Cray’s XC series leverages the combined advantages of the high-performance Aries™ interconnect and Dragonfly network topology, Intel® Xeon®, Intel® Xeon Phi™ and Cavium ThunderX2™ processors, NVIDIA® Tesla® GPU accelerators, integrated storage solutions, and the Cray OS and programming environment. The Cray® XC™ series supercomputer is a groundbreaking architecture upgradable to over 500 petaflops per system and delivering:

- Sustained and scalable application performance
- Tight HPC optimization and integration
- Production supercomputing
- Investment protection – upgradability by design
- User productivity
Extreme Scalability and Sustained Performance

Cray has an established reputation for regularly running the biggest jobs on the largest numbers of nodes in the HPC industry. With the Cray XC series there's even more focus on solving extreme capability computational challenges. Designed to avoid the limitations of commodity assemblies, the Cray XC system scales hardware, networking and software across a broad throughput spectrum to deliver true sustained, real-world production performance. It all means users can now model even bigger datasets and simulate massive systems which previously needed to be partitioned down into numerous smaller-sized modules.

Adaptive Supercomputing Architecture

Building on Cray's adaptive supercomputing vision, the Cray XC series integrates extreme performance HPC interconnect capabilities with best-in-class processing technologies to produce a single, scalable architecture.

Understanding that no single processor engine is ideal for every type of user application, the Cray XC series highlights the flexibility of scalar processing, coprocessing and accelerators to build hybrid systems capable of leveraging the strengths of each technology into one “adaptive” HPC environment. Computing applications often need a balance of scalar and parallel operations to execute optimally. Merging x86 multicore benefits with coprocessor or accelerator many-core advantages addresses this need to target the best processing engine type for a specific function. With a robust hardware and software environment empowering customer choice, users can configure their Cray XC systems to their own unique requirements to meet their specific goals.

With the Cray XC system, the adaptive supercomputing concept applies to building flexibility into hardware and network upgradeability, the comprehensive HPC software environment, optimized OS and ISV support, networking, storage and data management as well as power and cooling elements.

Holistic and Integrated Platform

Cray uses holistic and integrated methods to develop the world’s most complete and robust HPC systems. This R&D process is a key benefit of Cray supercomputers and ensures that each product is developed, tested and validated against the most demanding real-world HPC applications. Rather than assembling cluster-like components and commodity networks that can degrade or act unpredictably at high node counts, the Cray XC series architecture improves upon the Cray history of “system-centric” development.

With a comprehensive scope of extreme performance interconnects, processing, packaging, cooling, power options, file systems, upgradability, supervisory systems, OS and software development environment, the Cray XC series delivers a quality, reliable HPC solution. Additionally, like all Cray systems, Cray XC supercomputers offer the ability to efficiently scale key software applications, easy and proactive future upgradability by design, and a tightly coupled interconnect and software environment.

Regardless of your application requirements, the Cray XC series scales across the performance spectrum — from smaller footprint, lower-density configurations up to the world's largest and highest-performing supercomputers.
Aries Interconnect and Dragonfly Topology

To provide this breakthrough performance and scalability, Cray XC series supercomputers integrate the HPC-optimized Aries interconnect. This innovative intercommunications technology, implemented with a high-bandwidth, low-diameter network topology called Dragonfly, provides substantial improvements on all the network performance metrics for HPC: bandwidth, latency, message rate and more. Delivering unprecedented global bandwidth scalability at reasonable cost across a distributed memory system, this network provides programmers with global access to all of the memory of parallel applications and supports the most demanding global communication patterns.

The Dragonfly network topology is constructed from a configurable mix of backplane, copper and optical links, providing scalable global bandwidth and avoiding expensive external switches.

Adaptive supercomputing means a modular structure providing a customizable system for users to manage entry costs, and enables easy in-place upgrades for growing bandwidth requirements in the future.

The Aries ASIC provides the network interconnect for the compute nodes on the Cray XC system base blades and implements a standard PCI Express Gen3 host interface, empowering connectivity to a wide range of HPC processing compute engines. This universal nature of the Cray XC series open architecture allows the system to be configured with the best available devices today, and then augmented or upgraded in the future with the user's choice of processors utilizing processor daughter cards (PDCs), each with their own independent capabilities and development schedule.

The Cray XC series architecture implements four compute nodes per blade, with one or two processor sockets per node depending on processor/accelerator type. Compute blades stack in eight pairs (16 to a chassis), and each cabinet can be populated with up to three chassis, culminating in 192 to 384 sockets per cabinet.

Cray partners with silicon vendors like Intel, Cavium and NVIDIA to deliver state-of-the-art multicore and many-core technologies. The XC series adaptive supercomputing approach delivers user flexibility when it comes to choosing compute configurations and makes it as easy as possible to upgrade with new cutting-edge technologies.

The open architecture of the Cray XC series empowers users to accelerate performance and reduce power consumption by running hybrid applications leveraging GPUs as well as host processors. Adaptive supercomputing means power-efficient performance and customer choice.
Rather than being boxed in by a restricted system architecture, the Cray XC series provides complete workload flexibility. Based on generations of experience with both environments, Cray has leveraged a single machine to run both highly scalable custom workloads as well as industry-standard ISV jobs via the powerful Cray Linux® Environment (CLE). CLE enables a Cluster Compatibility Mode (CCM) to run out-of-the-box Linux/x86 versions of ISV software without any requirement for porting, recompiling or relinking. Alternatively, Cray's Extreme Scalability Mode (ESM) can be set to run in a performance-optimized scenario for custom codes. These flexible and optimized operation modes are dynamic and available to the user on an individual job basis. CLE has been optimized to make the most of the advancements in the Aries interconnect and the Dragonfly topology without requiring user tuning. Adaptive supercomputing means supporting different techniques of code execution on the fly.

**ROI, Upgradability and Investment Protection**

Besides the customizable configuration of the exact machine a user requires, Cray XC series supercomputer architecture is engineered for easy, flexible upgrades and expansion, a benefit that prolongs its productive lifetime and the user's investment. As new technology advancements become available, users can take advantage of these next-generation progressions deep into the life cycle before ever considering replacing an HPC system. Adaptive supercomputing means longevity.

**Cray XC Series System Resiliency Features**

The Aries interconnect is designed to scale to massive HPC systems in which failures are to be expected, but where it is imperative that applications run to successful completion in the presence of errors. Aries uses error correcting code (ECC) to protect major memories and data paths within the device. The ECC combined with the Aries adaptive routing hardware (which spreads data packets over the available lanes that comprise each of the Dragonfly links) provide improved system and applications resiliency. In the event of a lane failure, the adaptive routing hardware will automatically mask it out. The HSS can even automatically reconfigure to route around the bad links in the event of losing all connectivity between two interconnects.

Additionally, the Cray XC system features NodeKARE™ (Node Knowledge and Reconfiguration). If a user's program terminates abnormally, NodeKARE automatically runs diagnostics on all involved compute nodes and removes any unhealthy nodes from the compute pool. Subsequent jobs are allocated only to healthy nodes and run reliably to completion.

**Innovative Cooling and Green Systems**

Cray continues to advance its HPC cooling efficiency advantages, integrating a combination of vertical liquid coil units per compute cabinet and transverse air flow reused through the system. Fans in blower cabinets can be hot swapped and the system yields "room neutral" air exhaust. Innovative high-performance power and new cooling capabilities support powerful new high-wattage processors. Improve your TCO by reducing the number of chillers and air handlers. Eliminate the need for hot/cold aisles in your datacenter.
The Cray XC Series Supercomputer Delivers

- Sustained and scalable application performance
- Production supercomputing
- Tight HPC optimization and integration
- Investment protection
- Upgradability by design
- User productivity

Cray Provides

- A robust software environment
- Integrated storage solutions
- A broad partner ecosystem

Cray XC Series Targets

Environmental and Earth Sciences
- Climate
- Oceanography
- Weather

Energy, Oil and Gas
- Seismic analysis
- Reservoir simulation

Manufacturing and CAE
- Aerospace CFD simulation
- Automotive safety and crash analysis
- Noise, vibration and harshness simulation
- Materials

Financial Services

Healthcare and Life Sciences
- Medical imaging
- Simulation
- Sequencing

Government, Defense, National Security and Cybersecurity
**The HPC Challenge**

Higher performance or lower power? More flexibility or lower cost? Increased capabilities or improved greenness? Today’s demanding HPC technology requirements are often in conflict with each other. The driving metrics around supercomputing are no longer purely about peak performance and faster clock rates. Now, users need to balance speed and power with other critical system capabilities such as sustained real-world performance, economized power, cooling efficiency, tight packaging, and a robust partner ecosystem as well as full integration of OS, software and programming environments. Business requirements are equally important and need to address upgradeability and return on investment, operating and capital equipment costs, reliability and resiliency.

**PDCs and Compute Blades**

Processor daughter card options providing the adaptive supercomputing flexibility of customer choice on processing engine technology are outlined in detail in separate product briefs covering CPUs, accelerators and coprocessors.

**Software Environment**

Cray's XC software stack includes the HPC-optimized Cray Linux Environment, with industry-leading features to optimize workload deployment; and the Cray Programming Environment, which drives maximum computing performance at scale while focusing on programmability, portability, and powerful systems management for superior control and reliability.

**Data Storage**

Cray offers a range of complementary high-performance storage optimized for the XC series line of supercomputers:

- **Cray® ClusterStor™** systems reduce complexity to enable seamless system design, easy installation, workload management, data flow, scalability, system efficiency, and faster time to results. ClusterStor systems balance the value equation to achieve the right performance levels, scalability and availability, all at the right budget without the complexity typically associated with high-performance data storage architecture.

- **The Cray® DataWarp™** I/O acceleration option for the XC series supercomputer utilizes flash storage to speed up storage performance to applications and compute nodes in a variety of scenarios. The Cray DataWarp accelerator reduces the cost of delivering storage performance by up to 5x over hard-drive disk (HDD) based file systems.

Additional product briefs may be downloaded from Cray's website at [www.cray.com/xc](http://www.cray.com/xc)
## Cray® XC™ Series Specifications

### Processing Options
- Intel® Xeon®, Intel® Xeon® Scalable, Intel® Xeon Phi™ and Cavium ThunderX2™ processors
- NVIDIA® Tesla® K40 and P100 GPU accelerators

### Memory
- 64-256 GB per node
- Memory bandwidth: up to 153 GB/s per node

### Compute Cabinet
- Up to 384 sockets per cabinet, upgradeable with processors of varying core counts
- Peak performance up to 1 PF per system cabinet

### Interconnect
- 48 switch ports per Aries chip (500 GB/s switching capacity per chip)
- Dragonfly interconnect: low-latency, high-bandwidth topology

### System Administration
- Cray System Management Workstation (SMW)
- Single-system view for system administration
- System software rollback capability

### Reliability Features (Hardware)
- Integrated Cray Hardware Supervisory System (HSS)
- Independent, out-of-band management network
- Full ECC protection of all packet traffic in the Aries network
- Redundant power supplies; redundant voltage regulator modules
- Redundant paths to all system RAID
- Hot swap blowers, power supplies and compute blades
- Integrated pressure and temperature sensors

### Reliability Features (Software)
- HSS system monitors operation of all operating system kernels
- Lustre® file system object storage target failover; Lustre metadata server failover
- Software failover for critical system services including system database, system logger, and batch subsystems
- NodeKARE (Node Knowledge and Reconfiguration)

### Operating System
- Cray Linux® Environment (includes SUSE Linux SLES11, HSS and SMW software)
- Extreme Scalability Mode (ESM) and Cluster Compatibility Mode (CCM)

### Compilers, Libraries & Tools
- Cray Compiler Environment, Intel Compiler, PGI Compiler, GNU compiler
- Support for the ISO Fortran standard (2008) including parallel programming using coarrays, C/C++ and UPC
- MPI 3.0, Cray SHMEM, other standard MPI libraries using CCM; Cray Apprentice and CrayPAT™ performance tools; Intel Parallel Studio Development Suite (option)

### Job Management
- PBS Professional job management system
- Moab Adaptive Computing Suite job management system
- SLURM – Simple Linux Unified Resource Manager

### External I/O Interface
- Infiniband, 40 and 10 Gigabit Ethernet, Fibre Channel (FC) and Ethernet

### Disk Storage
- Lustre, Data Virtualization Service (DVS) allows support for NFS, external Lustre and other file systems

### Parallel File System
- Lustre, Data Virtualization Service (DVS) allows support for NFS, external Lustre and other file systems

### Power
- Support for 480 VAC and 400 VAC computer rooms
- 6 kW per blower cabinet, 20 AMP at 480 VAC or 16 AMP at 400 VAC (three-phase, ground)

### Cooling
- Water cooled with forced transverse air flow; 6,900 cfm intake

### Dimensions (Cabinets)
- XC40: H 80.25” x W 35.56” x D 62” (compute cabinet), H80.25” x W 18” x D 42” (blower cabinet)
- XC50: H 80.25” x W 35.56” x D 76.5” (compute cabinet), H80.25” x W 18” x D 59” (blower cabinet)

### Weight (Operational)
- XC40: 3,450 lbs. per compute cabinet – liquid cooled, 750 lbs. per blower cabinet
- XC50: 4,500 lbs. per compute cabinet – liquid cooled, 900 lbs. per blower cabinet

### Regulatory Compliance
- EMC: FCC Part 15 Subpart B, CE Mark, CISPR 22 & 24, ICES-003, C-tick, VCCI
- Safety: IEC 60950-1, TUV SUD America CB Report
- Acoustic: ISO 7779, ISO 9296