Cray X1 System, Site Planning

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ABSTRACT: *The Cray X1 air cooled (AC) and liquid cooled (LC) systems site preparation requirements are less complex and extensive than previous Cray products. This paper provides a system overview and information about site access, power wiring, system cooling, water piping, floor preparation, and environmental requirements as well as some system comparisons.*

1. System Overview

The Cray X1 AC and LC systems consist of four major components: the mainframe chassis, the IO cabinet, PC-20 cabinets, and the Cray workstation (CWS). The mainframe houses the node modules—each containing four CPUs and memory—and router modules. The IO houses the IO channel adaptor components and the PC-20s house the Cray programming environment server and the Cray network server as well as disk controllers and disk drives. The mainframe connects to the IO cabinet via an overhead trough to minimize cable lengths.

Site Access

The Cray X1 AC mainframe is shipped on a pallet that is very similar to those used for the Cray J90/SV1 products. The Cray X1 LC chassis is large enough (131"l x 46"w x 78"h or 3.3m l x 1.1m w x 1.9m h) on its lifts that special attention should be paid to the access route from the area where the system is unloaded from the truck to the computer room location. If elevator dimensions or corners in narrow hallways present a problem, Cray Inc. will provide a rolling caster platform that replaces the standard lifts, reducing the overall length to 95" (2.4m).

Power Wiring

The Cray X1 systems can be fed by 120/208, 100/200, or 230/400 VAC, 3 phase power. A typical Cray X1 16-CPU AC system with two PC-20s requires the installation of just five electrical circuits. A typical Cray X1 LC 64-CPU system with two PC-20s requires just eight. The maximum circuit size is 100 amp. The mainframes connect directly to the customer's power source rather than through the motor/generators or high-voltage direct-current (HVDC) cabinets used in previous Cray systems.

System Cooling

The Cray X1 AC mainframe rejects 100% of its heat to air, so no water piping is required. A typical system rejects about 85 kBTUs (7 tons) per hour. The Cray X1 LC mainframe is water cooled; the other system components (IO, PC-20s) are air cooled. A typical Cray X1 64-CPU LC system rejects about 48 kbtus/hr (4 tons) to air.

Water Piping

The Cray X1 mainframe utilizes a unique spray-evaporative cooling system to cool the CPU portions of the node board and air cooling to cool the memory and router components within the chassis. Two water-cooled heat exchangers cool the heated air returning from the air-cooled components and this air recirculates through the cabinet in a closed loop. The result is that 95% of the power dissipated by the mainframe is rejected to water. The mainframe connects to the building's chilled-water system via two 2" (5cm) water hoses that are 8 feet (2.4m) long, allowing flexibility in locating the Cray-provided water flanges. The system requires 45° to 55° F (7° to 13° C) chilled water.

Floor Preparation

The typical Cray X1 AC system requires 6 cutouts. The typical Cray X1 64-CPU LC system requires 10 cutouts. To ease preparations, Cray Inc. provides a full-size template for the mainframe cutouts. The mainframe requires approximately six additional pedestals to transfer the 5,750-lb (2433-kg) weight of the mainframe to the subfloor and to reinforce the floor in the areas near cutouts.

Environmental Requirements

The Cray X1 systems operate in a typical computer room environment: 50° to 90° F (10° to 32° C) with a relative humidity in the 20% to 80% range and a maximum dewpoint of 60° F (16° C).

2. System Comparisons

Liquid Cooling versus Air Cooling for Large System Configurations

For scaling to thousands of processors, liquid cooled systems offer many advantages over air-cooled rack-type systems. Processing density (Gflops per square foot) is greater at the cabinet level, and rather than requiring many air handlers, which complicates the opposing requirements of system interconnect cabling and heat rejection, the majority of heat goes directly to water. Overall operating costs can be reduced when the heat is rejected directly to water rather than through dozens of computer room air handlers. Floor depths can be kept to reasonable dimensions because the subfloor does not need to be accommodate the volume of air required for a large quantity of air-cooled racks. The quantity of electrical circuits and related power distribution panels (PDUs) is greatly reduced as well. The overall result is that liquid cooled systems such as the Cray X1 LC system provide greater processing power per square foot of computer room space and lower site preparation and operating costs.

Site Preparation Duration and Effort

While the Cray X1 AC system site preparation is very similar to a Cray J90/SV1 system, requiring roughly a week or two to complete, the Cray X1 LC system site preparation time is greatly reduced compared to previous Cray systems. For a Cray C916 system, the time to design the facility modifications, install the motor/generator sets, the refrigeration condensing units (RCUs) and related water and refrigerant piping and electrical circuits typically consumed 16 to 20 weeks. Likewise, a Cray T932 took 12 to 16 weeks to plan and prepare for. The Cray X1 LC system, however, due to the reduced number of electrical circuits and lack of any intermediate power and cooling components, allows site planning and preparation to be completed in 2 to 3 weeks. We estimate that a customer should expect to spend roughly 10% of what they spent to prepare their sites for Cray C90 or T90 systems.

Performance Density

The Cray X1's compact system footprint yields very high peak performance per square foot:

Cray C90 (16 processors)	.017 Gflops/sq ft	0.18 Gflops/sq m
Cray T90 (32 processors)	.094 Gflops/sq ft	1.01 Gflops/sq m
Cray Xl LC (64 processors)	2.66 Gflops/sq ft	28.6 Gflops/sq m
Earth Simulator (5120 processors)	1.89 Gflops/sq ft	20.3 Gflops/sq m

Performance per Kilowatt

The Cray X1 LC system also performs extremely well in the area of peak performance per kilowatt of power consumed to power and cool the system.

Cray C90, 16 processor	0.04 Gflops/kw
Cray T90, 32 processor	0.13 Gflops/kw
Cray Xl, LC 64 processor	12.84 Gflops/kw
Earth Simulator, 5120 processors	6.94 Gflops/kw

Conclusion

The Cray X1 systems require much less site design and preparation effort and yield very high performance for the floor space and power consumed. To obtain site planning information, please e-mail site@cray.com and let us know which system type you are interested in. If you provide a system configuration, we will e-mail you a document that states the anticipated input power, heat rejection to air, heat rejection to water, and size and weight for the specific system configuration.

About the Authors

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