Energy-Efficient, Liquid-Cooled Architecture
- Designed for 3x improved energy savings per rack over air-cooled systems
- Uses warm water instead of chilled water to reduce operating costs
- Offers the latest technologies with flexible open standards system configurations
- Delivers an integrated HPC cluster software stack and reliable cluster management software
- Provides a modular and scalable turnkey solution with worldwide support and services
System Overview
The Cray CS300-LC™ cluster supercomputer is based on a liquid cooling architecture that directly cools the compute processor to efficiently remove system heat. This architecture results in superior energy efficiency over air-cooled systems by using warm water heat exchangers instead of chillers, thus lowering energy costs in the datacenter.

The system is based on open standard server nodes connected to the rack coolant distribution unit (CDU), which is prefilled with liquid prior to system installation. The Cray CS300-LC system uses a low pressure isolated secondary loop with dripless quick connectors that are double sealed to reliably cool each server’s critical components.

In addition, processors, GPUs and coprocessors are field replaceable units (FRUs) offering serviceability and flexibility.

Less Energy, Lower TCO, Faster ROI
Requiring fewer or no air conditioning units, the liquid-cooled Cray CS300-LC cluster supercomputer reduces typical energy consumption in the datacenter by 50 percent with predicted power usage effectiveness (PUE) of 1.1 or lower. The Cray CS300-LC system was designed to deliver three times improved energy savings per rack compared to traditional air-cooled designs with immediate to one-year payback cycles typical.

Ideal Environments
The Cray CS300-LC system was designed for medium- to large-scale capacity and data-intensive computing workloads addressing both massively parallel and Big Data analytics challenges.

Capacity Computing
Configurations focus on the latest processors including Intel® Xeon® and AMD Opteron™ with support for Intel® Xeon Phi™ coprocessors or NVIDIA® Tesla® GPU computing accelerators.
- Energy-efficient platform and superior performance per dollar
- Maximizes throughput for massive parallel computing applications

Data-Intensive Computing
Configurations focus on memory and bandwidth with excellent memory capacity per FLOP.
- Tight integration with Lustre-based global parallel storage systems including Cray Cluster Connect and the Cray Sonexion® storage system using hierarchical storage – SSD, HD RAS features and data management and connectivity tools
- Processes, manages and analyzes large volumes of data

Flexible and Scalable Configurations
- Based on the Intel® Xeon® processor E5 family
- Two-socket industry-leading x86 processors and accelerator based platforms
- Multiple interconnect options, including 3D Torus/fat tree, single/dual rail, QDR/FDR IB, GigE
- Wide range of parallel file storage systems including Cray Cluster Connect and Cray Sonexion

Manageable
- Integrated HPC cluster software stack featuring Cray’s Advanced Cluster Engine (ACE™) management software
- Multi Linux OS support
- Manages heterogeneous nodes with different OS stacks
- Message passing libraries, compilers (including the Cray Compiler Environment), debuggers and performance tools
- Network, server, cluster and storage management
- Fine-grain system power and temperature monitoring
- Export and import of system configurations and images
- Detects hardware, fabric topology configuration errors
- Version control and ability to roll back changes
- Integrated support for SLURM and interoperable with any commercial or open source scheduler

Reliable and Serviceable
- No single point of failures with fault-tolerance capabilities
- All critical components easily accessible and hot swappable
- Redundant power, cooling and management subsystems with failover capabilities
- Built-in multi-generation configuration software
- Turnkey installation services with worldwide support and service options
Flexible and Energy-Efficient Architecture
The Cray CS300-LC system can be configured in a fat tree or 3D Torus architecture, making it optimized for superior application performance. The system incorporates two types of dedicated nodes: compute and service nodes. Compute nodes are designed to run parallel MPI and/or OpenMP tasks with maximum efficiency. Service nodes are designed to provide scalability and I/O connectivity and can function as login nodes where applications are compiled and launched.

Highly Configurable Compute Nodes
Each Cray CS300-LC system is composed of two processors per node supporting up to 60 nodes per rack cabinet. Each node can be configured with up to 512GB DDR3 memory. Memory controllers ensure highly reliable memory performance while retaining platform upgradeability and flexibility. In addition, the platform supports a variety of hybrid computing configurations.

Scalable Interconnect Performance
The interconnect fabric for the system can be configured as a single- or dual-rail InfiniBand network. If single-rail, the compute nodes have a single QDR or FDR InfiniBand connection to the InfiniBand interconnect fabric. If dual-rail, the compute nodes have two InfiniBand connections. The InfiniBand I/O channels on the compute nodes are based on low-latency host channel adapters. Each Scalable Unit (SU) modular rack system configuration can be replicated over and over to build reliable and very powerful large-scale systems using industry-standard components with a choice of fat tree or 3D Torus network topologies.

Intel® Xeon® Processor
The Intel Xeon processor is at the heart of the agile, efficient datacenter. Built on Intel’s industry-leading microarchitecture based on the 22nm 3D Tri-Gate transistor technology and featuring Intel Node Manager, the Intel Xeon processor delivers enhanced energy efficiency and performance that adapts to the most complex and demanding workloads. In addition, the processor offers Intel Advanced Vector Exchange for accelerating floating point operations, Intel Turbo Boost Technology 2.0 for greater peak load performance and Intel Hyper-Threading for multi-threaded and concurrently running applications. The Intel Xeon processor also offers Intel Integrated I/O, which supports PCIe 3.0 specifications to help reduce latency and improve bandwidth by up to 2x over the previous Intel Xeon processor.

Intel® Xeon Phi™ Coprocessor for Parallel Workloads
The Intel Xeon Phi coprocessor x100 series is based on Intel Many Integrated Core (Intel MIC) Architecture and its works synergistically with the Intel Xeon processor to increase developer productivity via common programming models and tools. The Intel Xeon Phi coprocessor x100 series enables dramatic performance gains for demanding applications delivering over 1 teraflops peak double-precision performance. It offers many-core compared to multicore with wider vector processing units for greater floating point performance/watt. The Intel Xeon Phi coprocessor is highly parallel and programmable based on open standards with support for data thread and process parallelism with full support from Intel Cluster Studio XE while delivering outstanding aggregate performance and higher memory bandwidth.

NVIDIA® Tesla™ K40 GPU Computing Accelerator
The NVIDIA® CUDA™ architecture enables developers to utilize simplified many-core NVIDIA GPUs to solve the most complex intensive computing tasks from the CPU to the GPU. It maximizes bandwidth while working with virtually any PCIe-compliant host system. Solve your most demanding HPC and big data challenges on the NVIDIA Tesla K40 GPU Accelerator, the world’s fastest accelerator that features 2,880 cores and the industry’s highest single and double precision peak floating point performance – 4.29Tflops and 1.43Tflops respectively. Equipped with 12GB of GPU accelerator memory, the NVIDIA Tesla K40 GPU accelerator processes 2x larger datasets to solve the world’s most challenging computational problems. It also outperforms CPUs by up to 10x and delivers additional performance with its GPUBoost feature, converting power headroom into user-controlled performance boost.
Cray's Advanced Cluster Engine (ACE™) management software is part of Cray's HPC cluster software stack. ACE offers a complete management software suite designed to eliminate the complexity of managing an HPC cluster while providing all of the tools necessary to run large, complex applications. ACE software includes command line (CLI) and graphical user interfaces (GUI) providing flexibility for the cluster administrator. An intuitive and easy-to-use ACE GUI connects directly to the ACE Daemon on the management server and can be executed on a remote system running Linux, Windows® or Mac OS. The management modules include network, server, cluster and storage management.

ACE Software Supports:
- Multiple network topologies and diskless configurations with optional local storage
- Network failover offers high scalability with maximum reliability
- Customizable HPC development environment for industry-standard platforms and software configurations
  - Heterogeneous nodes with different software stacks
  - System power and temperature monitoring

Cray delivers a complete end-to-end solution combining hardware, software and professional services to support the job execution, monitoring, management and debugging tools that support the running of large, complex HPC applications. The HPC cluster software stack works with multiple Linux OS distributions such as Red Hat, CentOS and SUSE as well as multiple open source and commercial compiler suites, MPI distributions and many other HPC software tools. The HPC software stack also supports the Cray Compiler Environment (CCE) and Cray LibSci.
### Cray CS300-LC Supercomputer Specifications

<table>
<thead>
<tr>
<th><strong>Architecture</strong></th>
<th>Liquid-cooled cluster architecture offers up to 60 nodes per rack cabinet</th>
</tr>
</thead>
</table>
| **Processor** | Support for up to 12-core, 64-bit, Intel® Xeon® processor E5-2600 v2 product family  
Optional support for Intel® Xeon Phi™ coprocessors (7120X – 61 cores)  
Optional support for NVIDIA® Tesla® GPU computing accelerators (K20 – 2,496 cores; K20X – 2,688 cores; K40 – 2,880 cores per GPU) |
| **Memory** | Up to 512GB registered ECC DDR3 SDRAM per compute node  
Intel Xeon Phi coprocessor (7120X – 16GB of GDDR5 memory)  
NVIDIA Tesla GPU computing accelerators (K20 – 5GB GDDR5 memory; K20X – 6GB GDDR5 memory; K40 – 12GB GDDR5 memory) |
| **Interconnect** | 1GbE or 10GbE Ethernet  
QDR or FDR InfiniBand with ConnectX®-3 or True Scale Host Channel Adapters  
Options for single- or dual-rail fat tree or 3D Torus |
| **System Administration, Resource Management, Job Scheduling** | Advanced Cluster Engine (ACE): Complete lights-out remote management capability  
Graphical and command line system administration  
System software version rollback capability  
Redundant management servers with automatic failover  
Automatic discovery and status reporting of interconnect, server, and storage hardware  
Partition a cluster into multiple logical clusters each capable of hosting a unique software stack  
Integrated job scheduling and management with options for Grid Engine, SLURM, Altair PBS Professional, IBM Platform LSF or Torque/Maui  
Enable the export, import of system configurations and images  
Ability to detect hardware, fabric topology configuration errors  
Remote server control (power on/off, cycle) and remote server initialization (reset, reboot, shut down)  
Scalable fast diskless booting for large node systems and root file systems for diskless nodes  
Multiple global storage configurations |
| **Reliable, Available, Serviceable (RAS)** | Redundant power, cooling, and management servers with failover capabilities  
Redundant networks (InfiniBand, GbE and 10GbE) with failover  
All critical components easily accessible and hot swappable |
| **File System** | Cray Cluster Connect, Cray Sonexion, NFS, Local FS (Ext3, Ext4 XFS) Lustre® and Panasas® PanFS available as global file systems |
| **Disk Storage** | Full line of FC-attached disk arrays with support for FC, SATA disk drives and SSDs |
| **Operating System** | Red Hat, SUSE or CentOS |
| **Performance Monitoring Tools** | Options for HPCC, Perfctr, IOR, PAPI/IPM, netperf |
| **Compilers, Libraries & Tools** | Options for Open MPI, MVAPICH2 or Intel MPI Libraries  
Cray Compiler Environment (CCE), Cray LibSci, PGI, Intel Cluster Toolkit compilers, NVIDIA® CUDA™, CUDA C/C++/Fortran  
OpenCL, DirectCompute Toolkits, GNU, TotalView, OFED programming tools |
| **Power** | Up to 28KW per cabinet depending on configuration  
Optional 480V power distribution with a choice of 208V or 277V 3-phase power supplies |
| **Cooling Features** | Liquid cooled - up to 80% heat capture  
Low pressure secondary loop that is completely isolated from the primary data center liquid loop  
Field serviceable cooling kits with integrated pressure and leak detection with remote monitoring |
| **Cabinet Dimensions (HxWxD)** | 82.40”(2093mm) H x 23.62”(600mm) W x 59.06”(1500mm) D Standard 42U/19” rack cabinet |
| **Cabinet Weight** | 1739 lbs. |
Cray GreenBlade™ System
Building Block Platform for the Cray CS300-LC™ Cluster Supercomputer

The Cray GreenBlade™ system is an energy-efficient, modular and affordable building block platform for the Cray CS300-LC™ cluster supercomputer. It features an innovative liquid-cooled blade design that directly cools the compute processor and memory to efficiently remove heat from the system. This design results in superior energy efficiency over air-cooled systems by using warm water heat exchangers instead of chillers, reducing datacenter energy costs.

The rack coolant distribution unit (CDU) is connected to the GreenBlade system through tubes called quick connects. The CDU is prefilled with warm water during system installation and the water is distributed via quick connects. As easy as connecting power cables, installation of the quick connects can be made by IT personnel without advanced training. Additionally, the Cray GreenBlade system uses a low pressure isolated double-sealed secondary loop with dripless quick connectors to cool each server’s critical components.

Additional features include hot-swappable and redundant cooling fans, power supplies and blade nodes. The Cray GreenBlade system is integrated with four high-efficiency power supplies with an option for 480V power distribution based on 208V or 277V 3-phase power for further energy savings. It houses up to 10 blade servers offering a total of 20 processors in a 6U form factor. It can be configured as a hybrid server offering two CPUs coupled with an expansion blade featuring two NVIDIA® Tesla® GPU computing accelerators or Intel® Xeon Phi™ coprocessors. The system also provides intelligent power control and integrated IPMI for remote server management capabilities. For customers that require a more complete management solution, Cray offers its Advanced Cluster Engine™ (ACE) management software suite.

The Cray GreenBlade system GB612X server node supports the new Intel® Xeon® processor E5 family, providing significant performance advantages while drawing less power to achieve higher clock speeds for better efficiency. It offers integrated SATA, PCIe, and support for Intel Advanced Vector Extensions, Intel Turbo Boost Technology 2.0 and Intel Integrated I/O with Intel Data Direct I/O.

Features and Benefits
- Two Intel Xeon processors per node, up to twelve cores for each CPU
  - Built on Intel’s industry-leading 22nm 3D Tri-Gate transistor technology
  - Up to 35% performance boost over prior Intel Xeon processor generations
  - Reduces latency and improves bandwidth with Intel Integrated I/O
  - Intel Node Manager allows hosting of heavier workloads while guarding against overheating
  - Intel Advanced Vector Extensions reduce compute time
- Warm water heat exchangers deliver up to 80 percent heat capture
- Leak detection and prevention features
- Support for Intel Xeon Phi coprocessors or NVIDIA Tesla GPU computing accelerators
- IPMI 2.0 compliant with cluster management software options
- Cost-effective, flexible and scalable computational capacity
- Reliable and serviceable with hot-swappable, redundant fans and power supplies
# Cray GreenBlade System: 6U Blade Node

**GB612X Blade Node**

## Cray GreenBlade GB612X Server

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPU Sockets</strong></td>
<td>2 per chassis</td>
</tr>
<tr>
<td><strong>Processor</strong></td>
<td>Up to 12-core Intel® Xeon® processor E5-2600 v2 product family (130W max per CPU)</td>
</tr>
<tr>
<td><strong>Chipset</strong></td>
<td>Intel C600-A Platform Controller Hub (PCH)</td>
</tr>
<tr>
<td><strong>System Bus</strong></td>
<td>Intel QuickPath Interconnect (QPI)</td>
</tr>
<tr>
<td><strong>Memory Type</strong></td>
<td>800/1066/1333/1686 MHz ECC RDIMM DDR3 memory</td>
</tr>
<tr>
<td><strong>Memory Capacity</strong></td>
<td>Up to 256GB in 8 DIMMs across 8 memory channels (4 channels per processor using 32GB DIMMs) Up to 512GB in 16 DIMMs across 8 memory channels (4 channels per processor using 32GB DIMMs)</td>
</tr>
<tr>
<td><strong>Disk Controller</strong></td>
<td>On-board SATA/SAS 6Gb/s</td>
</tr>
<tr>
<td><strong>Drive Bays</strong></td>
<td>2 fixed 2.5&quot; SATA HDD for 8 DIMM motherboard; 1 fixed 2.5&quot; SATA HDD for 16 DIMM motherboard</td>
</tr>
<tr>
<td><strong>Storage Capacity</strong></td>
<td>Up to 1.0TB per blade</td>
</tr>
<tr>
<td><strong>GPU Accelerator</strong></td>
<td>Optional GB612N expansion blade - supports up to 2 NVIDIA® Tesla® K20/K20X/K40 GPU accelerators (K20 - 2,496 cores; K20X – 2,688 cores; K40 – 2,880 cores per GPU accelerator)</td>
</tr>
<tr>
<td><strong>Coprocessor</strong></td>
<td>Optional GB612M expansion blade – supports up to 2 Intel® Xeon Phi™ coprocessors (7120X - 61 cores per coprocessor)</td>
</tr>
<tr>
<td><strong>On-Board Graphics</strong></td>
<td>Integrated VGA graphics, 128MB DDR2 memory</td>
</tr>
<tr>
<td><strong>Network Interface</strong></td>
<td>Integrated dual-port Ethernet controller (Optional: on-board ConnectX-3 QDR InfiniBand with QSFP)</td>
</tr>
<tr>
<td><strong>I/O</strong></td>
<td>2 USB 2.0 compliant ports, 2 RJ-45 LAN ports, DB-15 VGA, optional IB (QSFP)</td>
</tr>
<tr>
<td><strong>Expansion Slots</strong></td>
<td>1 x16 PCIe Gen3 PCI riser slot capable of supporting a low-profile add-in card</td>
</tr>
<tr>
<td><strong>Power and Cooling</strong></td>
<td>Provided on GreenBlade subrack in conjunction with integrated RackCDU Xtension for liquid cooling</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>10.7 lbs.; 4.85kg (CPU compute blade)</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>7.8&quot;H (198mm) x 1.7&quot;W (43mm) x 25.98&quot;D (660mm)</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>Operating: 10-35°C; Storage: 70°C</td>
</tr>
<tr>
<td><strong>Server Management</strong></td>
<td>IPMI 2.0 compliant, integrated baseboard management controller (BMC)</td>
</tr>
</tbody>
</table>
The Cray GreenBlade Subracks

The Cray GreenBlade SR6110 subrack model is a 6U rack height system that fits into the standard 19 inch rack cabinet of the Cray CS300-LC cluster supercomputer. Each subrack packages server, storage, power and simplified management capabilities while providing performance, reliability, density and upgradeability.

Features include:
- **Flexibility**: Shipped fully configured with built-in management and redundancy for all server blades
- **Green Architecture**: Power-optimized design delivers reduced power consumption
- **Increased Density**: Doubles the density of any standard 1U server
- **Improved RAS**: Hot-swappable blade nodes, redundant power supplies and cooling fans

### Cray GreenBlade SR6110 Subrack

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form Factor</strong></td>
<td>Supports 10 CPU compute blades or 5 CPU hybrid blades in 6U rack space</td>
</tr>
<tr>
<td><strong>Power Supply</strong></td>
<td>Up to 4 1630W high-efficiency PSUs with redundant N+1 configuration</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>Up to 3 cooling fan units</td>
</tr>
<tr>
<td><strong>Ethernet I/O</strong></td>
<td>Optional: Up to 2 GbE LAN ports for iSCB management communications</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>10.33&quot;H (262mm) x 17.51&quot;W (445mm) x 29.06&quot;D (738mm)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>205.4 lbs.; 93.2 kg. max (including 10 CPU compute blades)</td>
</tr>
</tbody>
</table>

**Management/OS**
- Support for high-speed interconnects, Advanced Cluster Engine (ACE™) management software, Windows® or Linux OS
- Enhanced management capabilities include leak detection, temperature monitoring and flow/pressure monitoring

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![Cray GreenBlade SR6110 Subrack Image](image-url)