SGI™ Origin™ 3000 Series
Modular, High-Performance Servers
The SGI Origin 3000 series takes system modularity to new heights, as NUMAflex™ allows you to scale CPU, storage, and I/O components independently within each system. Complete multidimensional flexibility allows organizations to deploy, service, and expand system components in every possible dimension to meet any business demand. The only limitation is your imagination.
Product Overview

SGI™ Origin™ 3000 Series of Servers

The SGI™ Origin™ 3000 Series of servers sets the standard for high performance in today's market place by delivering flexibility, resiliency, investment protection, and performance in a new and innovative package. SGI's third generation NUMA architecture addresses the challenges and cost of true scalability though a new approach in modular computing. We call this approach NUMAflex, and it will revolutionize the high performance server market by making it possible to scale in multiple dimensions as your business needs grow and change over time. Acquire only the computation, data processing, or communications power you need, and expand and reconfigure systems with ease as new technologies emerge.

NUMAflex™, Setting the Standard in Modular Computing

SGI realizes that a growing number of competitive business environments have increasingly complex problems that need to be resolved in a short period of time. But not every business has the same problems and needs or the resources to frequently replace computing systems. Providing the ability to build a system that meets the requirements for a specific problem, NUMAflex is an innovative approach to computing, combining the third generation of SGI NUMA architecture and a modular hardware design that isolates the various components of today's servers. These modular components, or "bricks", isolate the CPU and memory, I/O, interconnect fabric, and storage into separate bricks. Scalability is no longer measured by how many systems you can link together, but by the ability to scale the various components of your system to meet the demands of your applications.

Flexibility to Design Your Own System

You no longer have to pay for the wasted potential common in yesterday's server architectures. The SGI NUMAflex snap-together concept allows you to configure and reconfigure systems brick by brick to meet the exact demands of your business applications. Complete multidimensional flexibility allows you to deploy, upgrade, service, expand, and reconfigure systems in every possible dimension to meet your current and future business needs.

Systems Ready for Tomorrow's Technology

NUMAflex offers the most powerful investment protection in the industry. Keeping you on the leading edge, the SGI Origin 3000 series of servers can be upgraded with new technologies as they emerge, without having to replace the existing infrastructure. For example, upgrading to new I/O technology is as simple as adding a new brick to your system, instead of resorting to a "forklift" upgrade as required by other architectures.

And for those who are not sure about the operating system they want to use in the future, SGI is in development of an Intel® IA/64 CPU brick capable of running Linux®. SGI NUMAflex will allow you to upgrade your CPU bricks while maintaining your investment in the infrastructure of your existing system.

Minimize Downtime, Increased Serviceability

SGI NUMAflex also provides increased resiliency through its modular design. Many hardware components can be removed and serviced as needed without interrupting the overall system performance. And for maximum fault containment, IRIX® 6.5 on the SGI Origin 3000 series supports partitioning, allowing you the flexibility to divide a single large SSI (single system image) server into smaller SSI systems.

High Performance Scalability without Roadblocks

Building on the performance of the award winning SGI Origin 2000 series and its second generation NUMA architecture, the SGI Origin 3000 series achieves significant performance gains. Through its modular design and improvements in SGI NUMA 3 architecture, the system structure allows
for greater system and memory bandwidth with reduced latencies. And true scalability means that performance will scale proportionately as your system grows.

**SGI™ Origin™ 3200**
This affordable, routerless system scales from two to eight processors in a single shared-memory image and can be clustered (SGI™ Origin™ 3200C) to leverage the power of hundreds of CPUs using a variety of low-latency, high-bandwidth interconnects. A single point of administration is achieved to manage the cluster through the SGI IRISconsole™ management system.

**SGI™ Origin™ 3400**
This server includes two six-port routers to accommodate scaling from 4 to 32 processors in a single shared-memory image. For maximum flexibility, the processor and I-bricks can be configured within the same rack, with the option of adding a second rack for additional I-bricks in application areas demanding higher levels of I/O.

**SGI™ Origin™ 3800**
With the largest single-kernel, shared-memory image available, SGI Origin 3800 easily scales with snap-together modularity to 512 processors and a terabyte of memory. Built-in Metarouters allow clustering to tens of thousands of CPUs. Customers interested in solving very large problems will find SGI Origin 3800 the most powerful and flexible shared-memory system platform on the market. If workloads require a mixture of shared-memory and message-passing development environments, it is flexible enough to be configured with software as a single 512-processor shared-memory server or be divided into several partitions, each running a separate OS without having to recable or reconfigure the hardware. Partitioned system benefits from the low-latency and high-bandwidth NUMAlink™ interconnect between system partitions while also providing the advantage of higher availability that a cluster delivers.
With the revolutionary SGI™ NUMAflex™ computing model in the underlying system structure, you decide how much CPU, I/O, memory, and disk infrastructure to add to SGI Origin 3200. Every system component can be upgraded, maintained, or redeployed independently, so the 3200 system can evolve as quickly as your computing needs.

Built on the reliable SGI™ NUMA architecture and IRIX® 6.5 operating system, SGI Origin 3200 servers work with your existing application software and are fully compatible with other IRIX OS-based workstations and servers. The applications you use every day transition effortlessly and perform better than ever. With the same familiar tools and operating system, you can integrate the series with no retraining. The SGI Origin 3200 server protects your investments thoroughly and ensures the availability of a wide range of open systems software into the future.

**Processors:**

- 2-8 using 2 or 4-processor C-bricks

**System bandwidth:**

- 11.2GB/sec

**Maximum memory:**

- 16GB

**Router type:**

- none

**Base I/O:**

- I-brick

**Additional I/O:**

- I-brick, P-brick, X-brick, D-brick
SGI™ Origin™ 3400

With the revolutionary SGI™ NUMAflex™ computing model in the underlying system structure, you decide how much CPU, I/O, memory, and disk infrastructure to add to the SGI Origin 3400 system. Every system component can be upgraded, maintained, or redeployed independently, so the SGI Origin 3400 system can evolve as quickly as your computing needs.

With the industry's most advanced NUMA architecture from SGI, you can configure your SGI Origin 3400 system up to a single 32-processor shared-memory system, or use partitioning to divide it into 2 partitions and run them as a tightly coupled cluster. Many application environments can improve availability by implementing a cluster of smaller partitions that can contain failures and leave other partitions unaffected. Utilizing the ultra low latency and high-bandwidth NUMAlink™ interconnect fabric as a communication vehicle, partitioning is an option that can deliver both high availability and high performance.

Built on the reliable SGI™ NUMA architecture and IRIX® 6.5 operating system, SGI Origin 3400 servers work with your existing application software and are fully compatible with other IRIX OS-based workstations and servers. The applications you use every day transition effortlessly and perform better than ever. With the same familiar tools and operating system, you can integrate the series with no retraining. The SGI Origin 3400 server protects your investments thoroughly and ensures the availability of a wide range of open systems software into the future.

- Processes: 4-32 using 4-processor C-bricks
- System bandwidth: 44.8 GB/sec
- Maximum memory: 64 GB
- Router type: 6-port
- Base I/O: I-brick
- Additional I/O: I-brick, P-brick, X-brick, D-brick
SGI Origin 3000 Series
Technical Specifications

SGI Origin 3000

- Processors: 2-8 MIPS R10000 at 400 MHz
- Memory: 16 GB
- Cache: 32 KB instruction/32 KB data cache
- Secondary cache: 8 MB, 16 MB DDR full-speed SDRAM

SGI Origin 3400

- Processors: 4-32 MIPS R10000 at 400 MHz
- Memory: 64 GB
- Cache: 32 KB instruction/32 KB data cache
- Secondary cache: 8 MB, 16 MB DDR full-speed SDRAM

- Processor Data
  - Microprocessor: MIPS RISC, R10000 at 400 MHz
  - Primary cache: 32 KB instruction/32 KB data cache
  - Secondary cache: 8 MB, 16 MB DDR full-speed SDRAM

- System bandwidth: 11.2 GB/sec max.
- Maximum memory: 16 GB
- RISC: None
- RISCs: One 1-brick
- System disk: 180 GB
- Operating system: IRIX 6.5

- Power Bay
  - Power supplies: 220-240 VAC external source
  - Power distribution: +5 VDC internally distributed to all bricks

- PDAdapters
  - Fiber Channel optical
  - Ethernet 100 MB/sec
  - Gigabit Ethernet optical
  - Gigabit Ethernet copper
  - Ultra320 SCSI differential
  - Ultra2 SCSI (V2N)
  - Digital audio

- XIO Adapters
  - Fiber Channel Ultra320 and Ultra2 SCSI
  - RAID controller
  - Two controllers per SGI TP9100 module
  - Internal loops
  - Maximum cache: 64 MB
  - RAID storage: TP9100 RAID Maximal RAID storage of 9 TP9100 modules

- Device Capacity
  - SGI Origin 3000 Series
  - Dimensions and Weights: 34” H x 40” D x 40” W, 1225 lbs max.
  - SGIO Origin 3400/3600: 34” H x 50” D x 50” W, 1500 lbs max.
  - RAID/BX2 rack: 34” H x 50” D x 20” W, 380 lbs max.

- Environmental Operating
  - Temperature: +5 to +55°C, altitude 3,000 MSL
  - Humidity: 10% to 90% noncondensing

- Computer Power Supply
  - Voltage: 208-230 VAC, single phase and 3-phase, 50/60 Hz
  - Heat/power: 4,500 W maximum per power bay, N+1
  - Electrical service type: 3-Phase, 208 VAC, 30 A

- Software
  - System software: IRIX 6.5 Advanced Server Environment
  - Networking: TCP/IP, NFS, VFS, RVS, RAC, BNDCP, etc.
  - Samba environments
  - Security: Trusted IRIX, B1 security, Commercial Security Pack (CSP)

- Cluster software
  - MPI Toolkit, LSF, and IRIX Advanced Cluster Environment (ACE)

- Compilers
  - ANS C, C++, Fortran 77 and 90, Ada
  - PASCAL, Power C Accelerator (PCX), Power Fortran 77 and 90

- Interoperability
  - Samba environments for PC

- Other:
  -trusted systems
  - Commercial Security Pack (CSP)
  - Partitions
  - Customer interface module in IRIX®

* Available Q2/00

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**SGI™ Origin™ 3000 Series**

**SGI™ Origin™ 3200, SGI™ Origin™ 3400, and SGI™ Origin™ 3800 Servers**

**Features**
- True multidimensional scalability
- Snap-together flexibility, serviceability, and resiliency
- Clustering to tens of thousands of processors
- SGI Origin 3200—scales from two to eight MIPS processors
- SGI Origin 3400—scales from 4 to 32 MIPS processors
- SGI Origin 3800—scales from 16 to 512 MIPS processors

As Flexible as Your Imagination
Building on the robust NUMA architecture that made award-winning SGI Origin family servers the most modular and scalable in the industry, the SGI Origin 3000 series delivers flexibility, resiliency, and performance at breakthrough levels. Now taking modularity a step further, you can scale CPU, storage, and I/O components independently within each system. Complete multidimensional flexibility allows organizations to deploy, upgrade, service, expand, and redeploy system components in every possible dimension to meet any business demand. The only limitation is your imagination.

Build It Your Way
SGI™ NUMAflex™ is a revolutionary snap-together server system concept that allows you to configure—and reconfigure—systems brick by brick to meet the exact demands of your business applications. Upgrade CPUs to keep pace of innovation. Isolate and service I/O interfaces on the fly. Pay only for the computation, data processing, or communications power you need, and expand and redeploy systems with ease as new technologies emerge.

Performance, Reliability, and Versatility
With their high bandwidth, superior scalability, and efficient resource distribution, the new generation of Origin servers—SGI™ Origin™ 3200, SGI™ Origin™ 3400, and SGI™ Origin™ 3800—are performance leaders. The series provides peak bandwidth for high-speed peripheral connectivity and support for the latest networking protocols. The most advanced storage technologies are supported—up to 100MB-per-second Fibre Channel and the SGI clustered filesystem [CXFS™] for storage area networks [SANs]. To provide the reliability today's applications demand, the series delivers uninterrupted availability through ECC memory, redundant power and cooling, and hot-pluggable disks and PCI, along with IRIS FailSafe™ software. And for integrated graphics, SGI Origin 3000 series servers support a full spectrum of high-performance visualization capabilities. Simply add a graphics expansion module to take advantage of InfiniteReality3™ graphics.

Investment Protection
Built on the reliable SGI NUMA architecture and IRIX® 6.5 operating system, SGI Origin 3000 series servers work with your existing application software and are fully compatible with other SGI IRIX OS-based workstations and servers. The applications you use every day transition effortlessly and perform better than ever. With the same familiar tools and operating system, you can integrate the series with no retraining. SGI Origin 3000 series servers protect your investments thoroughly and ensure the availability of a wide range of open systems software into the future.
The SGI Origin 3000 series gives you the flexibility to build a system that truly matches tomorrow's growth plans and today's business requirements—whether you need advanced computation for weather simulation, massive storage for archiving bioinformatic data, or high-performance I/O for media streaming. To scale system performance to meet your needs, choose the bricks your applications require.

Build and Maintain Your Ideal System—One Brick at a Time

SGI Origin 3200
This affordable, routerless system scales from two to eight processors in a single shared-memory image and can be clustered to leverage the power of hundreds of CPUs using a variety of low-latency, high-bandwidth interconnects. A single point of administration is achieved to manage the cluster through the SGI IRISconsole® management system.

SGI Origin 3400
This server includes two six-port routers to accommodate scaling from 4 to 32 processors in a single shared-memory image. For maximum flexibility, the processor and I-bricks can be configured within the same rack, with the option of adding a second rack for additional I-bricks in application areas demanding higher levels of I/O.

SGI Origin 3800
With the largest single-kernel, shared-memory image available, SGI Origin 3800 easily scales with snap-together modularity to 512 processors and a terabyte of memory. Built-in Metarouters allow clustering to tens of thousands of CPUs, making supercomputing more accessible than ever. Customers interested in very large memories to solve the largest problems will find SGI Origin 3800 the most powerful and flexible shared-memory system platform. If workloads require a mixture of shared-memory and message-passing development environments, SGI Origin 3800 is flexible enough to be configured with software as a single 512-processor shared-memory server or be divided into several partitions, each running a separate OS without having to recable or reconfigure the hardware. A partitioned system benefits from the low-latency and high-bandwidth NUMAlink™ Interconnect between system partitions while also providing the advantages of higher availability that a cluster delivers.
Router Interconnect
As the structural building block of the system, the R-brick replaces the system bus; it's a high-speed crossbar connecting processors and memory enabling each system component to be serviced or upgraded individually. Add infrastructure as you need it—from routerless desktop systems to an eight-port router multirack configuration that delivers 512 processors in a single shared-memory environment.

CPU Module
The basic C-brick module contains four MIPS® CPUs and local memory. A single crossbar memory controller delivers 200% greater CPU-to-memory bandwidth than previous generations. Now with four CPUs in a C-brick, the system offers a two-fold increase in CPU density, improving memory latency by up to 50% and minimizing the use of valuable floor space.

Base I/O Module
The I-brick, standard in all systems, provides base I/O in a module and includes the system disk, CD-ROM, Ethernet, and four available PCI slots. As the system grows, customers have the option to partition the system for greater availability, using additional I-bricks as base I/O for each partition.

PCI Expansion
For PCI expansion, a P-brick provides 12 hot-swappable PCI slots distributed over six 64-bit/66 MHz PCI buses. Total peak I/O bandwidth exceeds 3GB per second.

XIO Expansion
For high-performance I/O expansion, X-bricks deliver four XIO slots that support HIPPI, GSN, VME, and digital video.

Graphics Expansion
Tightly integrated InfiniteReality3 graphics add large-scale visualization capabilities for accelerated insight into complex data sets.

Disk Storage
D-bricks provide modular JBOD mass storage for data-intensive applications. D-bricks support up to 12 drives, have dual-power supplies standard, and support drive capacities of 18GB, 36GB, and 73GB.
### SGI Origin 3000 Series

#### Technical Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Processor</th>
<th>System Bandwidth</th>
<th>Maximum Memory</th>
<th>Base I/O</th>
<th>Additional System I/O</th>
<th>System Disk</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGI Origin 3200</td>
<td>MIPS RISC</td>
<td>2.5-12 GB/sec</td>
<td>16 GB</td>
<td>None</td>
<td>None</td>
<td>18 GB</td>
<td>IRIX OS 5.5</td>
</tr>
<tr>
<td>SGI Origin 3400</td>
<td>MIPS RISC</td>
<td>4.32 GB/sec max.</td>
<td>48 GB</td>
<td>6-port</td>
<td>One I/O</td>
<td>18 GB</td>
<td>IRIX OS 5.5</td>
</tr>
<tr>
<td>SGI Origin 3800</td>
<td>MIPS RISC</td>
<td>6-12 GB/sec max.</td>
<td>72 GB</td>
<td>8-port</td>
<td>Metarouter</td>
<td>18 GB</td>
<td>IRIX OS 5.5</td>
</tr>
</tbody>
</table>

#### R-brick
- **-port**: Supports shared memory system configurations up to 32 CPUs
- **-port**: Supports shared memory system configurations up to 128 CPUs
- **-port**: Supports shared memory system configurations up to 512 CPUs

#### G-brick
- **-port**: Supports shared memory system configurations up to 256 CPUs
- **Memory**: 4 GB DDR200 or 16 GB DDR400 CPUs
- **Memory**: 512 MB, 1 GB, 2 GB
- **Memory**: 5-port crossbar
- **Memory bandwidth**: 2.5 GB/sec total memory bandwidth
- **Memory interface**: Interleaving 4-way per G-brick

#### I-brick
- **Ports**: 2 ports USB, 300Base-T, 1 port IEEE 1394, 1-port serial, 1-port Fibre Channel
- **Internal devices**: 1 system disk standard, IDE/IDE drive
- **Disk interface**: One 64-16/16 MHz PCI bus, 2 slots; one 64-bit/33 MHz PCI bus, 5 slots

#### P-brick
- **-port**: 16-bit/66 MHz PCI, 3.3 V, and Universal
- **-port**: 6-port crossbar, 16-bit/66 MHz PCI, 3.3 V, and Universal
- **-port**: 16-bit/66 MHz PCI, 3.3 V, and Universal
- **-port**: Total I/O bandwidth: 1.5 GB/sec peak total

#### X-brick
- **-port**: 40-port crossbar, 16-bit/66 MHz PCI, 3.3 V, and Universal
- **-port**: 40-port crossbar, 16-bit/66 MHz PCI, 3.3 V, and Universal
- **-port**: 40-port crossbar, 16-bit/66 MHz PCI, 3.3 V, and Universal
- **-port**: Total I/O bandwidth: 2.7 GB/sec peak total

#### D-brick
- **-port**: 64-bit/66 MHz Fibre Channel, SANE aware
- **-port**: 64-bit/66 MHz Fibre Channel, SANE aware
- **-port**: 64-bit/66 MHz Fibre Channel, SANE aware
- **-port**: Maximum bandwidth: 200 MB/sec

#### G-brick
- **-port**: 2-ports USB, 100Base-T, 2 ports
- **-port**: 2-ports USB, 100Base-T, 2 ports
- **-port**: 2-ports USB, 100Base-T, 2 ports
- **-port**: Maximum bandwidth: 512 MB/sec

#### Processor Data
- **Microprocessor**: MIPS RISC R2000 at 400 MHz, R4000 at 500 MHz
- **Primary cache**: 256 KB 32-bit (2) cache
- **Secondary cache**: 8 MB, 8 MB, 8 MB, 8 MB

### SGI Origin 3000 Series

#### Environment Operating
- **Temperature**: -5 + 55°C, altitude 5,000 MSL
- **Humidity**: 10% to 90% noncondensing

#### Electrical and Power
- **Voltage**: 200-230 VAC, single-phase and three-phase, 50/60 Hz
- **Heat/power**: 4.5 W maximum power per bay, N+1 (6 x 75W supplies), 15,000 BTU/hr

#### Software
- **-port**: IRIX 6.5 Advanced Server Environment, X/Open XPG4A Base P5, IETF POSIX 1003.2, and 1003.1, X3.13 and FIPS 122, UNIX System 4.4, and 4.3 BSD extensions, MIPS ABI, SVID Issue 3, SGI RAC, Novell Workstation 12, IRIS CL, OpenLinux
- **-port**: Networking: TCP/IP, NFS, VCON, SVIP, DHCP, Bulk Data Service (BDS), NIS, NIS+, and X.509
- **-port**: Server software: X/Open XPG4A Base P5, IETF POSIX 1003.2, UNIX System 4.4, and 4.3 BSD extensions, MIPS ABI, SVID Issue 3, SGI RAC, Novell Workstation 12, IRIS CL, OpenLinux
- **-port**: Cluster software: MPI Toolkit, LSF, and IRIX Advanced Cluster Environment (ACE) provide centralized administration to support clustered or partitioned servers, job scheduling, accounting, load balancing, and batch/interactive jobs, S/W distribution, and user, system, and network management
- **-port**: Compilers: ANS C, C++, Fortran 77 and 90, ADA, Pascal, Power C Accelerator (PCA), Power Fortran 77 and 90
- **-port**: Interoperability: Samba environments for PC
- **-port**: Security: Trusted IRIX® B1 security, Commercial Security Pack (CSP)
- **-port**: Partitioning: IRIX kernel in IRIX® B1 security, Commercial Security Pack (CSP)

### SGI Origin 3000 Series

#### Processor Data
- **Microprocessor**: MIPS RISC R2000 at 400 MHz, R4000 at 500 MHz
- **Primary cache**: 256 KB 32-bit (2) cache
- **Secondary cache**: 8 MB, 8 MB, 8 MB

### SGI Origin 3000 Series

#### Processor Data
- **Microprocessor**: MIPS RISC R2000 at 400 MHz, R4000 at 500 MHz
- **Primary cache**: 256 KB 32-bit (2) cache
- **Secondary cache**: 8 MB, 8 MB, 8 MB

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**Available: Q4 CYO1**
SGI™ 3000 Family
Reference Guide
Introduced in July 2000, the SGI 3000 family of high-performance servers and visualization systems is the latest addition to the line of distributed shared-memory systems from SGI. Known as the SGI™ Origin™ 3000 line of servers and the SGI™ Onyx® 3000 line of visualization systems, all members of the SGI 3000 family are designed with the SGI™ NUMA 3 architecture, the third generation in a line of Non-Uniform Memory Access (NUMA) architectures from SGI.

Starting from a minimum configuration of two 64-bit MIPS® RISC microprocessors, the NUMA 3 architecture of the SGI 3000 family scales to support up to 512 processors in a single memory image, single operating system kernel, cache-coherent multiprocessor system. In addition to being a highly scalable server platform, the SGI InfiniteReality3™ graphics subsystem is tightly integrated into the architecture to provide customers with a highly scalable visualization system.

There are a total of six models in the SGI 3000 family--three configurations are specified as servers and another three as visualization systems. Each model is defined by the maximum number of processors supported in the system.

- SGI 3200 series--supports a maximum of 8 processors
  - SGI™ Origin™ 3200
  - SGI™ Onyx® 3200
- SGI 3400 series--supports a maximum of 32 processors
  - SGI™ Origin™ 3400
  - SGI Onyx 3400
- SGI 3800 series--supports a maximum of 512 processors
  - SGI™ Origin™ 3800
  - SGI™ Onyx® 3800
SGI 3000 Family Product Overview

With the announcement of the SGI 3000 family, SGI introduces NUMAflex™ as the desired methodology for creating high-performance systems to meet the vast information demands of the future. NUMAflex offers the ability to configure a modular and scalable system to meet the demands of your application environment. The concept of NUMAflex delivers a proven SGI NUMA architecture and a bevy of benefits for the customer, namely maximum flexibility, resilience, and investment protection:

- Delivers precise mix of capabilities, saving money and space
- Virtually unlimited expansion takes the guesswork out of planning
- Reconfigures to meet changing requirements without penalty
- Breakthrough in availability, service, administration, and logistics
- Incorporate new technologies as they’re introduced (e.g., IA-64, I/O)
- Independent component upgrades for maximum investment protection
- Isolate components as necessary for easy serviceability
- Run your machine in single system image (shared-memory) or cluster mode
- Manage your large SSI system, partitioned system, or cluster from a single point of administration using a management platform from SGI
- Use NUMAlink™ as a high-speed interconnect to run shared memory, message passing, or OpenMP™ jobs, and as a capability or throughput machine simply through software changes—no cabling changes are required
- Customers can buy, deploy, and redeploy building blocks to build the correct system and exact configuration for the job they wish to do
- Modular and reconfigurable system allows easy upgrades as needed when new technology is introduced
- NUMA 3 modularity allows customers to remove and service failed components while the rest of the system continues to produce results
- Software enhancements offer increased control of partitioning and automatic restart of system
NUMA 3 Architecture

The system architecture for the SGI 3000 family is a third-generation NUMA architecture from SGI known as NUMA 3. In the SGI NUMA 3 architecture, all processors and memory are tied together into a single logical system through the use of special crossbar switches developed by SGI. This combination of processors, memory, and crossbar switches constitute the interconnect fabric called NUMAl ink.

One component of the SGI NUMA 3 architecture is the Bedrock chip. This ASIC is an 8-input by 6-output crossbar that acts as the memory controller between processors and memory in the system, both local and remote. The Bedrock chip has a total aggregate peak bandwidth of 3.2GB/second. The chip also has a channel that connects processors to system I/O, which allows every processor in a system direct access to every I/O slot in the system.

Another component of the SGI NUMA 3 architecture is the router chip. This 8-port crossbar ASIC is found in a router node and, through the use of highly specialized cables, provides the high-bandwidth, extremely low latency interconnect known as NUMAl ink. The router node channels information between all the compute nodes in the system, connecting all Bedrock switches together to create a single contiguous memory in the system of up to 1 terabyte.

These crossbar switches, together with the NUMAl ink interconnect fabric, deliver an extremely low-latency and high-bandwidth architecture, not just another cluster solution tightly integrated in a single chassis and passed off as an SMP system. From the smallest 4-processor system to the largest 512-processor supercomputer, the memory latency ratio between remote and local memory in the SGI NUMA 3 architecture is only 2:1 and still less than 600 nanoseconds round-trip in the largest configuration. Not all NUMA implementations are considered equal. Other NUMA architectures available in the industry exhibit remote to local memory latencies of 3:1 or worse, proving how difficult it is to design an effective NUMA implementation. While other system vendors introduce NUMA architectures for the first time, SGI is delivering its third generation and has nearly 4 years of experience delivering advanced NUMA solutions.

The SGI NUMA 3 architecture provides the flexibility necessary to build a series of highly scalable servers and high-end visualization systems. The SGI 3000 family consists of modular systems built by using SGI NUMA building blocks installed in industry-standard 19-inch racks. Two rack sizes are offered as a starting point from which the customer can configure a system. For smaller configurations or situations where space is limited, a 17U deskside rack is recommended. For larger systems where scalability is required, a
39U full-height rack can be used to build systems capable of supporting thousands of processors. A 16-processor block diagram of the SGI NUMA 3 architecture is illustrated in Figure 1.

Figure 1. SGI 3000 Family 16-Processor Configuration
SGI NUMA 3 Building Blocks-Bricks

All system configurations are generated by combining SGI NUMA building blocks called "bricks." Each brick provides a specific function and can be added independently of other functional bricks in the system to achieve a design specifically addressing your application requirements. As bricks are added to a system, the bandwidth and performance scale in a manner that is almost linear.

The following is a list of bricks used to build the SGI 3000 family of systems:

- C-brick: CPU module (processors and memory)
- R-brick: Router Interconnect
- I-brick: Base I/O module
- P-brick: PCI expansion
- X-brick: XIO expansion
- G-brick: Graphics expansion
- D-brick: JBOD disk storage
- Power bay: N+1 redundant power
C-brick

Features:
- Two or four processors
- Four memory banks
- Bedrock memory controller with 6.4GB/second aggregate bandwidth
- 512MB to 8GB memory
- 512MB, 1GB, 2GB memory options

The C-brick is a 3U rack-mountable enclosure that houses processors and memory in the system. Scaling the compute performance of the system is as simple as adding more C-bricks. Each C-brick contains two or four MIPS 64-bit processors, and CPU to memory bandwidth is controlled by the Bedrock switch. Two MIPS processors share a single 1.6GB/second channel to the Bedrock, and the Bedrock has two such channels, so an aggregate of up to 3.2GB/second of CPU to memory bandwidth is available for local memory addressing per C-brick throughout the system. Refer to Figure 2, which illustrates two C-bricks in an 8-processor configuration.

Each C-brick includes one network interface (NI) and one I/O interface (II). These interfaces are used to attach NUMAlink interconnect cables, which in turn integrate each C-brick into the interconnect fabric. The NI channel connects the C-brick to a router in the system, and the II channel connects to a single I/O brick.

C-bricks within SGI NUMA 3 will support a mixture of processor speeds in the system, where each processor runs at its own native speed. This feature allows you to upgrade as necessary by adding newer, faster processors without replacing all existing processors and benefit from increased performance with the latest technology.

![Figure 2. SGI 3000 series 8-processor configuration](image)
R-brick

The R-brick is the foundation of the SGI NUMA 3 architecture used in the SGI 3000 family. The R-brick is a 2U rack-mount enclosure that acts as a central hub connecting all C-bricks in the SGI NUMA 3 interconnect fabric. Each R-brick provides eight NUMAlink channels, one for every port of the router crossbar. Four channels are used to connect to four C-bricks, so up to 16 processors can be interconnected to a single R-brick. The remaining four channels are responsible for communication to other Router nodes in the system. Each router node can communicate with similar router nodes, each supporting 16 processors, up to a maximum configuration of 128 compute nodes or 512 processors.

There are three versions of the R-brick:

- 6-port router-standard in SGI Origin 3400 and SGI Onyx 3400, can be configured to support systems up to 32 processors
- 8-port Router-standard in SGI Origin 3800 and SGI Onyx 3800, can be configured to support up to 128 processors
- Metarouter—For the largest configurations, supporting up to 512 processors in single shared-memory system (required on systems over 128 processors)

The R-brick, like all other bricks in the SGI NUMA 3 architecture, can be independently upgraded at any point in the future. This is critical for your system to support additional bandwidth and functionality required for advanced bandwidth needs of the future.
I-brick

The I-brick contains the base I/O for all members of the SGI 3000 family. One I-brick comes standard in all entry-level system configurations. The SGI 3000 series supports partitioning to improve system resiliency while maximizing access to your data. A number of these 4U rack-mount enclosures can be added to a system configuration to provide multiple base I/O features and multiple copies of the IRIX® operating system. Implementing a configuration that consists of several I-bricks assists customers interested in a very flexible, resilient server with the highest level of availability.

Features:
• One 18GB system disk, optional 2nd drive bay for OS mirroring
• CD-ROM
• 5 PCI expansion slots
• Two Xtown2 1.2GB/second ports (to connect to C-brick)
• Two external USB ports
• One 10/100Base-T Ethernet port
• One external IEEE 1394 port
**P-brick**

The P-brick is a PCI-based I/O expansion subsystem that is available for customers wanting server configurations with PCI I/O beyond the base I/O offered in the I-brick. Each P-brick is 4U high, comes standard in all SGI 3800 configurations, and is optional on the SGI 3200 and SGI 3400 systems. The P-brick does not merely add PCI slots to the system, it adds incremental I/O to the system. Every P-brick contains three Xbridge chips, each supporting two separate PCI buses, for a total of six PCI buses. Aggregate incremental I/O that is provided by a single P-brick is more than 3GB/second. Two I/O (II) interface connectors in the rear of the unit allow the unit to be dual-hosted to two separate C-bricks, increasing the availability of the I/O in case of a failure.

Features:
- Provides 12 hot-plug PCI expansion slots
- Provides six 64-bit/66-MHz PCI buses
- Comes with 12 PCI carriers for hot-plug PCI
- Supports 3.3V or Universal PCI cards

**PCI Card Carrier**

The PCI card carrier is a custom-designed carrier that provides the ability to hot-plug PCI cards in both an I-brick and a P-brick. This feature allows you to add or remove PCI adapters while the system is still in operation, so your ability to change I/O requirements is flexible and dynamic while not affecting application availability. Each carrier supports both full-length or half-length PCI adapters.
X-brick

The X-brick is an optional I/O expansion subsystem that supports the XIO interface. Designed to support high-bandwidth applications beyond what the PCI bus can offer, the X-brick is 4U high and supports a number of SGI XIO adapter cards. Each X-brick is powered by a single Xtown2 crossbar, whose aggregate bandwidth is 2.4 GB/second, shared between all four XIO slots. Two I/O (II) interface connectors in the rear of the unit allow the unit to be dual-hosted to two separate C-bricks, increasing the availability of the I/O in case of a failure.

Features:
- Provides four expansion slots for standard XIO cards
- Provides two Xtown2 ports
  (1.2 GB/second in each direction)
- Supports many existing XIO cards
**G-brick**

The G-brick is an optional expansion module that houses advanced SGI graphics subsystems, referred to as graphics pipes. The G-brick is optional on all SGI Origin 3000 servers and is part of the standard base configurations of the SGI Onyx 3000 series of systems. The G-brick supports one or two graphics pipes, either InfiniteReality™ or InfiniteReality3 versions, and has a maximum configuration of one 4RM pipe and one 2RM pipeline. Customers with existing Onyx InfiniteReality class graphics pipelines can simply migrate to the G-brick by ordering an upgrade kit. The G-brick measures 18U and requires both one G-brick and one I/O brick for each pipeline. In the SGI Onyx 3400 and 3800 systems, up to two G-bricks can be configured in a graphics rack, each with two pipes, supporting solutions up to 8 pipes and 16 pipes per system, respectively.

The G-brick with graphics pipeline isn’t just an adapter that plugs into an I/O slot in the machine, but a tightly integrated graphics subsystem that has a special high-bandwidth I/O interface to deliver the extreme levels of performance necessary to generate sophisticated visualization solutions.
D-brick

The D-brick provides JBOD storage capacity for the SGI 3000 family. The D-brick can be integrated into single-rack SGI 3200 and SGI 3400 systems or into the I/O rack of SGI 3800 systems.

Features:
- Maximum 12 dual-ported Fibre Channel disk drives
- Hot-pluggable drive carriers
- Mounts in standard 19-inch rack, 4U high
- Single-phase input power is switchable 200 to 230 VAC
- Industry-standard SCA-2 interface connectors
- Two hot-pluggable 400 W power supplies and fans that offer full redundancy
- 18.2GB, 36.4GB, and 72.8GB drive capacities, all 10,000 RPM
## PCI Cards

<table>
<thead>
<tr>
<th>Marketing Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI-SCSI-LVD-2P</td>
<td>Ultra2 SCSI (80MB/sec) Single-ended 2 port card</td>
</tr>
<tr>
<td>PCI-FC-IPOPT-A</td>
<td>Fiber Channel 1-Port card with Fiber optic cable</td>
</tr>
<tr>
<td>PCI-FC-IPCOP-A</td>
<td>Fibre Channel 1-Port card with copper cable</td>
</tr>
<tr>
<td>PCI-GIGENET-C</td>
<td>Gigabit Ethernet (100/1000) copper</td>
</tr>
<tr>
<td>PCI-GIGENET-OR</td>
<td>Gigabit Ethernet (100/1000) fiber optic</td>
</tr>
<tr>
<td>PCI-AUD-D1000</td>
<td>Digital Audio</td>
</tr>
<tr>
<td>PCI-ATMOC3-1P</td>
<td>ATM OC3 card</td>
</tr>
<tr>
<td>PCI-ATMOC12-1P</td>
<td>ATM OC12 card</td>
</tr>
</tbody>
</table>

## XIO Cards

<table>
<thead>
<tr>
<th>Marketing Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XT-HIPPI-800-SER</td>
<td>Single Port Serial HIPPI card</td>
</tr>
<tr>
<td>XT-DIVO</td>
<td>Digital Video card</td>
</tr>
<tr>
<td>XT-DIVO-DVC</td>
<td>Digital Video card, supports DVC</td>
</tr>
<tr>
<td>XT-GSN-C-XIO</td>
<td>GSN Adapter single XIO slot, copper</td>
</tr>
<tr>
<td>XT-GSN-C-2XIO</td>
<td>GSN Adapter dual XIO slot, copper</td>
</tr>
<tr>
<td>XT-HD</td>
<td>High Definition video card</td>
</tr>
<tr>
<td>XT-FDDI-D</td>
<td>FDDI Dual Attach single port card</td>
</tr>
<tr>
<td>XT-VME-6U</td>
<td>VME card, supports 6U</td>
</tr>
<tr>
<td>XT-VME-9U</td>
<td>VME card, supports 9U</td>
</tr>
<tr>
<td>XT-ATM-DC3C-4P</td>
<td>Four-port ATM OC3 card</td>
</tr>
</tbody>
</table>
Power Bay

The power bay delivers power to each of the bricks that are used to configure a system. Each power bay is 3U high and houses up to six hot-swap distributed power supplies (DPS). System configurations come standard with a predetermined number of DPSs that provide N+1 redundancy. Smaller configurations come standard with one power bay, while larger or more complex configurations will have two.

Features:
- Provides N+1 power
- Holds a maximum of 6 hot-swap DPSs
- Each DPS is rated at 950 W
- Has eight 48 VDC output connections

Power Distribution Unit (PDU)

Both single-phase and three-phase power distribution are available.

- HU-SN-PDU-1P-NAJ single phase for domestic, Mexico, Canada, and Japan
- HU-SN-PDU-1P-INTL single phase for Europe and elsewhere
- HU-SN-PDU-3P-NAJ three phase for domestic, Mexico, Canada and Japan
- HU-SN-PDU-3P-INTL three phase for Europe and elsewhere
Short Rack

The short rack can be configured multiple ways by combining any of the standard 19-inch rack-mounted bricks up to a total of 17U. The short rack was designed for customers with space limitations or for solutions that are satisfied by scalability to 8 processors. A minimum server configuration would require one power bay, one C-brick, and one I-brick.

Features:
- 17U of configurable space
- 19-inch EIA standard mounting rails
- Mounted on casters
- 36 in. high x 25.5 in. wide x 36 in. deep
- One 220 VAC 10 A power distribution strip

Tall Rack

The 19-inch industry-standard tall rack is the base rack for all highly scalable server configurations. It provides maximum flexibility, allowing customers to design a server that addresses a specific application. An endless combination of bricks can be used to configure an ideal system. Processors, I/O bandwidth, and storage can be added independently to provide a level of granularity and flexibility not offered by any other system architecture.

Features:
- 39 U of configurable space
- 19-inch EIA standard mounting rails
- Mounted on casters
- 74 in. high x 30 in. wide x 50 in. deep
- Can use any of the standard rack PDUs
The SGI Origin 3200 server comes in one of four easy to order preconfigured bundles. Designed for customers with limited space requirements or modest scalability needs, SGI Origin 3200 is integrated into a short rack and uses the same bricks as all other models in the SGI 3000 family. A maximum of two C-bricks are supported, connected point-to-point with the NUMAlink Interconnect. SGI Origin 3200 models are routerless configurations and do not come with an R-brick.
SGI Origin 3200 Technical Specifications

A single 17U deskside rack configuration with no additional racks for processors or I/O:

<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory size</td>
<td>512MB: (one C-brick with one 512MB bank installed)</td>
<td>16GB: (two C-bricks, each with four 2GB banks installed)</td>
</tr>
<tr>
<td>Processors</td>
<td>One C-brick (2 processors)</td>
<td>Two C-bricks (8 processors)</td>
</tr>
<tr>
<td>Input/output</td>
<td>One I-brick</td>
<td>One I-brick and one optional I/O brick</td>
</tr>
<tr>
<td>R-bricks</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Power bays</td>
<td>One power bay</td>
<td>One power bay</td>
</tr>
</tbody>
</table>

SGI Origin 3200 pre-configured bundles:

<table>
<thead>
<tr>
<th>Standard Bundles</th>
<th>Processor Base Configurations</th>
<th>Processor Upgrade Possibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 processors</td>
<td>One 2P C-brick</td>
<td>Add (1) 2P PIMM or Add (1) 4P C-brick</td>
</tr>
<tr>
<td>4 processors</td>
<td>One 4P C-brick</td>
<td>Add (1) 4P C-brick</td>
</tr>
<tr>
<td>4 processors</td>
<td>Two 2P C-bricks</td>
<td>Add (1-2) 2P PIMMS</td>
</tr>
<tr>
<td>8 processors</td>
<td>Two 4P C-bricks</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Although offering the same easy-to-order four bundles as SGI Origin 3200, the SGI Onyx 3200 bundles are all based on the taller 39U rack. Due to the size of the G-brick (necessary for graphics pipes), customers cannot upgrade SGI Origin 3200 servers with a graphics subsystem. All SGI Onyx 3200 system configurations are single-rack solutions, a benefit to customers interested in minimizing space. The base configuration comes with a single G-brick, to which one or two graphics pipes can be added. Additional G-bricks cannot be added. The G-brick also supports the graphics pipes from legacy Onyx2 systems, for customers wanting to migrate their existing graphics to a newer CPU architecture. As with other models of the SGI Onyx 3000 series, InfiniteReality2 or InfiniteReality3 graphics pipes are supported.
SGI Onyx 3200 Technical Specifications

A single 39U rack configuration with no additional racks for processors or I/O:

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<td>16GB: (two C-bricks, each with four 2GB banks installed)</td>
</tr>
<tr>
<td>Processors</td>
<td>One C-brick (2 processors)</td>
<td>Two C-bricks (8 processors)</td>
</tr>
<tr>
<td>Graphics module</td>
<td>One G-brick (pipe not included)</td>
<td>One G-brick</td>
</tr>
<tr>
<td>Graphics pipe</td>
<td>One InfiniteReality2 or IR3 pipe, one RM, one DG, one monitor</td>
<td>Two graphics pipes</td>
</tr>
<tr>
<td>Graphics options</td>
<td>Keyboard, mouse, audio card, USB extender</td>
<td>Two sets of options, one for each graphics pipe</td>
</tr>
<tr>
<td>Input/output</td>
<td>One I-brick</td>
<td>One I-brick and one optional I/O brick</td>
</tr>
<tr>
<td>R-bricks</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
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SGI Onyx 3200 pre-configured bundles:

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<td>One 4P C-brick</td>
<td>Add (1) 4P C-brick</td>
</tr>
<tr>
<td>4 Processors</td>
<td>Two 2P C-bricks</td>
<td>Add (1-2) 2P PIMMS</td>
</tr>
<tr>
<td>8 Processors</td>
<td>Two 4P C-bricks</td>
<td>N/A</td>
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</table>