Ten Years of "Plug-and-Play" Cluster Computing

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Abstract

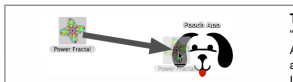
In 1998, at the UCLA Plasma Physics group, **we invented the Mac cluster** to achieve accessible computational power for our research goals. On the Macintosh platform, we developed the earliest tools to build easy-to-use numerically-intensive parallel computing clusters.

From the beginning, our patented software technology supports the Message-Passing Interface, today a dominant industry standard. We used Mac OS 8's AppleTalk to discover computing nodes across the network and support supercomputing-style communications on the Mac cluster. Using plasma physics calculations we use for research, we demonstrated performance on our 8-node Mac G3 cluster similar to that of 8 nodes of a Cray T3E.

Prompted by Mac OS X's introduction, in 2001 we introduced the first OS X cluster solution with the Pooch App debut, reincarnating Mac clustering with IP-based communication and network discovery. Development of Mac clusters continues, adapting to all six major versions of OS X, multiprocessing, Xserves, the G5, Bonjour-based node discovery, the Intel transition, seven MPI implementations, and multicore.

We apply our clustering approach to mainstream applications. We accelerate Wolfram Research's Mathematica by combining it with the programming paradigm of today's supercomputers. Our Mac cluster approach accelerates QuickTime video compression, particularly frame-reordering H.264, plugging into mainstream desktop video-editing applications such as Final Cut Pro. On a single 8-core Mac Pro, our solution exceeds Apple's multicore implementation by 300%, plus the ability to further increase performance with additional Macs. We are excited by the benefits clustering can bring mainstream computing.

The year 2008 marks the tenth anniversary of Mac clustering. We find that the reliability of cluster technology is as important as its performance. By "reinventing" the cluster computer, we provide a unique solution designed to maximize accessibility and usability for users.



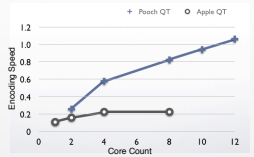
The Pooch App Debut
"Parallel OperatiOn and Control Heuristic Application": With IP-based communications and network discovery, even over the Internet, and an iTunes-like user interface, the Mac cluster was reborn. Drag-and-drop and AppleScript support for newly-introduced parallel applications defined how the famed ease-of-use of the Macintosh was combined with high-performance computing. Supporting both OS 9 and the brand-new OS X, it was the first to cluster both Unix and non-Unix. On demand, it rated machines to support automatic node selection for "grid"-like behavior. [2]

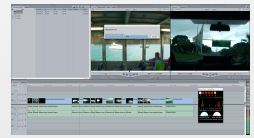
As Seen on TV!

"Keeping America Strong" Award
On William Shatner-hosted national television, we were profiled and interviewed by Doug Llewelyn about Mac clustering and what it can bring to the world. [3]

Clustering Video Compression
First to accelerate HD H.264 encoding using MPI-based clusters, the Pooch QuickTime Exporter plug-in accepts data from any video editing application that uses the QuickTime component architecture and redistributes it onto a Mac cluster for parallelized encoding by any QuickTime-supported codec. [8]

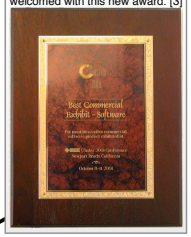
For content creators and other video producers, this technology can produce simultaneously multiple compression formats, varying both in codec settings and frame sizes, to make most efficient use of limited source speed (15 fps for HD) from video editors like Final Cut, iMovie, and After Effects targeted for Apple TV, websites, iPods, DVDs, and other devices.

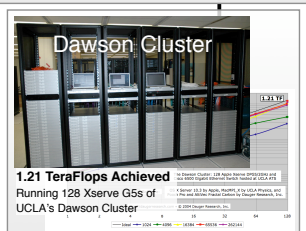




So Easy a Child Could Build One
Kenny from Hawaii built his own Mac cluster using our software and five iMacs. Kenny was eleven years old.

IEEE Cluster Award for "Most Innovative" Software
The Pooch App's first year welcomed with this new award. [3]





1.21 TeraFlops Achieved
Running 128 Xserve G5s of UCLA's Dawson Cluster

"One of the best pieces of software on the Mac platform. I'm continually increasingly impressed. It's a really simply beautiful piece of work."
- Professor Noah W. Allen, Dept. of Chemistry, University of North Carolina Asheville

The reign of the single-processor computer is over
The popularized version of Moore's law, expecting doubling performance per processor, has ended. Processor makers instead offer multiple "Core"s, giving all software writers a renewed opportunity to learn parallel programming. [4-6]

Bonjour Technology
Pooch was the first to cluster using this new network discovery mechanism.

"A Must-Read" Cluster Article
CiSE editor's comment on article featuring the Pooch cluster solution.

1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

10.0
10.1

10.2

10.3

10.4

"Universal Clustering"
Pooch supports mixed Intel- and PowerPC-based Mac clustering.

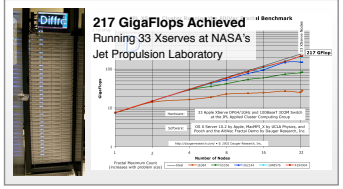
10.5

Open MPI

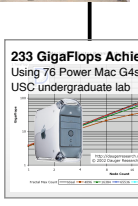
Pooch Patent Granted

iPhone Cluster ???
Yes, it could be done. But what would that do to the battery life?

The First Mac Cluster
When the Bondi Blue iMac and beige G3 were new, our group was the first to build a Mac cluster, one using Mac hardware and OS. MacMPI, the first Message-Passing Interface implementation for the Macintosh, used AppleTalk to enable parallel codes that ran on large supercomputers to run on the Mac. [1] Incredulous naysayers doubted a "Mac flop" could be compared to a "Cray flop".



217 GigaFlops Achieved
Running 33 Xserves at NASA's Jet Propulsion Laboratory

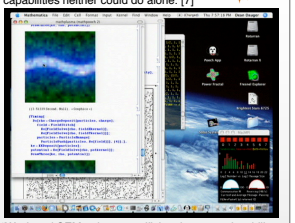


233 GigaFlops Achieved
Using 76 Power Mac G4s of a USC undergraduate lab

"The simplest method to control parallel jobs is to use Pooch."
- Professor John Huelsenbeck, Ecology, Behavior & Evolution, UCSD

"Pooch is outstanding software, and I am very glad I made the decision to create a Mac cluster."
- Professor Todd K. Timberlake, Dept. of Physics, Berry College, GA

Supercomputing Engine for *Mathematica*
We implement and support an MPI library within the *Mathematica* environment, an industry first. Combining easy-to-use Pooch cluster technology with Wolfram Research's *Mathematica* creates a technology with unprecedented capabilities neither could do alone. [7]



"We found SEM to be very efficient in terms of stability and use for financial engineers who do not have the time to optimize load balancing issues but want to focus on modeling." - Vineer Bhansali, Mng. Director, PIMCO.

References

1. http://daugerresearch.com/vault/aua.shtml
2. http://daugerresearch.com/pooch/firsts.shtml
3. http://daugerresearch.com/media/
4. http://daugerresearch.com/vault/parallelization.shtml
5. http://www.macresearch.org/multicore_eroding_moores_law
6. http://daugerresearch.com/vault/parallelparadigm.html
7. http://daugerresearch.com/pooch/mathematica/
8. http://daugerresearch.com/pooch/quicktime/

Portions of this work are patented or patent-pending. The Supercomputing Engine for Mathematica was produced in partnership with Zvi Tannenbaum of Advanced Cluster Systems plus the assistance of Wolfram Research.

Thanks goes the UCLA Plasma Physics Group and the Applied Cluster Computing group at NASA's Jet Propulsion Laboratory for their support over the years. Particularly, our thanks goes to the late John M. Dawson for his support at the most sensitive stages of this work.