Cyclone™
SGI Cloud Computing for HPC

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Agenda

- Rationale for Cyclone SGI offering
- Role in SGI business model
- Cyclone service and usage models
- Partnerships
- Future Directions
Limitations of Existing Cloud Services for HPC

- Most cloud systems built on virtualized instances only
- Limited scalability of available servers:
  - Scale-out clusters only
- Lack of high speed networks
  - Mostly GigE
- Lack of user control over node interconnect topology
  - MPI latency, core distribution, contiguous memory
- Lack of available HPC software stacks
- Lack of technical application specific configurations
Benefit of HPC Cloud Computing

Scalability (50% Efficiency)

NUMBER OF USERS, APPLICATIONS

10000
1000
100
10
1

High-End Computing (HPC)

Entry-Level Cluster Computing

Desktop Computing

Leading-Edge Computing

NUMBER OF PROCESSORS, MEMORY SIZE, JOB COMPLEXITY

Enabling wider use of HPC

Source: Nimbis Services, 2010

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Graphic adopted from OSC, Council on Competitiveness and the University of Southern California.
Completing the need

- Personal & Workgroup
- Traditional Data Center
- Modular Data Center
- Cloud

Access & Compute  Scale & Control  Modular & Mobile  On Demand

Move freely between the environments
SGI Cyclone- results on demand™

- Cloud computing dedicated to technical computing
- Cyclone Offers Flexible Choice of
  - Platform
    - Scale-up (Altix 4700 and Altix UV) and Scale-out (Altix ICE and Altix XE)
    - Hybrid systems with NVIDIA Tesla, ATI FireStream and Tilera accelerators
  - Operating System (SLES, RHEL)
  - Interconnect (NUMAlink, InfiniBand, GigE)
  - Physicalization and virtualization
- Application-Specific Cloud
  - Application-tuned software stacks
  - Open source and close source applications
- Differentiators
  - Significantly broader platform flexibility
  - SGI Performance Suite for application acceleration
  - Deep Application Engineering expertise

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SGI Cyclone - Usage Models

- **Cloud Service for Customers**
  - SaaS and IaaS
  - Bridge for overflow capacity
  - Bridge for new system installation
  - Hub for new applications and architectures

- **Cloud for Software Development**
  - SGI Solutions Partner Program

- **Internal Cloud**
  - Benchmarking
  - Software development
## SGI Cyclone Domain and Application Focus

<table>
<thead>
<tr>
<th>Domain</th>
<th>Use Cases</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational Biology (BIO)</td>
<td>Genomics, proteomics, molecular modeling and drug discovery</td>
<td>BLAST, FASTA, HMMER, ClustalW</td>
</tr>
<tr>
<td>Computational Chemistry and Materials (CCM)</td>
<td>Nanotechnology, materials research (metal alloys, polymers, composites, ceramics and plastics)</td>
<td>Gaussian, Amber, Gamess, Namd, Gromacs, LAMMPS, DL_POLY</td>
</tr>
<tr>
<td>Computational Fluid Dynamics (CFD)</td>
<td>Automotive design, aerospace design, defense systems design and power generation design</td>
<td>StarCCM+, OpenFOAM, Acusolve, NUMECA</td>
</tr>
<tr>
<td>Computational Structural Mechanics (CSM)</td>
<td>Structural, heat transfer, fatigue and vibrational analysis for manufactured products</td>
<td>LS-DYNA</td>
</tr>
<tr>
<td>Computational Electromagnetism (CEM)</td>
<td>Design and analysis of antennas, antenna placement, EMC (shielding, coupling.), RF components and bioelectromagnetic analysis</td>
<td>FEKO</td>
</tr>
<tr>
<td>Ontologies (ONT)</td>
<td>Semantic Web, data mining</td>
<td>OntoStudio, SemanticMiner</td>
</tr>
</tbody>
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SGI Cyclone System Architectures

**Fluent Performance: FL5L3 9.7M cells**

![Graph with data points and lines showing performance metrics.](graph.png)

**Cluster**

Altix ICE, XE

IB Fabric

Platform interconnect choices determine the achieved application performance

![Platform interconnect choices diagram.](diagram.png)
SGI Cyclone System Architectures

**SMP**

Altix UV

NUMAlink Router

- **NUMAlink® 5** is the glue of Altix® UV
- Global Shared Memory
  - Sockets: 2 to 256 in one OS image system
  - Memory: up to 16TB in one OS image system
  - NUMAlink5 BW: 15 GB/s aggregate

**Cluster**

Altix ICE, XE

IB Fabric

- **MPI off-load engine on Altix® UV**
  - MPI reduction, barrier -> Synchronization 3x - 10x
  - MPI short messages -> local Latency 2x
  - MPI next neighbor communication -> local BW 3x
  - MPI Barrier Latency <1sec (4096 thread)

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Performance Preview on Altix UV

**SPECfp_rate base2006**
- SGI Altix UV 1000, 64S: 6840
- Next x86 competitor: 2550
- X2.7

**SPECint_rate base2006**
- SGI Altix UV 1000, 64S: 10400
- Next competitor: 3150
- X3.30

**SPECjbb2005**
- SGI Altix UV 1000, 64S: 20000000
- Next competitor: 6000000
- X3.2

**GUPS**
- SGI Altix UV 1000, 256C: 900
- Next SSI competitor: 500
- X1.8

**STREAM**
- SGI Altix UV 1000, 64S: 401
- Next x86 competitor: 201

SGI Altix UV is the industry’s leading supercomputer in relevant performance metrics.
Rationale for GPU Analytics of Top500 list, Nov 2009

System Performance = Chip Performance x Nr of Chips

1 Pflops

10 Pflops

100 Pflops

1 Eflops

Low-power
Comm. overhead

General Purpose
power, clock

Hybrid
SW availability

Rationale
for
GPU
Analytics of Top500 list, Nov 2009

General Purpose
power, clock

Low-power
Comm. overhead

Hybrid
SW availability

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SGI Cyclone Software Stack

Applications

Development Tools and Libraries

Altair PBSProfessional

SGI® Management Suite
SGI Management Center

SGI® Performance Suite
SGI ProPack

SGI® Foundation Software

Novell® SUSE® Linux®, Red Hat® Enterprise Linux®

SGI Scale-up, Scale-out and Hybrid Systems and Storage

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SGI products

Third party product (available from and/or integrated by SGI)
SGI Performance Suite – Application Accelerator

**FFIO** – IO Accelerator
- Linkless IO library that enhances performance for jobs that have much larger IO footprint sizes than free memory sizes on the systems.

**SGISolve**
- Scalable SMP parallel in-core and out-of-core sparse solvers
- Parallel iterative solvers and preconditioners library

**MPT** - MPI offload engine for SMP and Clusters

**PerfBoost** – Accelerate applications certified HP-MPI, Intel MPI or OpenMPI
- No recompile or re-linking needed

**XPMEM, XPNET** – fast cross-partition data transfer

**MPIInside** – MPI performance modelling and projection tool

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Cyclone Technical Application Library
Application-tuned HPC environments

SGI Apps Portal

Gaussian Recipe
Process

LS-Dyna Recipe
Process

Fluent Recipe
Process

OpenFOAM
Process

StarCCM+
Recipe
Process

..... Recipe
Process

Persistent Storage

Management Server for Pre & Post Processing and Job Scheduling

SGI Servers

Scale-Up

Scale-Out

Hybrid

Systems Workload Storage

Factory Integration

Shipping

Factory Order Customer

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Conclusions

- Cyclone completes the need
- Specifically dedicated to technical computing
- Making HPC pervasive
- Fast access to new technologies