Condor:
A Concept, A Tool and A Model

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The Condor Project
(Established '85)

Distributed systems research performed by a team that faces

- software engineering challenges in a UNIX/Linux/NT environment,
- active interaction with users and collaborators,
- and the daily maintenance and support challenges of a real-life distributed production environment.

Funding - **NSF, NASA, DoE, DoD, IBM, INTEL, Microsoft and the UW Graduate School**

National Grid Efforts

- National Technology Grid - NCSA Alliance (NSF-PACI)
- Information Power Grid (NASA)
- Particle Physics Data Grid (DoE)

Applications

- Optimization - UW, ANL, NW
- High Energy Physics - INFN, UNM, UW, Caltech
- Biological Sciences - UW, UMN
- Animation - UW, C.O.R.E
- Software Engineering - Oracle
- JAVA - NASA

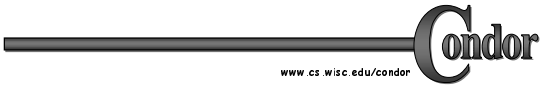
CS Collaborations

- Argonne National Lab (Globus) - Grid middleware
- Universitat Autonoma de Barcelona - Scheduling of Master-Worker Applications
- Clark Atlanta University - User Interfaces

Funding Distribution

Source	FTEs	50% RAs	Comments
Federal	3.5	12.0	
Industry		3.0	Unrestricted grants
Grad School	2.0	2.0	
128 account	0.5		"For fee" support
Total	6.0	17.0	

Concept(s)



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" ... Since the early days of mankind the primary motivation for the establishment of *communities* has been the idea that by being part of an organized group the capabilities of an individual are improved. The great progress in the area of inter-computer communication led to the development of means by which stand-alone processing sub-systems can be integrated into multi-computer *'communities'*. ... "

Miron Livny, " ***Study of Load Balancing Algorithms for Decentralized Distributed Processing Systems*****.", Ph.D thesis, July 1983.**

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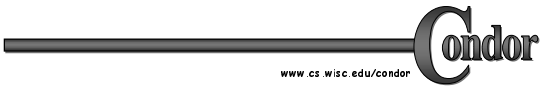
Every Community needs a Matchmaker!



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Why? Because ...

.. someone has to bring together members who have requests for goods and services with members who offer them.

- Both sides are looking for each other
- Both sides have constraints
- Both sides have preferences

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High Throughput Computing

For many experimental scientists, scientific progress and quality of research are strongly linked to computing throughput. In other words, they are less concerned about instantaneous computing power. Instead, what matters to them is the amount of computing they can harness over a month or a year --- they measure computing power in units of scenarios per day, wind patterns per week, instructions sets per month, or crystal configurations per year.

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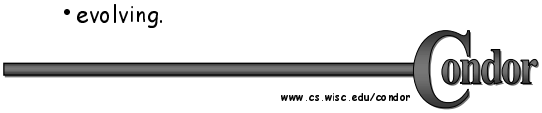
Computing is a Commodity

Raw computing power is everywhere - on desk- tops, shelves, and racks. It is

- cheap
- dynamic,
- distributively owned,
- heterogeneous and
- evolving.



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Master-Worker (MW) computing is common and
Naturally Parallel.
It is by no means
Embarrassingly Parallel.
Doing it right is by no means trivial.

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A Tool

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Our Answer to High Throughput MW Computing on commodity resources

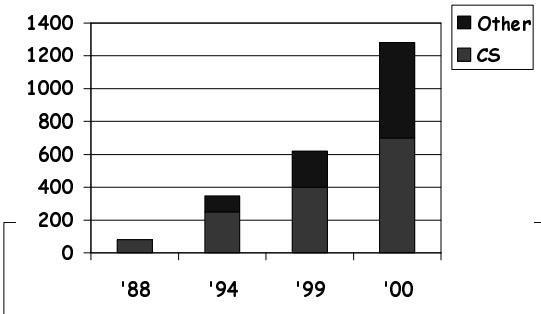
The Condor System

A High Throughput Computing system that supports large dynamic MW applications on large collections of distributively owned resources developed, maintained and supported by the Condor Team at the University of Wisconsin - Madison since '86.

- Originally developed for UNIX workstations.
- Fully integrated NT version is available.
- Deployed world-wide by academia and industry.
- More than 1300 CPUs at the U of Wisconsin.
- Available at www.cs.wisc.edu/condor.

www.cs.wisc.edu/condor

Condor CPUs on the UW Campus



Some Numbers-CS Pool

Total since 6/98	4,000,000	hours	~450 years
"Real" Users	1,700,000	hours	~260 years
CS-Optimization	610,000	hours	
CS-Architecture	350,000	hours	
Physics	245,000	hours	
Statistics	80,000	hours	
Engine Research Center	38,000	hours	
Math	90,000	hours	
Civil Engineering	27,000	hours	
Business	970	hours	
"External" Users	165,000	hours	~19 years
MIT	76,000	hours	
Cornell	38,000	hours	
UCSD	38,000	hours	
CalTech	18,000	hours	

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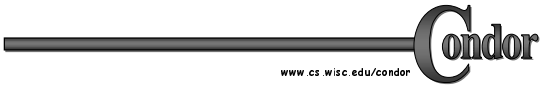
A Model for ...



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CS-Domain Collaborations

Multi disciplinary research that advances the state-of-the-art in CS and a domain science.

- Based on mutual respect and understanding of objectives, needs, constraints and culture
- Leverage expertise, resources and funding
- Enables experimental Computer Science
- Enables speculative science

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Campus Scientific Computing

Support the increasing demand from domain scientists for advanced computing, storage and networking services

- Computing power
- State-of-the-art middle-ware and libraries
- Access to experts who understand the nature and dynamics of scientific computing
- Cycles for class/research projects

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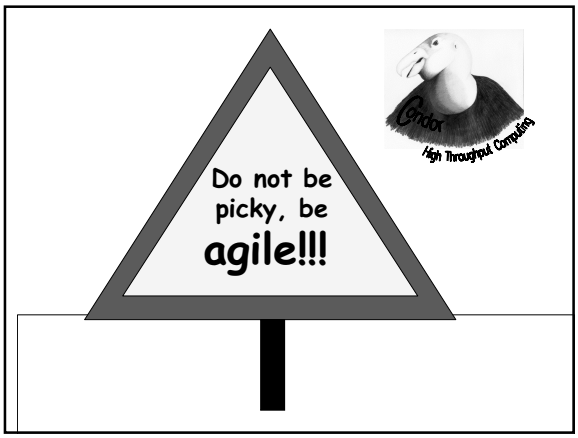
Software Distribution and Support

Making software developed in academia available to academic and commercial users.

- Legal and technical support for software distribution
- Infrastructure for "for-fee" support
- Blueprint for dealing with IP rights

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