WHITE PAPER

SGI® UV™ System Reliability, Availability and Serviceability

Optimizing RAS for the World's Most Scalable Coherent Shared Memory Computing Platform

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SGI UV provides single-system image (SSI) scalability up to 2,560 cores (256 sockets). Given the potential size of these systems, and the importance of the applications that run on them, reliability, availability and serviceability (RAS) features are vital to ensuring continuous operation. Even as SGI pushes the number of supported processor cores and coherent shared memory (CSM) to new heights, the company is bringing innovative RAS features to high-end Linux deployments. Building on the advanced RAS features found in Intel® Xeon® processor E7 family, the company's RAS efforts leverage unique experience building the world's largest and most robust server systems. Together, SGI and Intel® are making focused investments to enhance system reliability for large shared memory environments.

1.0 Introduction

SGI UV was designed to address computational and data access challenges faced by some of the most demanding scientific and commercial applications, and to overcome some of the limitations of traditional compute clusters of smaller, thin-node servers. A growing number of applications in both scientific and enterprise settings require the ability to operate on and analyze extremely large data sets, requiring large numbers of processors and very large amounts of memory. Many of these applications benefit enormously from being able to fit a large data set or database entirely into system memory. At the same time, as traditional compute clusters grow in size — both in terms of the number of compute nodes and the number of individual processors — communications processing can become a substantial portion of the computation time required. SGI addresses both of these issues with the UV server family.

In SGI UV, the NUMAlink 5 Hub ASIC on each UV compute blade performs communications processing in hardware, essentially fusing a large number of processors into a high-capability cluster that can function as a single Linux® system. Large-scale CSM architecture can provide entirely new ways of solving a wide range of problems in science, engineering and business that are not available with clusters of smaller compute nodes, enabling breakthroughs in areas that include:

- Fraud detection/cyber security
- Bioinformatics
- Data analytics
- Real-time interaction with massive data sets
- Memory-resident databases (e.g., Oracle TimesTen database)
- Dataflow applications

The architecture and fundamental design parameters of the SGI UV systems provide an important value with direct advantages for large-scale, data-intensive technical and enterprise computing. UV provides the ability to scale coherent shared memory, compute power and I/O bandwidth from very small to essentially unlimited sizes. The SGI UV 1000 system (Figure 1) provides a multi-cabinet solution with up to 256 sockets for Intel® Xeon® processor E7 family (2,560 processor cores) and up to 16TB of shared memory in four racks. The SGI UV 1000 system delivers up to 24.6 teraflops of compute power in a single system image. For more modest needs, the UV 100 system addresses the mid-range market based on an industry-standard three rack unit (3U) rackmount form factor. The UV 100 system scales to 96 sockets for Intel® Xeon® processor E7 family (960 processor cores) and 12TB of shared memory in only two racks — delivering up to 9.2 teraflops of compute power in a single system image.

Large, monolithic CSM systems bring value in terms of the problems they can address, and in terms of ease of use. Delivering on that value requires that these systems be extremely dependable. SGI UV advances the company's more than 25 years of achievement in delivering myriad high-performance servers that operate dependably for years or even decades. These achievements cut across all aspects of the product — from design, manufacturing and testing to deployment, operation and the service cycle. This white paper describes the RAS capabilities of the SGI UV platform.

Figure 1. The SGI UV 1000 system (left) contains up to 256 Intel® Xeon® processor E7 family and up to 16TB of memory in four racks (single rack shown), while the SGI UV 100 system (right) supports up to 960 processor cores.

2.0 SGI UV: Built-In Dependability

Given the level of integration required to build large CSM systems, SGI has a strong collaborative partnership with Intel®. A variety of hardware and software enhancements have been made to the SGI UV platform for Intel® Xeon® processors to provide the reliability required for a system architecture that is ultimately designed to scale to over 256,000 cores and 8PB of memory. To enhance reliability for petascale systems, the architecture includes extensive fault isolation, data path protection, and monitoring and debugging functions to help ensure data integrity and prevent disruptions. System software has also been enhanced to identify problematic nodes and memory and to remove them from the active pool of scheduled resources.

With its high-end scalability and advanced RAS support, the latest Intel® Xeon® processor E7 family offers a dramatic increase in capability and value. In addition to up to ten high-performance cores, 20 execution threads and 24MB of level 3 cache, each Intel® Xeon® processor E7 family provides technology that can protect data, increase availability and minimize planned downtime. By utilizing these advanced processors, SGI UV can yield the highest levels of scalability, availability and data integrity — at a fraction of the cost of proprietary mainframe and RISC architectures. Beyond the base functionality offered by Intel® Xeon® processor E7 family, UV offers considerable advantages as summarized in Table 1.

System Element	RAS Feature
System	• Full data path integrity • Firmware provisioning • FRU failure analysis • Online diagnosis • Uptime management
Blade Interconnect	• Full data path integrity • Auto retry on failure detection • Alpha immune latches
Processors	• Boot-time isolation
Memory	• DRAM failure analysis • Page migration • Boot time disable • Tiered failure containment
Power and Cooling	• Redundant, hot-swappable power supplies and cooling fans • Online fault detection and ACPI support

Table 1. SGI UV systems provide a wealth of RAS features.

2.1 Reliability

As both system and memory sizes increase, reliability becomes increasingly important. Experience has shown that memory errors are the most common type of error.

- Soft memory errors can occur when alpha particles or cosmic radiation strikes a component, causing a transistor to change its state unexpectedly.
- Hard memory errors typically occur with the failure of a memory bit, link or device.

In designing UV, SGI engineers paid detailed attention to circuit design rules, as well as executing comprehensive verification and testing, to help avoid both soft and hard memory errors. Components have been carefully screened and selected to meet the company's tough performance and reliability standards. During manufacture, highly stringent quality control procedures are further enhanced with special QA testing of specific customer configurations to assure that the system as a whole will function reliably once deployed.

Reduced physical complexity can contribute directly to system reliability. By using the latest CMOS VLSI design, manufacturing and blade packaging, SGI has dramatically reduced the component count in UV systems. Fewer components means reduced complexity, fewer mechanical joints and interconnects, and much higher availability of the resulting system. Where necessary, redundant components are provided in UV. For example, all fans and power supplies are hot-pluggable and N+1 redundant. Additionally, all disks and I/O cards have hot-swap capabilities.

Preservation of data integrity is paramount to the company's RAS efforts. Traditional error-detection mechanisms are extensively employed, including memory, cache, register and interconnect data path checks, as well as end-to-end ECC (error-correcting code) data checks. In addition, the UV system has features to prevent silent data corruption, including:

- Enhanced memory error correction to correct up to 8 bits
- The ability to detect multiple failing DRAMs on a memory module
- Error scrubbing to minimize cumulative error growth
- Extensive data integrity assurance tools
- Hardware error injection capabilities to verify proper error detection and recovery

Reliability also extends from the components used in the system, as well as from the operating system and storage subsystems employed.

- **Linux reliability.** SGI UV systems run the Linux operating system, and Linux features are key to system reliability. In fact, SGI is a leading contributor to the Linux community in all aspects of shared memory computing on Linux, including RAS. Specific features to prevent silent data corruption include internal state and consistency checks, application abort/system halt capabilities and extensive regression testing.
- **NUMAlink 5 technology.** Given its pivotal and central role in the system, the NUMAlink 5 Hub ASIC is key to system reliability. All NUMAlink and XIO™ connections use cyclical redundancy checking (CRC) error detection and retry on all messages. NUMAlink 5 furthers data protection with ECC or parity on all memory-mapped registers and internal memories, address path parity protection, soft error correction-in-transit and alpha immune latches.
- **Reliable storage technology.** Reliable storage is vital to providing reliable system operation, and all SGI UV servers support a variety of reliable storage products that provide features to enhance reliability. The XVM volume manager can automatically provide mirroring of important data to help ensure that no data is lost in the event of a disk failure. Fully fault-tolerant RAID units are also available. All SCSI or Fibre Channel storage units have redundant power, cooling and controllers, and can continue to serve data in the event of a failure. Hot plugging of disk drives is supported with RAID and Fibre Channel vaults to allow the replacement of failed drives without having to take storage offline. The system supports warm plug-in of disks, using an administrative command to shut down the bus before removing or inserting a disk.

2.2 Availability

Availability is a measure of how well an overall system responds to failed components or other unforeseen operation issues. SGI has considerable experience deploying high-performance systems in demanding environments, strengthening capabilities in this area. In the case of UV, enhanced availability results from the ability to detect problems or failed components and safely remove them from the system, while also effectively handling issues related to power and environmental conditions.

In the event of a problem, sophisticated UV software minimizes the impact on system use. Power-on diagnostics run to check for problems every time the system is started. Detected problem areas — including both CPUs and memory — can be de-configured from the system, allowing the system to start and continue to function. The UV Chassis Management Controllers (CMCs) support the capture of specific data that is needed for field-replaceable unit (FRU) analysis once components are de-configured.

During normal operation, environmental sensors monitor temperatures and voltages to identify problems and gracefully shut down systems before a crash can occur. NUMAlink 5 on UV also features full data and address path protection, as well as cable disconnect/reconnect and signal auto-retire. Uninterruptible Power Supply (UPS) solutions are available, with a single solution covering the UPS system, power monitoring software and support. SGI also offers an optional integrated water-cooled door that efficiently removes machine heat before it reaches the datacenter.

2.3 Serviceability

Serviceability relates to the ability of a system to be serviced while it continues to operate. Many enhancements have been made to shorten the mean time to repair (MTTR) on SGI UV systems. The UV blade form factor greatly simplifies serviceability, since components can be easily accessed and removed from a system without the need to remove bulkheads and cables. Independent power within a module or rack makes it possible for parts of the system to be shut down for maintenance while the remaining parts continue to function. Sophisticated online diagnostics keep watch over ongoing system operations. UV systems also integrate a service node that allows for quick diagnostics and repairs before a technician arrives on site. A variety of services options are also available, and are described later in this document.

3.0 Reliable System Components

While not all hardware faults are preventable, careful design and selection of components can help reduce the number and impact of errors that do occur, through automatic error detection and correction. For example, the UV systems are designed to reliably detect all errors in system memory, directories and data paths. SGI utilizes ECC (Error-Correcting Code) on all system buses and memories to detect and correct single-bit errors, and detect double-bit errors. Effective environmental control also contributes to system reliability.

3.1 Memory Scaling

All SGI UV systems utilize Intel® Xeon® processor E7 family or 7500 series. With support for high-end scalability and advanced RAS features, the latest Intel® Xeon® processor E7 family provides a dramatic increase in capability and value for systems such as UV. Intel® Xeon® processor E7 family provides silicon-level support for new advanced RAS features (Table 2). Key RAS benefits of these processors include:

- **Robust data integrity.** Data errors are prevented, detected, corrected and contained more comprehensively and effectively to preserve data integrity. If an uncorrectable error does occur, it is tagged and contained to help prevent propagation to other systems and applications.
- **Improved system availability.** Machine Check Architecture Recovery (MCA Recovery) enables OS-assisted system recovery from certain uncorrectable errors that would have brought down previous generation servers.
- **Enhanced serviceability.** Enhanced error logging and reporting enables predictive failure analysis to identify problematic components before they cause downtime or uncorrectable errors.

Benefits	Silicon Features
Protects Data: • Reduces circuit-level errors • Detects data errors across the system • Limits the impact of errors	• Parity checking and Error Correction Code (ECC) • Memory thermal throttling • Memory demand and patrol scrubbing • Corrupt data containment mode • Intel® QuickPath Interconnect (Intel® QPI) protocol protection via Cyclic Redundancy Checking (CRC): 8-bit or 16-bit rolling
Increases Availability: • Heals failing data connections • Supports redundancy and failover for key system components • Recovers from uncorrected data errors	• Machine Check Architecture Recovery (MCA Recovery) • Intel® Scalable Memory Interconnect (Intel® SMI) lane failover • Intel® SMI clock failover • Intel® SMI and Intel QPI packet retry • Intel® QPI clock failover • Intel® QPI self-healing • Single Device DRAM Correction (SDDC) plus random bit error recovery • Dynamic memory migration
Minimizes Planned Downtime: • Predict failures before they happen • Maintain partitions instead of systems • Proactively replace failing components	• Electronically isolated (static) partitioning • MCA error logging (CMCI) • CPU on-lining

Table 2. Intel® Xeon® processor E7 family provides a wealth of RAS functionality

3.2 Innovative NUMAlink 5 Hub ASIC

Each SGI UV compute blade is equipped with two sockets for Intel® Xeon® processor E7 family, with 128GB RAM maximum per blade. The two processor sockets interface with the rest of the system through a NUMAlink 5 Hub ASIC (Figure 2). Besides supplying the basic building block for the UV system architecture, these components include error detection and correction capabilities that benefit the reliability of the overall system. In addition to providing hardware-accelerated communications processing and connectivity, the NUMAlink 5 Hub ASIC provides several innovations that contribute directly to increased RAS capabilities of SGI UV systems.

- NUMAlink 5 protocols and the NUMAlink 5 Hub ASIC have been enhanced with additional error checking and retry capabilities to reduce transient communications errors by two orders of magnitude.
- By off-loading remote memory reads to the NUMAlink 5 Hub ASIC, failures that would have caused processor hangs in previous generation systems can instead be retried or dealt with gracefully.
- The NUMAlink 5 Hub ASIC provides safe mechanisms to communicate between nodes, even in the presence of node, memory or interconnect failures.
- CRC (Cyclic Redundancy Check) is provided on all NUMAlink 5 channels between UV blades.

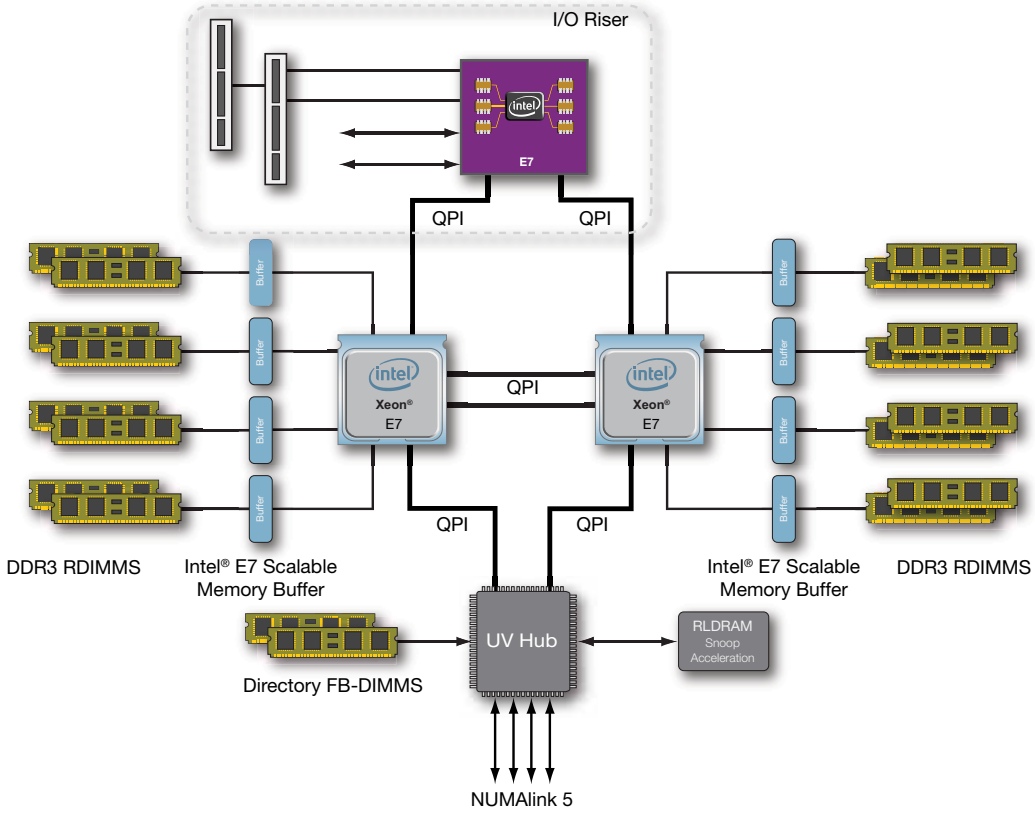

Figure 2. A NUMAlink 5 Hub ASIC connects to two sockets for Intel® Xeon® processor E7 family on each SGI UV compute blade.

3.3 Environmental Monitoring, Power and Cooling

Environmental control is a critical element in system reliability. Clean power and proper cooling can dramatically improve observed reliability in a large system, avoiding overheated components that can rapidly become unstable and lead to more complex and unpredictable failures. SGI UV features an extensive environmental monitoring and control system to protect hardware operation:

- Redundant power and fans protect against failure in these components.
- Variable-speed fans ensure that the system always runs at the optimal temperature.
- Automatic system shutdown is provided in the (unlikely) case of over-temperature conditions, to prevent damage.
- Power efficiency contributes to cool operation and low failure rates.
- Power-efficient components help maximize performance while minimizing physical server footprint, power consumption and cooling requirements.

SGI UV systems feature a power supply and conversion architecture designed to convert AC power to DC voltages with over 90% efficiency (compared to efficiencies in the 60-70% range for many other vendors' products). Moreover, UV compute blades are designed to minimize power loss, with 12V DC blade input voltage requiring only one additional conversion to usable logic-level voltage. Finally, Intel® Xeon® processor E7 family are some of the most efficient processors on the market, in some cases running at a fraction of the power of competitive RISC CPUs.

The superior energy efficiency of UV means that the vast majority of deployments do not require water cooling. However, SGI has a long history of deploying very large systems in densely-populated datacenter facilities, and was an early adopter of water cooling technologies for traditional air-cooled servers. Optional available water cooling for UV provides radiator-like cooling coils that intercept hot air as it exits each rack, efficiently cooling the air and preventing machine room hot-spots and the common problem of hot-aisle to cold-aisle recirculation. SGI water cooling systems can stabilize the ambient inlet air temperature and result in increased reliability.

4.0 Availability Features

SGI includes a number of features in UV systems that enhance overall availability beyond the reliability provided by the base hardware components. For example, as a leader in the development of high-end Linux solutions, SGI has made significant contributions to ensure the performance and reliability of Linux. SGI releases Linux enhancements that improve availability to the broader Linux community whenever they are generally applicable. Examples of SGI contributions relating to RAS functionality include:

- UCE (Uncorrectable Error) recovery enhancements
- Improved hardware error reporting
- Reduced panics on double-bit errors
- Better fault containment for cross-partition jobs

All such strategies represent potentially significant compromises in computational accuracy, performance and productivity.

4.1 System Partitioning

SGI UV hardware partitioning allows a single physical system to be subdivided into multiple logical systems without re-cabling. Partitioning capabilities are designed into the UV hardware to ensure ease-of-use along with highly reliable operation. In addition, while partitioning does change the OS configuration, memory used by applications can still be selectively shared across partitions using UV coherent shared memory capabilities. Through this technique, a UV system can be partitioned and run as a cluster for improved availability without losing all of the large-memory advantages of the architecture. UV hardware partitions can be rebooted independently without affecting operations in other partitions, providing a number of availability benefits:

- Necessary hardware repairs in one partition can be undertaken without disrupting other partitions.
- When upgrades are necessary, rolling kernel updates can be used to update each partition in turn without bringing the entire computing infrastructure to a halt.
- Organizations doing software development and testing can use partitioning to create development and test environments that closely approximate the production environment. These development and test partitions can be re-started as necessary — or brought down by ill-behaved software — without affecting other production partitions.

A number of unique hardware features increase the robustness of hardware partitioning on UV as compared with other systems.

- **Memory Protection.** UV has memory protection built into the SGI-designed chipset that resides in each UV compute blade. This feature provides fault containment by protecting each partition from unexpected

writes from other partitions. Other systems that lack this hardware feature may be subject to memory corruption if a misconfigured kernel or poorly-behaved application attempts an inappropriate memory access. For example, XPMEM support in SGI MPI libraries allows the hardware to change memory protection on memory being shared with other partitions. As a result, Global Reference Units (GRUs) in one partition can directly load and store to shared memory without opening memory to access from all other partitions.

- **Reset Fences.** This capability is also built into the NUMAlink 5 Hub ASIC to protect a partition from hardware resets occurring in another partition. Reset fences ensure that each partition operates independently and reliably in the face of restarts or hardware and software failures occurring in other partitions, and provides support for concurrent replacement of system modules.
- **Global Reference Unit (GRU).** The GRU built into SGI UV Hub chips provides a reliable way to transfer data between partitions. This capability allows partitions to share data via high speed copying, if desired. To ensure fault containment, the GRU is designed so that a disruption in a remote partition will not crash or hang a partition that is actively performing a remote reference.

4.2 Memory Enhancements

Memory errors remain the most common errors experienced by servers. In typical Linux environments, memory configurations are relatively modest compared to those achievable with UV systems. For this reason, SGI is committed to improving the robustness of Linux for large memory systems.

When a memory location is determined to be bad because it has exceeded a threshold number of single-bit errors, the UV memory flawing feature allows the OS to move the data to a different page and mark the page containing that memory as flawed. The operating system subsequently avoids using the flawed page. SGI has also enhanced Linux to ensure that if an MCA event due to a hardware failure disrupts the system, the complete hardware state is captured. This ability improves root cause failure analysis to help ensure that the right components are quickly replaced to restore the system to full operation.

4.3 Reliable I/O

SGI has long been a leader in Fibre Channel and high-performance storage. In fact, SGI pioneered the deployment of highly redundant Fibre Channel storage infrastructure along with the software necessary for efficient utilization. SGI UV profits directly from the reliability benefits of robust storage systems, with features that include:

- **Multi-path I/O.** Systems with multiple Fibre Channel host bus adapters spread across multiple blades and are connected either directly or through a fabric to SGI InfiniteStorage™ RAID arrays, resulting in I/O infrastructures with no single points of failure. Multi-path I/O balances I/O load across channels and shifts the load from a failed port or HBA over to survivors.
- **InfiniteStorage File System (XFS).** Created by SGI, and now available in standard Linux distributions, XFS accommodates the I/O requirements of high-performance computing (HPC) environments while providing the reliability of journaling for error recovery and rapid restarts.
- **SGI InfiniteStorage Shared File System (CXFS).** For shared data access in clusters, CXFS builds on XFS to create a highly reliable, high-performance storage infrastructure that lets cluster members read and write data directly to disk at full SAN speeds. UV systems that have been partitioned can use CXFS to allow partitions to share access to the same data sets without compromising performance.

4.4 High Availability Cluster Configurations

To further enhance UV system availability, clustered configurations can be designed using SGI InfiniteStorage Cluster Manager for Linux or other third-party high-availability software solutions for Linux. With Cluster Manager, highly-available application services can be created that span separate UV systems, or partitions in a single UV system. Applications fail over from one cluster member to another, should anything affect the running service.

5.0 Maximum Serviceability

The company's goal is to make most components of the SGI UV platform serviceable by an administrator with minimal or no system disruption. The UV system design includes important serviceability features that provide advanced system control capabilities, system health monitoring, online system management and maintenance, and failure analysis. By its very nature, the advanced, modular blade design of UV enhances serviceability, with individual system components easily accessed for service, maintenance or upgrade.

5.1 SGI UV Features to Maximize Uptime During Servicing

UV compute blades are housed in a chassis referred to as an Individual Rack Unit (IRU). The UV 1000 IRU enclosure contains up to 16 compute blades. A single UV 1000 rack houses up to two IRUs (32 blades, 64 sockets, 640 cores) as shown in Figure 3. The UV 100 system features a smaller-scale IRU that houses up to two UV compute blades. The UV 100 system can support up to 96 Intel® Xeon® processor E7 family for up to 960 cores.

SGI UV 1000 IRU

SGI UV 100 IRU

Figure 3. An SGI UV 1000 IRU (two per rack) supports up to 16 UV compute blades while a UV 100 IRU supports up to two compute blades.

Components in each IRU are electronically isolated so that they can be replaced without powering down the IRU. In most cases, power supplies and individual PCI cards can be hot-swapped without interrupting the operation of the system or partition containing the component. If a system has been partitioned, a failed compute blade in one partition can be replaced without affecting the operation of other partitions. However,

the partition containing the failed compute blade must be shut down while the operation is in progress. Other related features of the UV system help minimize downtime caused by component failure, including:

- The advanced RAS capabilities of Intel® Xeon® processor E7 family minimize the likelihood of a CPU failure.
- Compute blades can be disabled and a system can run without them until scheduled maintenance becomes possible.
- Individual memory pages can be marked as flawed and retired while operations continue.
- Processors and memory are always subjected to self-test at boot time and automatically de-allocated if failures occur. The system is then able to boot without the affected resource so that operations can continue.

5.2 Chassis Management Controller (CMC) Network

All UV 1000 and 100 IRU enclosures contain an embedded Chassis Management Controller (CMC) that runs on standby power and is operational whenever the enclosure is connected to an active power source. The CMC network manages the hardware partitions within each system, providing pinpoint power control, system booting and support for configuration control. CMCs can transparently extract all internal register states and actions from the attached UV compute blades while the system is running, providing a wealth of input data that allows a fault analyzer to produce failure data reports down to the field replaceable unit (FRU) level.

The CMC is able to read the complete hardware configuration down to the level of individual FRU serial numbers in real-time. This capability supports the rapid and accurate notification and transmittal of essential information for system service actions. The CMC provides control and monitoring functionality for each IRU in an enclosure and communication to other CMCs. The CMC is active even when the system is not booted or powered off. Overall, the system controller network provides the following functionality:

- Power control to the entire system
- Power control to individual compute blades
- Environmental monitoring
- Monitoring status and error message information
- Specific commands to monitor or change system functions
- System boot control

6.0 SGI Service Options to Assure Uptime

As a long-standing global leader, the SGI Customer Service organization offers a broad range of SGI Customer Support services, up to and including 7x24 system support. The SGI Customer Service organization consistently ranks among the top in the industry according to third-party evaluation metrics. Additional available services include:

- **SGI MAS (Managed Services) Console.** The SGI Solution for Console Server Management is a valuable tool to help system administrators monitor and manage SGI servers during a system-down situation by providing an interface to the system even when network access is not available. The solution is a combined hardware, software, support and on-site installation package for management of one or more heterogeneous servers.
- **SGI UpSafe Uninterruptible Power Supply (UPS).** UPS systems are critical to protect electronic equipment

from power problems such as blackouts, brownouts and electrical surges/sags caused by the weather or by events such as the switching off of heavy industrial equipment (elevators, factory machines, etc.). A UPS is especially critical in systems located in a multi-tenant building where there is competing demand for power and momentary blackouts are common. Through UpSafe, SGI delivers a full line of UPS solutions configured to meet the specific needs of the datacenter environment and the UV server configuration. A single solution covers the uninterruptible power system, power monitoring software and support.

- **SGI Electronic Support - Embedded Support Partner.** SGI Electronic Support is a fully integrated suite of services that work together seamlessly to monitor and manage the system and proactively protect against problems. For example, if an anomaly is detected while SGI Embedded Support Partner (ESP) is activated, SGI Electronic Support notifies the system administrator and an SGI professional, searches for possible fixes, and then sends field-proven solutions related to the identified system problems. SGI Electronic Support provides a smooth, seamless, multipoint support experience that reduces downtime, minimizes administrative resources and saves money. In many cases, problems may be detected and corrected before users are even aware of them. SGI Electronic Support is available at no additional cost to system owners who have a valid SGI Warranty, SGI FullCare™, SGI FullExpress™ or SGI FullExpress 7x24 support contract.

7.0 Conclusion

The SGI UV product line represents a new level of performance, serviceability and overall capability that builds on the strong tradition of powerful and available shared memory systems from SGI. Along with support for up to 2,560 processor cores and up to 16TB of memory, SGI UV RAS capabilities demonstrate a trend of constant improvement. Based on a close and fruitful collaboration with Intel®, the SGI UV 1000 and 100 systems combine the RAS features of Intel® Xeon® processor E7 family with the innovative NUMAlink 5 interconnect to create the reliable, available and serviceable UV system architecture from SGI.

SGI considers the RAS capabilities of our flagship systems a vital and integral component of a reliable and dependable high performance computing solution. The RAS infrastructure of UV systems — including the system controllers, operating system software, diagnostics and internal firmware — undergo steady RAS capability improvements as techniques for monitoring and managing systems are refined and optimized in customer environments. SGI manufacturing also employs strong feedback and process control methods for continued enhancement of reliability. Future development will include continuous advancement in RAS capabilities based on customer feedback and real-world experience, enabling SGI to continue to deliver some of the largest high performance computing systems available.

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