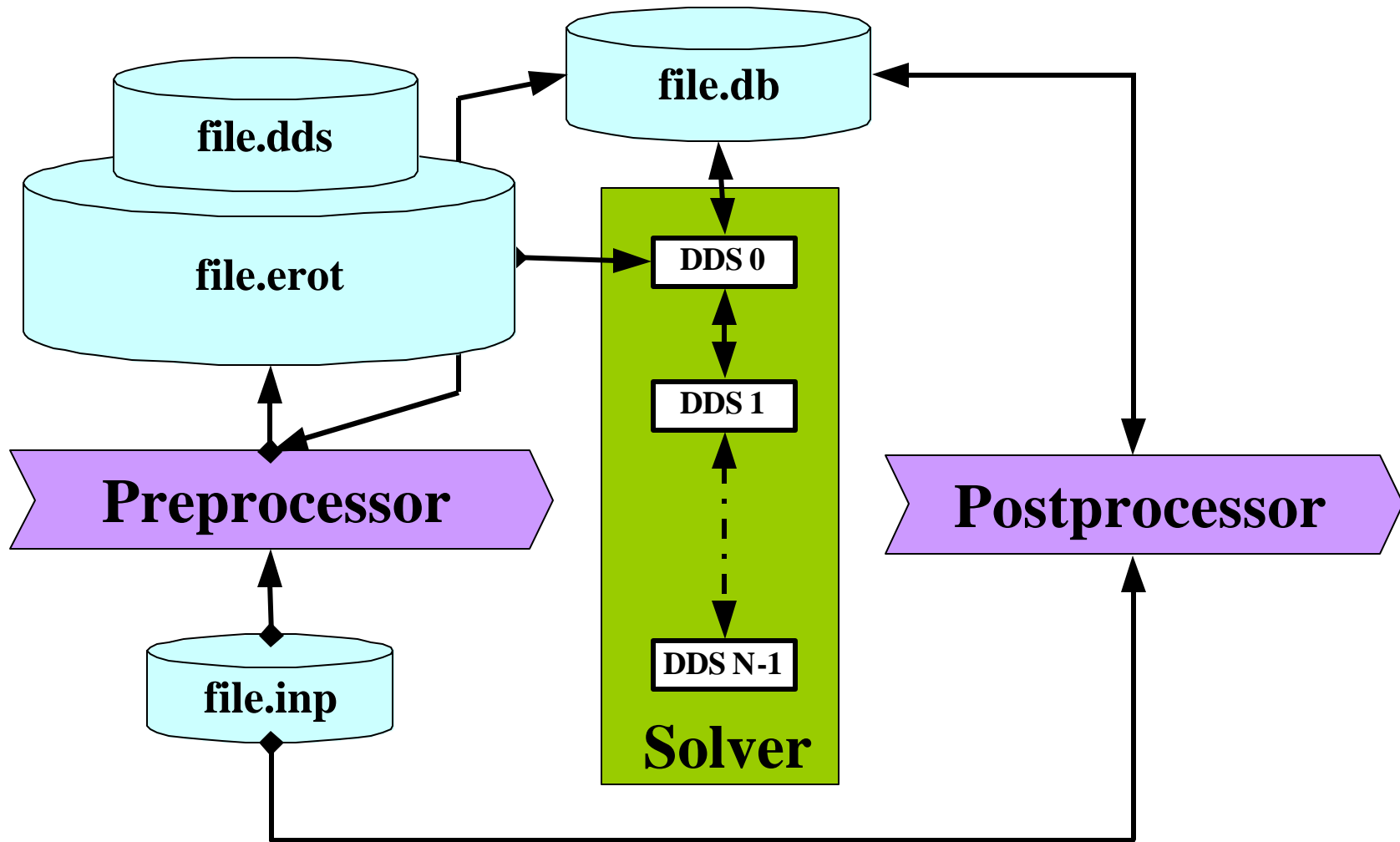
- Use supercomputer-class platforms to identify DDS limitations and isolate problems
- Characterize DDS memory utilization and scalability
- Report results and make recommendations
- Promote collaboration between ANSYS, NCSA, and PSC

DDS Overview



- Parallel Performance for ANSYS component
- Based on the method of Finite Element Tearing and Interconnecting (Farhat)
- Decomposition component derived from METIS graph partitioning software
- Intended for large static and full transient analyses represented by symmetric systems
- Initial release: January 2001 (v5.7)

Execution Sketch

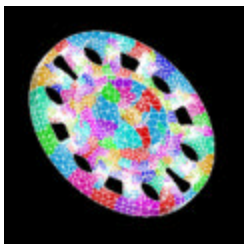
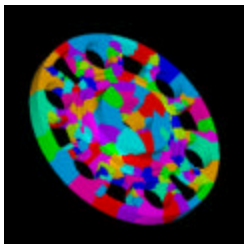
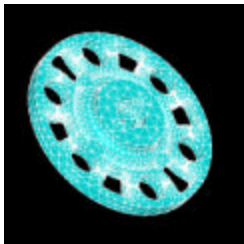
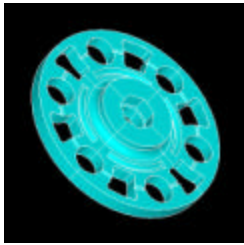


Resource Management



- Split host and solver functions into separate jobs
- Run the host on a server with a large memory space
- Run DDS on a uniform cluster of compute nodes
- Caveat: Use of an undocumented DDSOPT feature is required

Test Cases



- All scalability experiments based on the extensible *carrier* model
- Results for carrier cases ranging from 57K to 1M DOF are presented here
- Cantilever model consisting of 26K DOF was used to test input modifications, job scripts, etc.

Experimental Platforms



- Windows/NT Supercluster
 - 32 HP Kayak compute nodes, 64 processors
 - 550-MHz Intel Pentium III, 1 GB per node
 - Myrinet Fast Ethernet network (10 MB/s)



- SGI/Cray Origin 2000 Cluster
 - 12 SNO systems, 1520 processors
 - Dual 250-MHz MIPS R10000, 1 GB/board
 - SGI NUMA link network (600 MB/s)



- Compaq TCS AlphaServer Cluster
 - 750 ES45 compute nodes, 3000 processors
 - 1000-MHz Alpha EV6, 4 GB per node
 - Quadrics QsNet network (340 MB/s per rail)

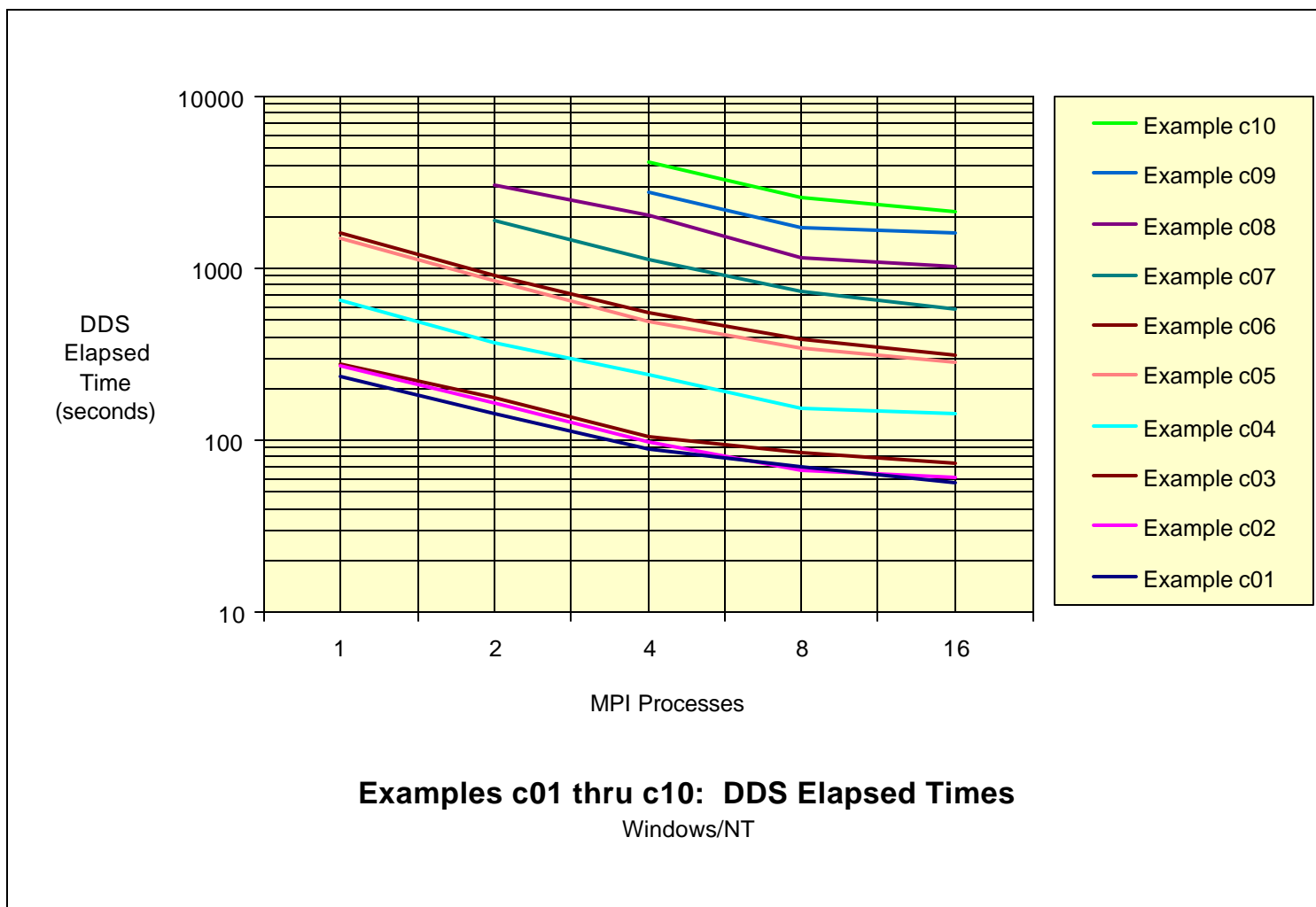
Dimensioning Details



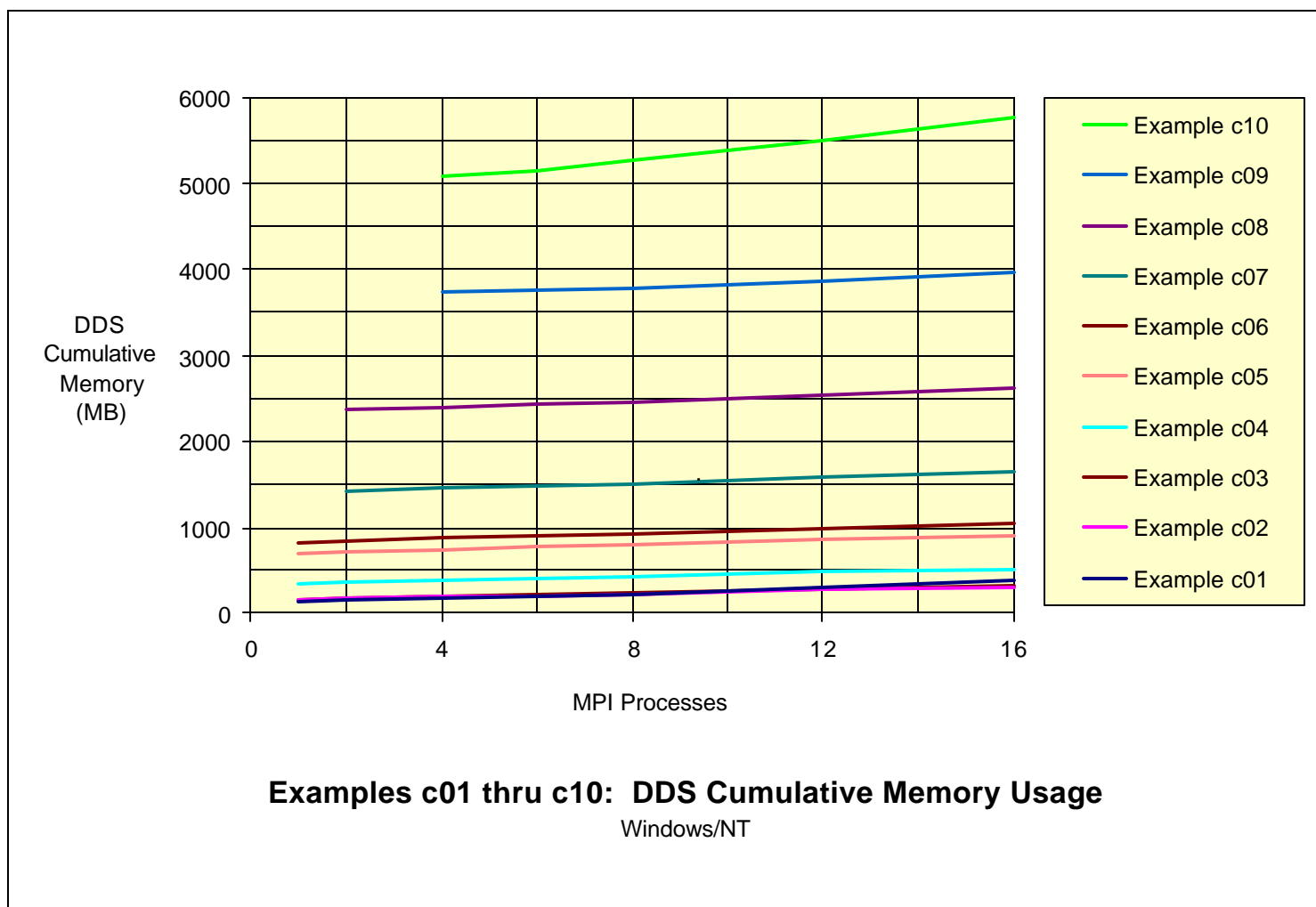
Carrier Cases	NT Supercluster			Origin 2000			AlphaServer SC		
	Elements	Nodes	DOFs	Elements	Nodes	DOFs	Elements	Nodes	DOFs
c01	10,915	19,213	57,639	10,994	19,320	57,960	11,572	20,515	61,545
c02	11,796	20,506	61,518	11,830	20,543	61,629	12,401	21,895	65,685
c03	12,538	21,766	65,298	12,530	21,749	65,247	13,611	23,844	71,532
c04	24,007	39,983	119,949	23,999	40,017	120,051	25,745	43,181	129,543
c05	46,056	73,689	221,067	46,869	74,801	224,403	48,277	77,722	233,166
c06	53,429	84,671	254,013	54,676	86,393	259,179	54,107	86,530	259,590
c07	85,273	132,213	396,639	85,243	132,114	396,342	89,140	138,719	416,157
c08	133,999	205,718	617,154	133,527	205,105	615,315	144,517	220,971	662,913
c09	197,389	298,907	896,721	197,049	298,518	895,554	219,762	330,566	991,698
c10	249,194	372,148	1,116,444	248,095	370,493	1,111,479	252,644	377,218	1,131,654

Carrier Model Dimensioning Details

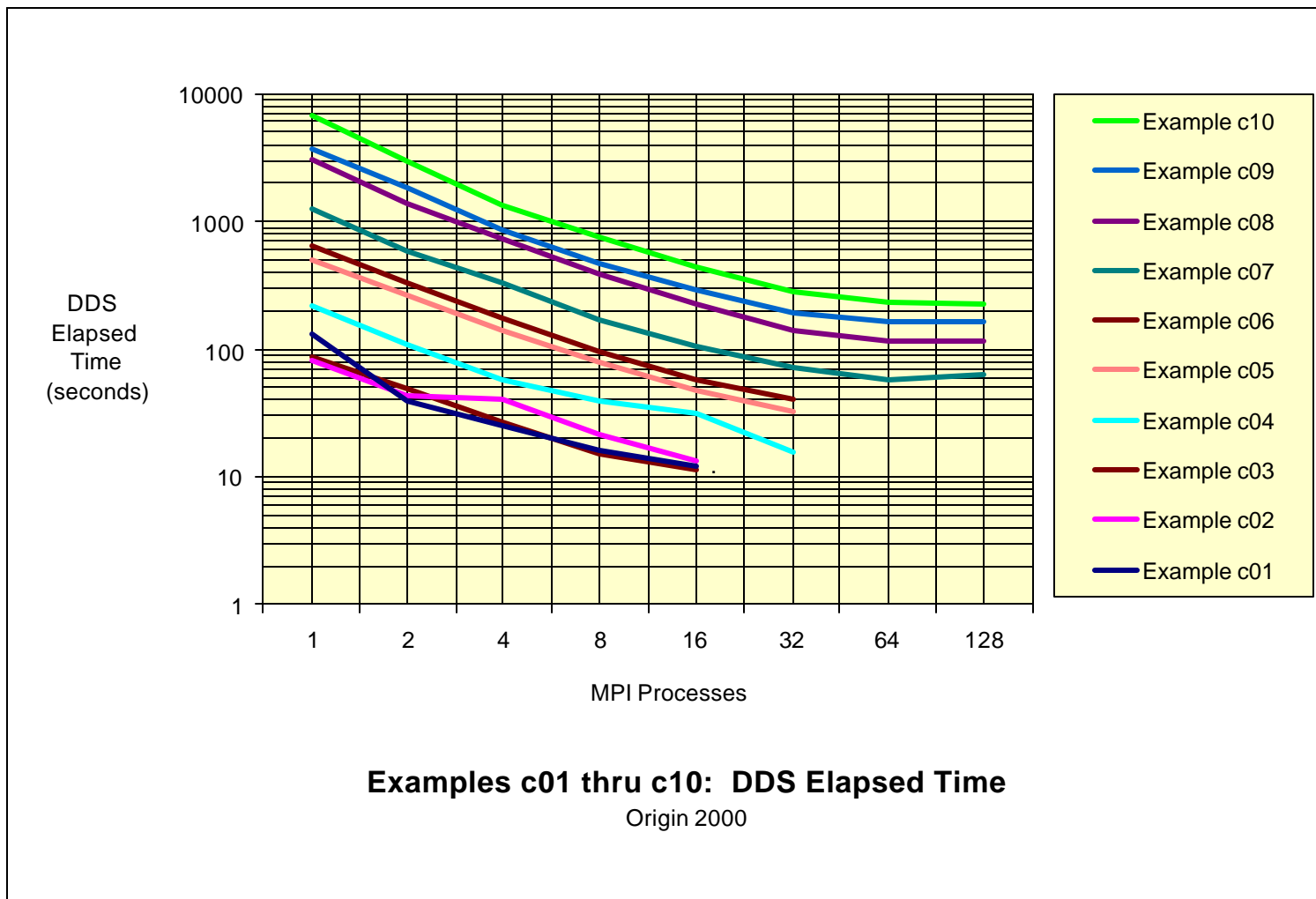
NT Supercluster



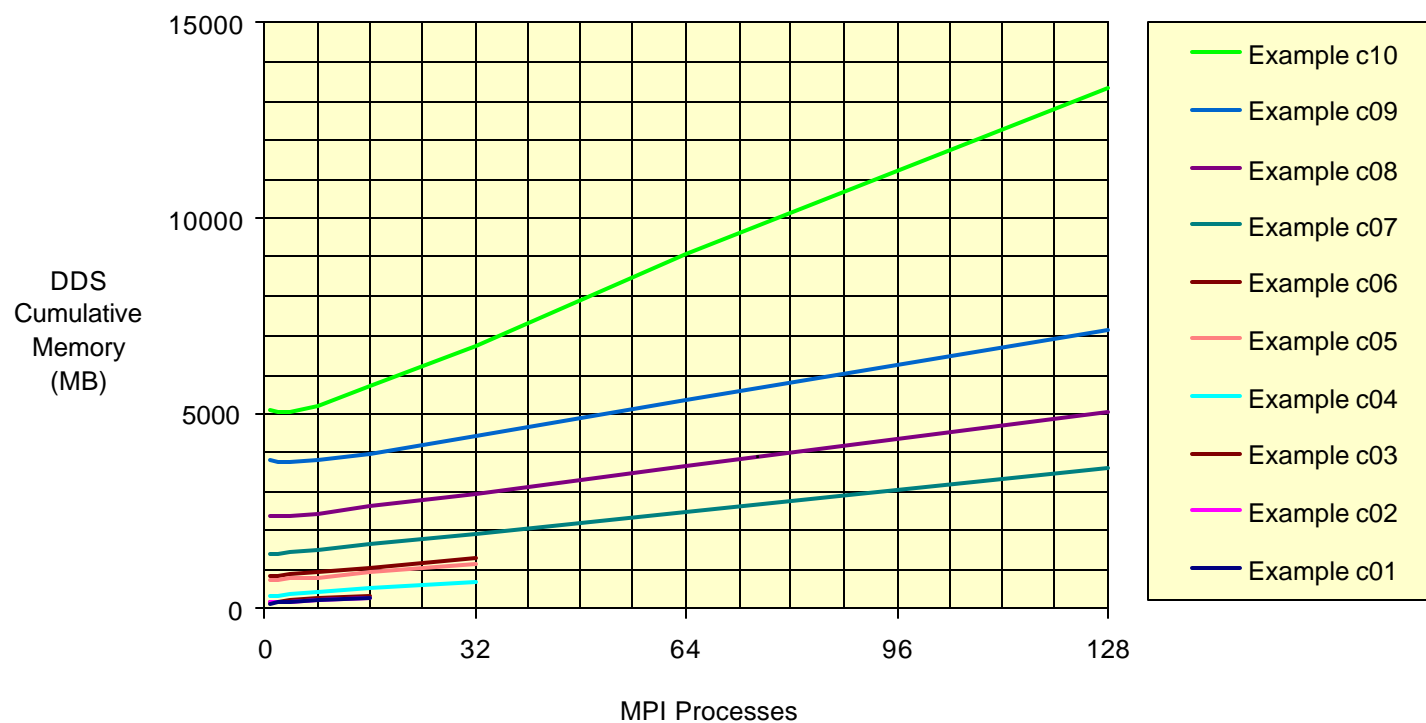
NT Supercluster



Origin 2000



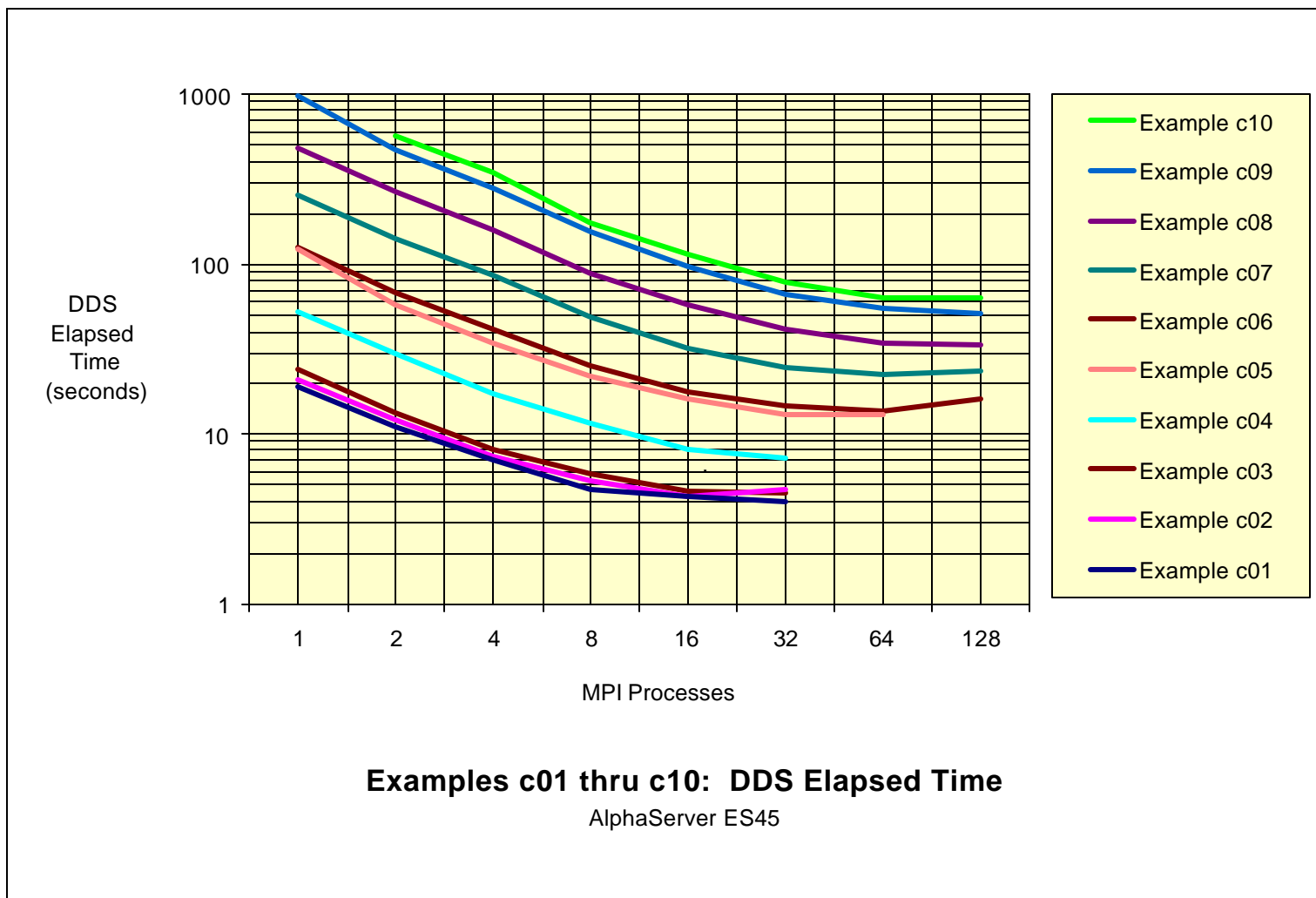
Origin 2000



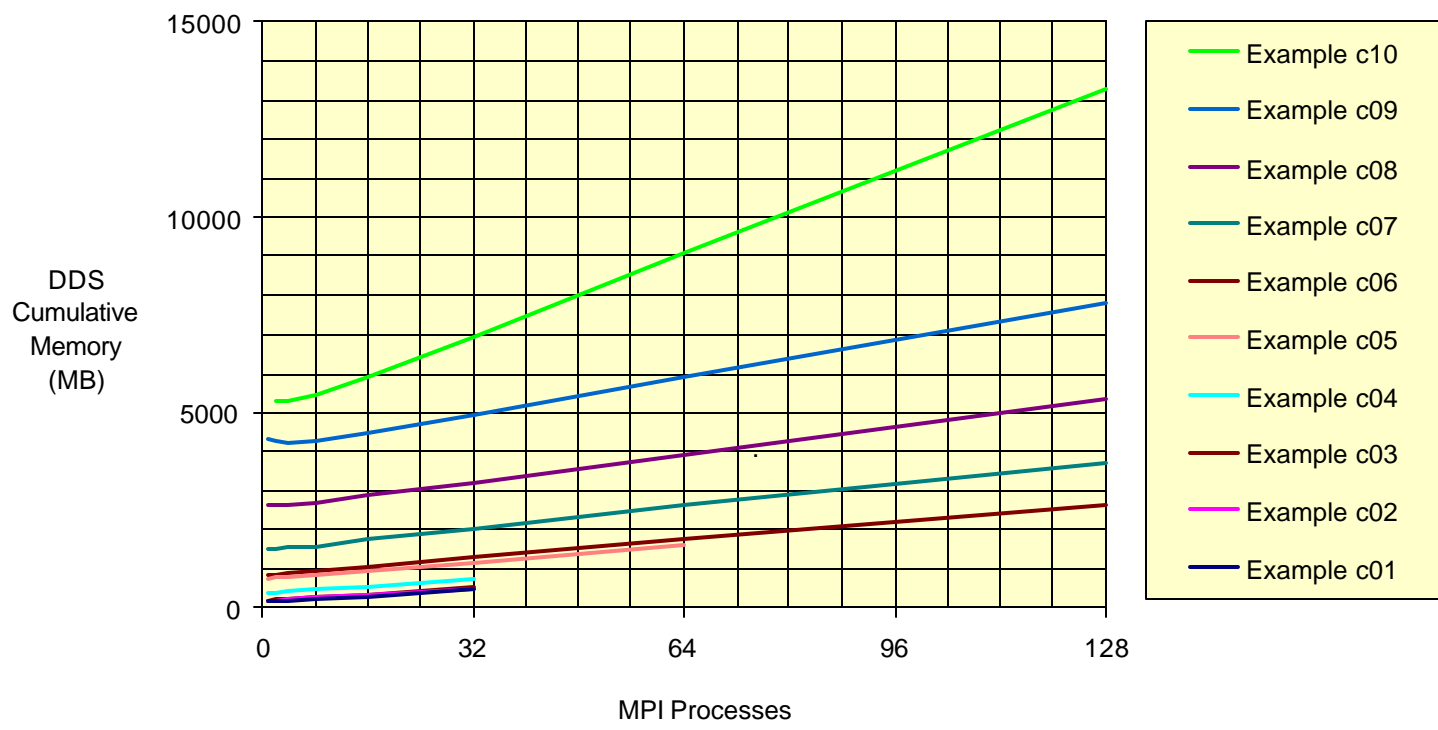
Examples c01 thru c10: DDS Cumulative Memory Usage

Origin 2000 Platform

AlphaServer ES45



AlphaServer ES45



Examples c01 thru c10: DDS Cumulative Memory Usage
AlphaServer ES45

Summary



- Preprocessing of large problems requires significant amounts of time and memory
- Scalability of DDS depends on problem size, but speedups are approximately linear up to 32 processes
- Each Origin 2000 process = 10 NTSC
- Each AlphaServer process = 4 O2K

Recommendations



- Continue AlphaServer study, e.g. larger problems, effect of second rail on scalability
- Enhance access to interface between the host and solver to facilitate job separation
- Improve performance of the preprocessor e.g. parallel assembly and decomposition
- Develop OpenMP DDS executables for Windows 2000 and Tru64

Contact Information



David O'Neal

oneal@ncsa.uiuc.edu

www.psc.edu/~oneal

(412) 364-6299

Sam Murgie

sam.murgie@ansys.com

www.ansys.com

(724) 514-2938