Introducing
the

Air Force Research
Laboratory
Information Directorate

Condor Supercomputer

DOD's Largest Interactive Supercomputer

Ribbon Cutting Ceremony
AFRL, Rome NY
1 Dec 2010

Ribbon Cutting Ceremony Agenda

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0900 - 0930 : Assemble in Urtz Conference Room

0930 - 0945 : Welcome from the AFRL Information Director and Chief Scientist

0945 - 1000 : Move to Naresky Facility

1000 - 1015 : Ribbon Cutting

1015 - 1115 : Presentations and Demos

A Note from Dr. Richard W. Linderman, ST

Chief Scientist, AFRL Information Directorate

"Thank you for joining us today to "cut the ribbon" on a unique, world-class high performance computer that represents the fastest interactive supercomputer in Department of Defense (DoD). This 500 trillion operations per second machine can process real-time sensor data at tens of gigabytes per second. Condor can also store and sort more than 400 terabytes of information, equivalent to 40 times the entire printed collection of the Library of Congress. This machine will push the frontiers of science and engineering in diverse fields such as signal and image processing, information fusion and exploitation, large scale cyber simulations, and basic research into models of cognition.

Condor continues an AFRL Information Directorate tradition of pushing the state-of-the-art in high performance computing (HPC). It builds upon earlier innovations in real-time supercomputing, embedded processing, and low cost HPC. The new Condor machine achieves a 10X price-performance advantage, and a 15X power-performance advantage over other large HPSs by combining Playstation 3 gaming consoles and commercial graphics cards with high performance servers. It is lean and green! It is also made freely available to DoD research and development organizations and their contractors."

What is the Condor Supercomputer?

The Air Force Research Laboratory's Information Directorate has recently designed and assembled what is currently the DoD's largest interactive supercomputer. Our "Condor Cluster" is a heterogeneous supercomputer comprised of commercial-off-the-shelf commodity components including 1,716 Sony Playstation III® (PS3) game consoles and 168 General Purpose Graphical Processing Units.

The computing power of supercomputers is measured in "FLOPS" or Floating Point Operations per Second. A floating point operation is a single operation done by a computer. A typical household laptop can achieve approximately 10 billion FLOPS of computing power. AFRL's Condor supercomputer will achieve 500 trillion FLOPS of processing power. That's equivalent to about 50,000 laptops, which is about one fifth the speed of the fastest computer in the world, for a small fraction of the cost to develop and operate!

Condor is a "green" supercomputer, designed to consume significantly less energy than comparable supercomputers. It can achieve approximately 1.5 GigaFLOPS per Watt of computing power, where a typical supercomputer achieves only 100 MegaFLOPS per Watt. This is a 15X improvement in performance for the same power. The sleep mode inherent in the PS3 further contributes to power savings. We are able to intelligently cycle between operational mode and sleep mode, thus requiring less cooling and achieving further energy savings.

A primary application of Condor is radar image processing for urban surveillance. Condor is capable of processing the complex computations required to create a detailed image of an entire city from radar data. AFRL also plans to implement neuromorphic computing, which involves emulation of the human brain to reason over complex problems. Potential future applications include quantum computing simulations, intrusion detection system modeling for cyber operations, wireless cloud computing, and computing for nano technology material development.

Building the Condor

1700 PS3s arrive at AFRL/RI in February 2010. Testing, staging, and accountability of all 1700 PS3's.

A Linux boot loader is installed in preparation to install and operate Linux operating system within the Condor Cluster.

Fabrication and installation of 44 PS3s on each cart. The cart assembly, network wiring and design were all performed by AFRL/RIT personnel.

The entire assembly of 25 carts (1100 PS3s) and wrapping the carts for storage.

The Naresky facility under went power, A/C, floor and wall upgrades to accommodate the Condor Cluster.

Moving all 25 carts into the Naresky facility for initial power test, staging of the Linux operating system and final network assembly.

All PS3s and Condor server head nodes were networked together with state-of-the-art Ethernet and Infiniband switches.

Final integration, testing and modifications to the HPC-ARC center included the 150 Mega Pixel data wall and integration of the visualization computers on the 10GbE HPC network.

AFRL Information Directorate DoD Affiliated Resource Center

The Information Directorate maintains and operates an Affiliated Resource Center for the DoD High Performance Computing Modernization Program (HPCMP). The HPCMP funded the development of Condor under their Dedicated High Performance Computing Project Investment program. In addition to Condor, we maintain the following clusters to support DoD supercomputing needs. The clusters are available for various DoD applications. Users can access the machines remotely to develop and experiment with processing capabilities for military systems design, development, test and evaluation.

53 TERAFLOPS Cell Broadband Engine (CBE) Cluster: This cluster enabled early access to IBM's CBE® chip technology included in the low priced commodity PS3 gaming consoles. This is a heterogeneous cluster with powerful sub-cluster head nodes. The cluster is comprised of 14 sub-clusters, each with 24 PS3s, and one server containing dual quad-core Xeon chips.

Emulation Laboratory (EMULAB) Cluster: The EMULAB cluster provides researchers with an easy to use, flexible and repeatable environment for experimentation on networks, software-intensive systems, cyber operations, and areas requiring modeling and simulation. It is comprised of 3 head nodes and 92 compute nodes (Dell 2950III Dual quad-core Xeon Chips). The network configuration utilizes state-of-the-art switching equipment from Cisco including 6 network interface cards on each compute node.

HORUS Cluster: HORUS provides General Purpose Graphical Processing Units (GPGPUs) in a heterogeneous computing environment for use onboard aircraft to process synthetic aperture radar images. The cluster has been flown on experiments in support of multi-national programs. With 16 Nvidia Corp.GPGPUs, a total of 22 trillion FLOPS (TERAFLOPS) of computing power are achieved.

Other smaller HPC clusters are also currently under development at our facility.

DoD's High Performance Computing Modernization Program (HPCMP)

From the HPCMP Web Page (http://www.hpcmo.hpc.mil)

The High Performance Computing Modernization Program (HPCMP) was initiated in 1992 in response to congressional direction to modernize the high performance computing capabilities of Department of Defense laboratories. The HPCMP was assembled out of a collection of small high performance computing departments, each with a rich history of supercomputing experience that had independently evolved within the Army, Air Force, and Navy laboratories and test centers.

HPC tools solve complicated and time-consuming problems. Researchers expand their toolkit to solve modern military and security problems using HPC hardware and software. Programs can assess technical and management risks, such as performance, time, available resources, cost, and schedule. Through HPC solutions, programs gain knowledge to protect our military through new weapon systems, prepare US aircraft for overseas deployments in Afghanistan and Iraq, and assist long-term weather predictions to plan humanitarian and military operations throughout the world.

The HPCMP supports DoD objectives through research, development, test, and evaluation (RDT&E). Scientists and engineers that focus on Science and Technology (S&T) to solve complex defense challenges benefit from HPC innovation. The HPCMP is organized into three components to achieve its goals: HPC Centers, Networking/Security, and Software Applications Support.

Affiliated Resource Centers (ARCs) are DoD Laboratories and test centers that acquire and manage HPC resources as a part of their local infrastructure. ARCs share their resources with the broader DoD HPC user community with HPCMP coordination. AFRL Information Directorate operates one of only four ARCs nationwide.

The mission of the
AFRL Information Directorate is to lead the
discovery, development, and integration
of affordable warfighting information technologies
for our air, space and cyberspace force.