Open Source Efforts in Grid Computing and HPC

Bob Porras
Vice President,
Solaris Data, Availability, Scalability & HPC
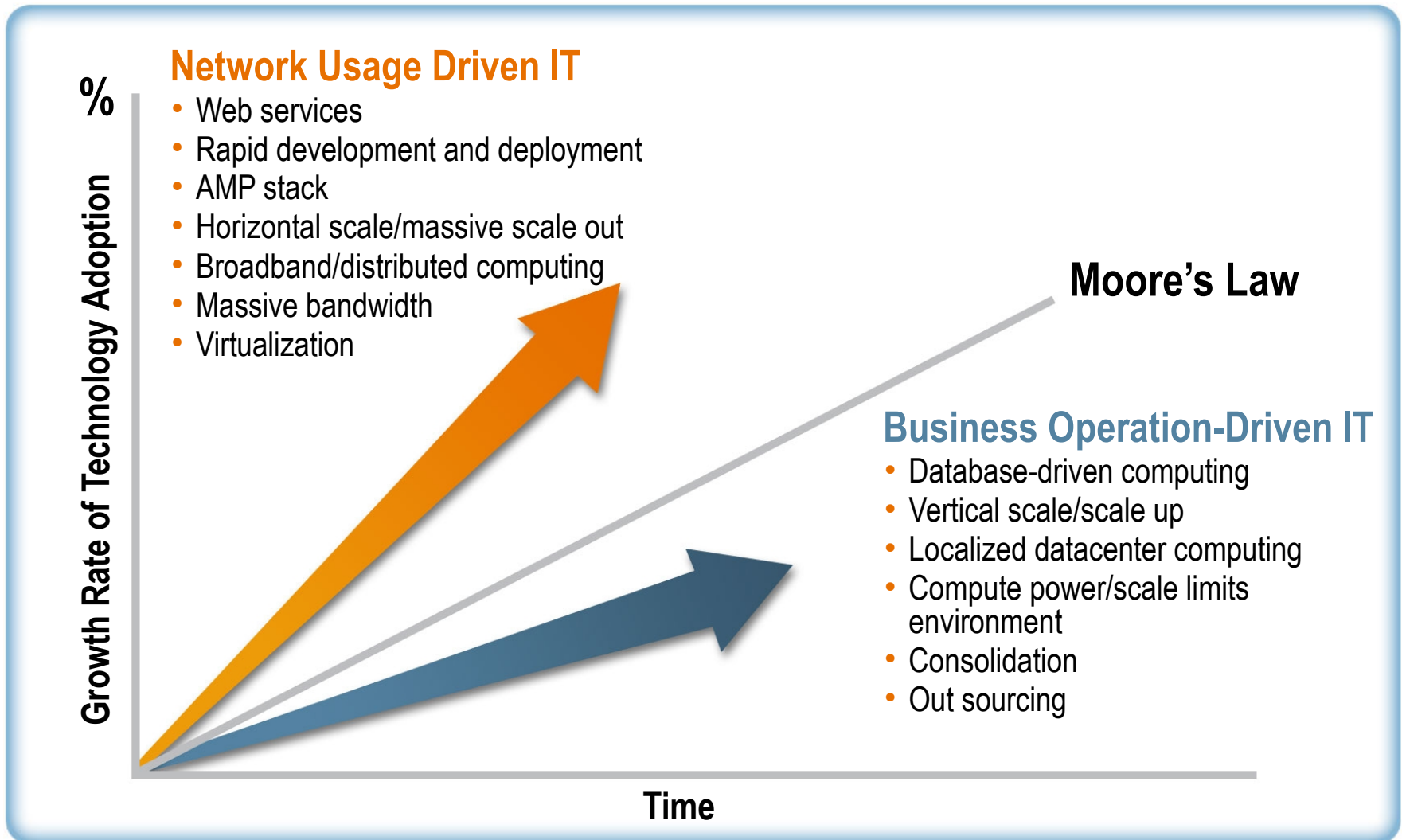Sun Microsystems, Inc.
blogs.sun.com/bobp

Keynote Topics

- **The *RedShift* Opportunity**

- **Open Source @ Sun**
  - > **OpenSolaris**
  - > **Open HPC and Grid Software Stacks**
  - > **Open Development Platforms and Tools**
  - > **OpenStorage**
  - > **Open Virtualization**
  - > **Open Java Platform**

- **Call for Participation**

Grid & HPC – The *RedShift* Evolution

Network Usage Driven IT
- Web services
- Rapid development and deployment
- AMP stack
- Horizontal scale/massive scale out
- Broadband/distributed computing
- Massive bandwidth
- Virtualization

Moore's Law

Business Operation-Driven IT
- Database-driven computing
- Vertical scale/scale up
- Localized datacenter computing
- Compute power/scale limits environment
- Consolidation
- Out sourcing

%

Growth Rate of Technology Adoption

Time

Sun's Vision
The Journey: Open Innovations to Create Breakthrough Economics

Open Servers

- Leveraging innovative product design and packaging
- Common components
- Open-source software
- Wide interoperability to deliver breakthrough economics

Open Storage

- Open software
- An open architecture
- Common components
- Open interoperability to create innovative storage products
- Delivers breakthrough economics

Open Networks

- Unified datacenter network that utilizes common components
- Open-source software
- Seamless integration with existing environments
- Delivers breakthrough economics

Sun's Open Stack
Flexible and Heterogeneous with Zero Barrier to Exit

Developer Environment	NetBeans, The Apache Software Foundation, php, JRuby	eclipse, Visual Studio
Database/ Storage Platform	MySQL, ZFS The Zettabyte File System, lustre, PostgreSQL	ORACLE, SYBASE, Windows
Application Infrastructure	Java, Project Glassfish	bea Think liquid., WebSphere, Windows
Virtualization	xVM, Ops Center, Grid Engine	vmware, Windows
Operating System	solaris, opensolaris	ubuntu, redhat, suse, Windows
Systems — Servers Storage Networking	Sun microsystems	FUJITSU, IBM, DELL, hp
Microprocessor	OpenSPARC, AMD 64 Opteron, intel, ULTRASPARC	

Sun's Contribution to Linux

Rank	Company	Estimated $ value
1	Sun Microsystems Inc	404 m
2	IBM Corp	116 m
3	Red Hat Corp	76 m
4	Silicon Graphics Corp	61 m
5	SAP AG	60 m
6	MySQL AB	45 m
7	Netscape Communications Corp	41 m
8	Ximian Inc	39 m
9	RealNetworks Inc	35 m
10	AT&T	34 m

Estimated Substitution Cost of Sun's contribution to Debian GNU/Linux

**includes code in
GNOME
Linux kernel
Mozilla
OpenOffice.org
X.org
and other projects**

Source: UNU-MERIT report for the European Commission
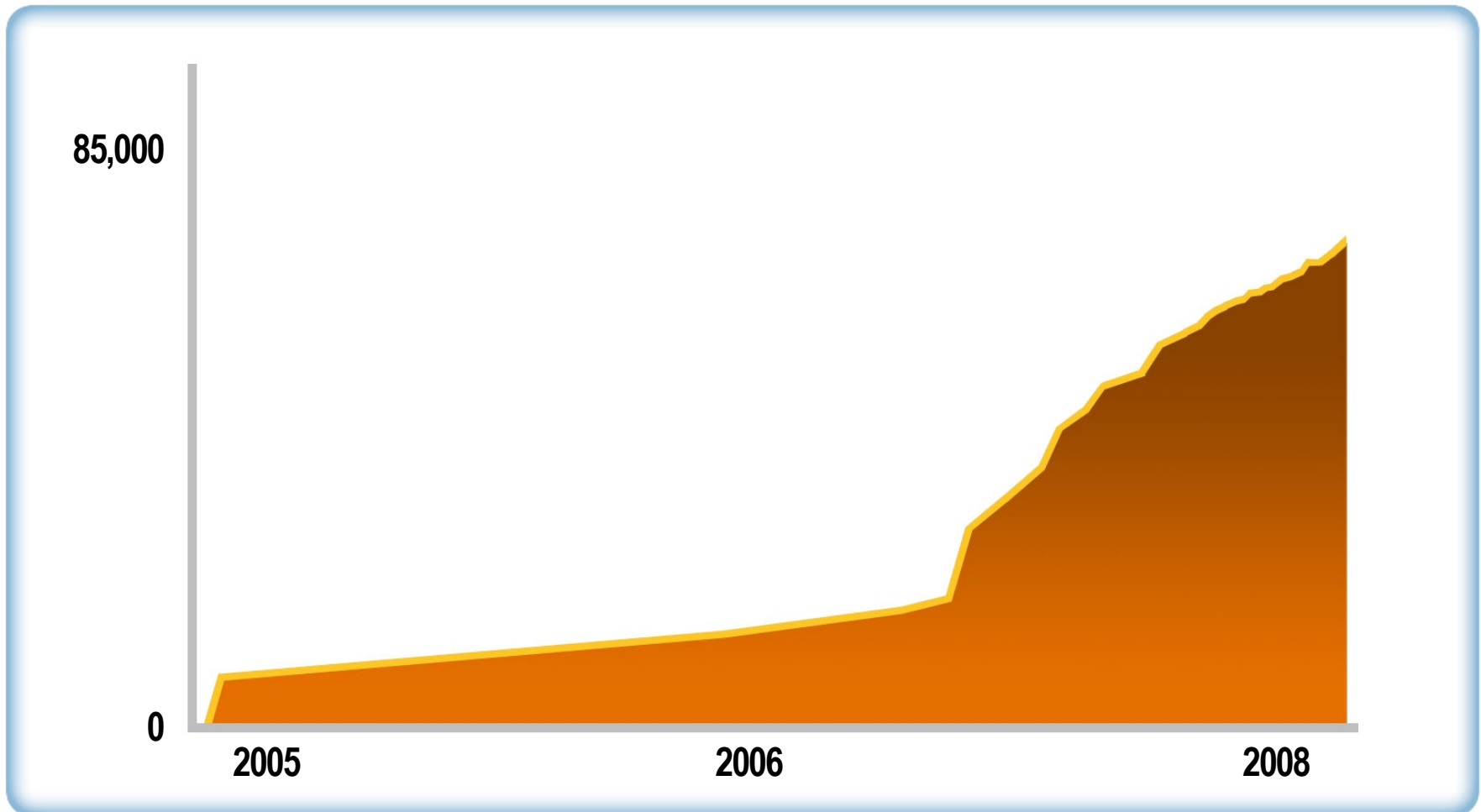"Economic impact of FLOSS on innovation and competitiveness of the EU ICT sector"
January 2007

What is OpenSolaris?

ZFS

DTrace

CIFS

opensolaris

Clearview

IPS

FMA

GNOME

MySQL

php
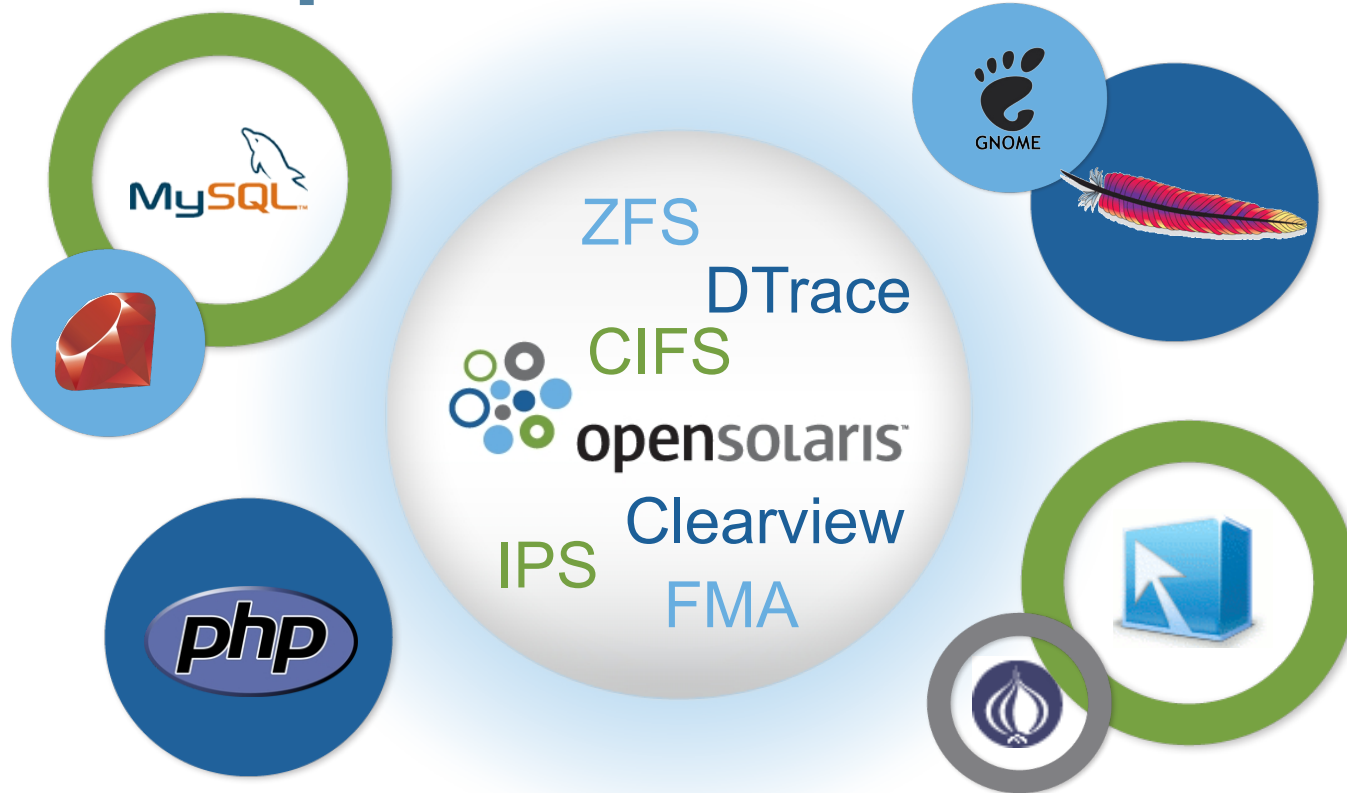
Community Participation + Solaris = Innovation
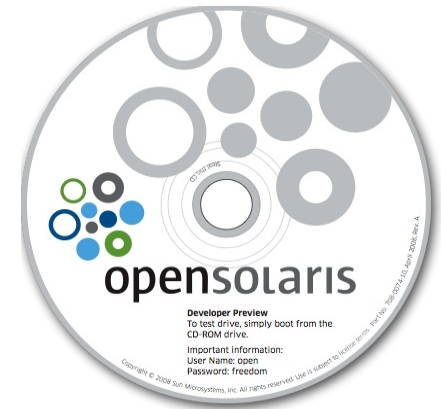
OpenSolaris Community Growth
Registered Community Members

Cumulative Growth

OpenSolaris 2008.05

- First release of the OpenSolaris OS
  - > First OS with ZFS as default file system
  - > Enhanced DTrace with D-Light
  - > Fast in kernel CIFS server
- New OpenSolaris package repositories
  - > Integrated & optimized AMP/MARS stack
- Fully supported for production deployments

OpenSolaris Repositories

Community	Sun	Subscription
Latest Releases	Free Sun and 3rd Party Binaries	Bug Fixes
3rd Party Open Source Packages	Developer Showcase	Security Updates
Community Open Source Packages	Partner Marketplace	Back Ports
Current Release Updates		Early Access

World Class Support

Telephone, Online Tech Support	OpenSolaris Essentials	OpenSolaris Production
	Email only 48-hour Response	24/7 P1 Live Transfer
OpenSolaris full release and major updates	✔	✔
Knowledge base access	✔	✔
Sun alerts and notifications	✔	✔
Installation assistance	✔	✔
Sun Spectrum eLearning Library	✔	✔
Administration support*	✔	✔
Solaris fix and erata patch updates		✔

OpenSolaris Features

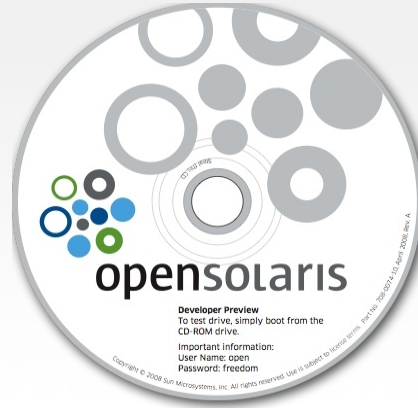|		
OpenSolaris 6 month releases	✔	✔
Free Sun and OpenSolaris Community IPS server	✔	✔
Sun OpenSolaris Premium IPS Server	✔	✔
OpenSolaris Bug Logging	✔	✔
OpenSolaris Bug Escalation		✔
Open Stack and Postgres Support		*promo inclusion

OpenSolaris. Start It Up!

Get It

- Available everywhere
- Smaller faster download

Experience It

- Live CD
- See the best in OpenSolaris, risk free

Install It

- Easy
- Graphical
- Supported on ~1000 systems
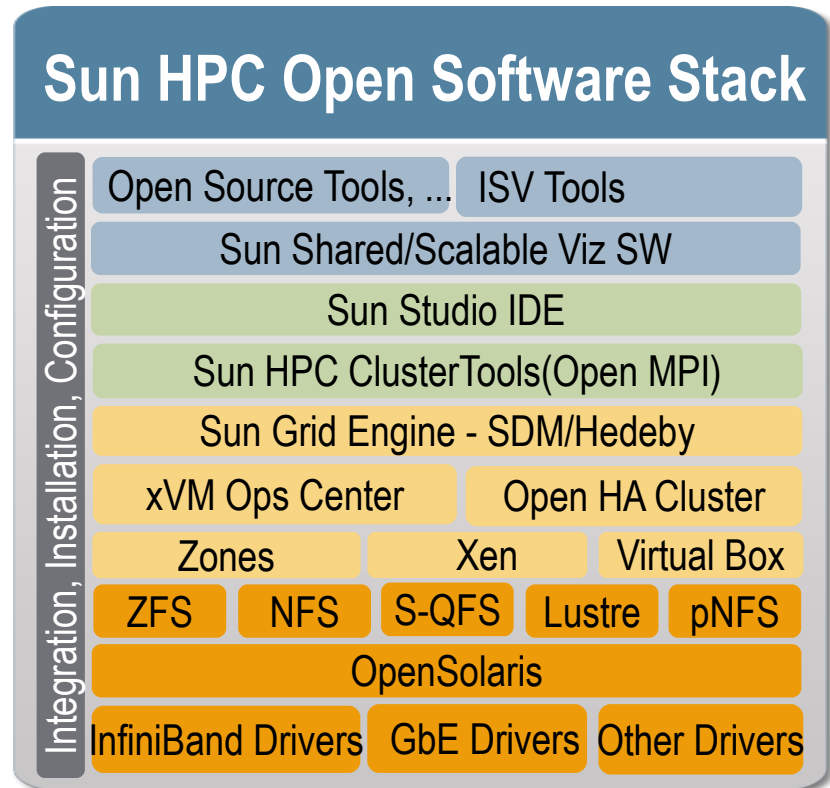- Runs in popular virtualization environments

OpenSolaris.com

- Learn
  - > Explore the learning opportunities
  - > Get the guides and videos

- Collaborate
  - > Join the communities
  - > Make your mark; help shape the next generation of the Solaris OS
  - > Connect with Sun distinguished engineers and other leading lights of the OpenSolaris community

- Get it, use it, learn it
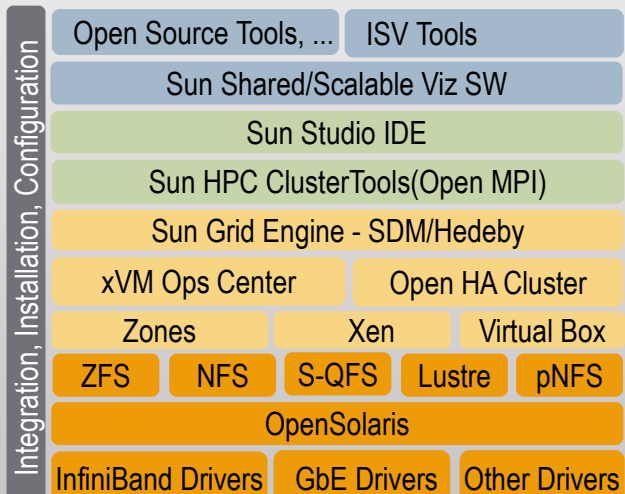 - > opensolaris.com/get

OpenSolaris/Solaris HPC Distro

- HPC Developer Community & HPC Stack Project

- Objective:
  - > Build a tightly integrated, low-barrier-to-entry stack

- Two life lines – two platforms Solaris 10 & OpenSolaris*
  - > HPC Developer Preview
    - – Centered around IDE
    - – Seamless developer experience
  - > HPC vertical distros
    - – Deployment stack targeted at specific vertical market segment needs
    - – Integrated with OpenSolaris and Solaris 10
    - – Also available unbundled

Sun HPC Open Software Stack

Integration, Installation, Configuration		
Open Source Tools, ...		ISV Tools
Sun Shared/Scalable Viz SW		
Sun Studio IDE		
Sun HPC ClusterTools(Open MPI)		
Sun Grid Engine - SDM/Hedeby		
xVM Ops Center		Open HA Cluster
Zones	Xen	Virtual Box
ZFS NFS	S-QFS	Lustre pNFS
OpenSolaris		
InfiniBand Drivers	GbE Drivers	Other Drivers

* A Sun-supported Linux HPC stack is also underway

HPC Stack- Download, Join, Succeed

Sun HPC Open Software Stack

Integration, Installation, Configuration

Open Source Tools, ...	ISV Tools
Sun Shared/Scalable Viz SW	
Sun Studio IDE	
Sun HPC ClusterTools(Open MPI)	
Sun Grid Engine - SDM/Hedeby	
xVM Ops Center	Open HA Cluster

Zones	Xen	Virtual Box

ZFS	NFS	S-QFS	Lustre	pNFS

| OpenSolaris | | | | |

InfiniBand Drivers	GbE Drivers	Other Drivers

- We need your input!
  - > What tools do you need?
  - > What features do you need?
  - > What applications do you have to get integrated?
  - > What platforms do you need?
  - > What support model do you need?
- Participate with us.....
  - > Port applications
  - > Test
  - > Get the word out
- opensolaris.org/os/community/hpcdev/
- opensolaris.org/os/project/hpc-stack/

Award-winning Sun Grid Engine
Thousands of successful Grids
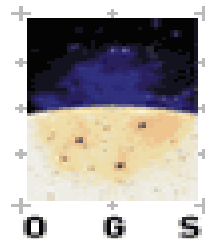
Excellence in Cluster Technology

Grid Engine & Sun Grid Engine
The Ultimate Try & Buy

Grid Engine Open Source

- Full source code access; liberal license (SISSL)
- Regular courtesy binary updates
- Open development and issue tracking
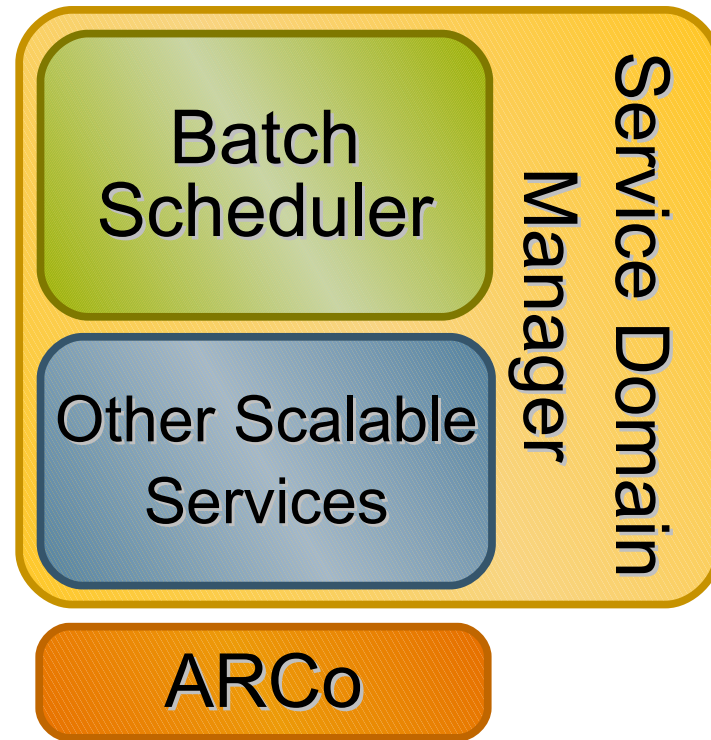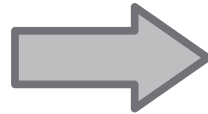- Vibrant mailing lists
- Community contributions

Sun Grid Engine

- Indemnification (also for free download from SDLC)
- Strong Support options; relief patches, on-site diagnosis, etc.
- More "muscle" to influence product direction
- Partner Solutions
- Integrated in Sun's HPC Stack

Future of Sun Grid Engine

Sun Grid Engine 6.x   Sun Grid Engine Next

Grid Engine- Download, Join, Succeed
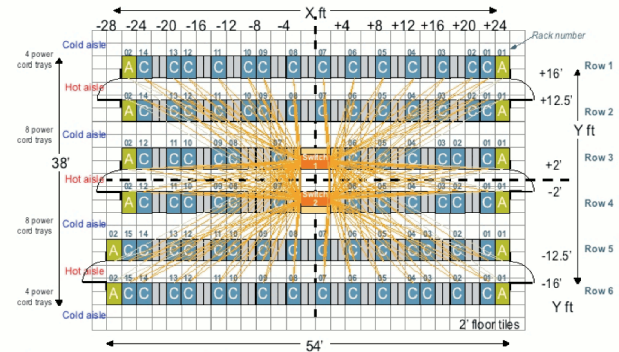

- Download Grid Engine from Sun Download Center or gridengine.sunsource.net

- Join the Grid Engine community gridengine.sunsource.net

- Join the Hedeby community hedeby.sunsource.net

- Subscribe to the Grid Engine and Hedeby mailing lists

- Get news about Grid Engine at gridengine.info – from the community for the community

- Join Grid.org, a Grid stack community encompassing Grid Engine

# Texas Advanced Computing Center

Ranger System

- *First* National Science Foundation Track2 system
  - > $30M acquisition budget
    - – $29M for support over 4 years
  - > Awarded September 2006
  - > Production December 2007

Two Sun DS 3456 systems 16 line cards per switch | 82 Sun Blade 6048 chassis with 3,936 server modules | 12 APC racks for 72 Sun Fire X4500 bulk storage nodes, and 25 Sun Fire X4600 servers (19 support and 6 metadata nodes)

Space for cable management arms and trays | 116 APC row coolers | 328 bundles of four 12x cables / 24 bundles of three splitter cables

- TeraGrid member
  - > Over 3200 users
  - > Over 1000 projects
  - > From 48 states
  - > Physics, molecular biology, chemistry, astronomy, etc.
  - > *Larger than current top 20 TeraGrid systems combined*
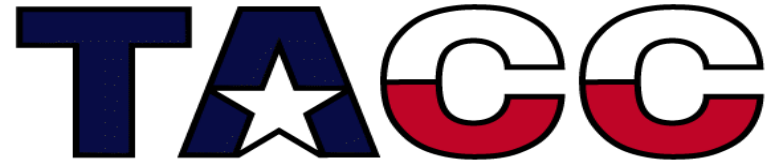
Visualization Customer Needs

- Understand and act upon increasing quantity and complexity of data

- More and better utilization of graphics resources

- Collaborate with geographically dispersed colleagues

- Secure proprietary data and control access

Share Visualization on the Grid over the Network
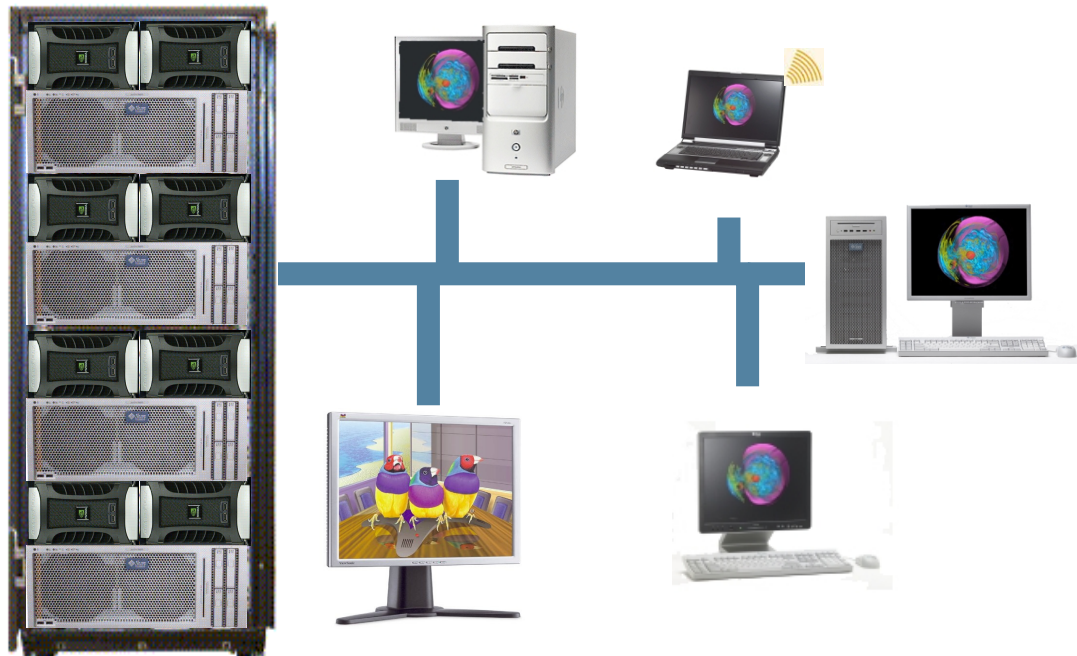
Sun HPC Visualization Solutions

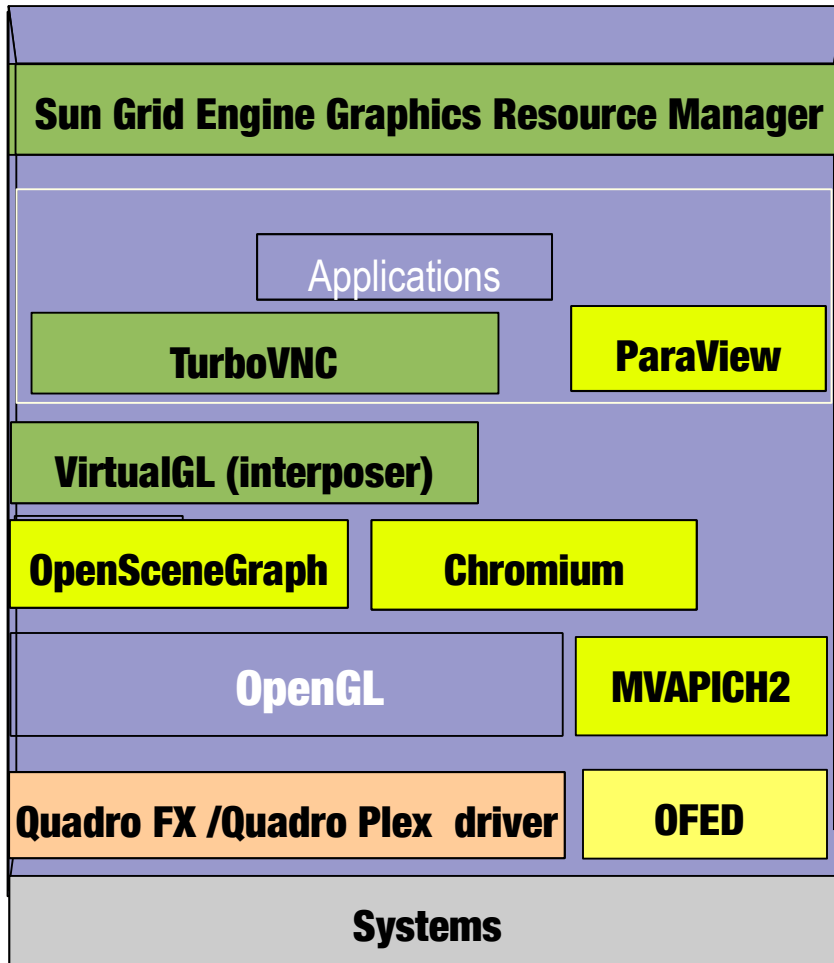Central Visualization Server

Graphics

WAN

LAN

Direct video
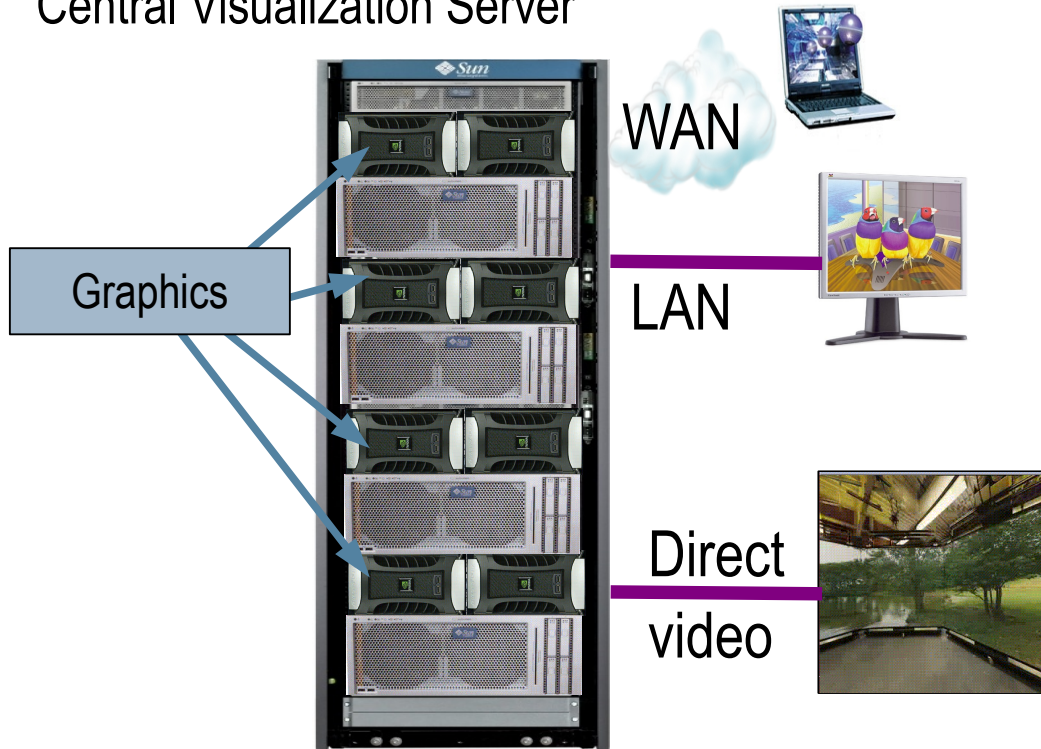
Shared Visualization software provides secure access to 3D apps on a central resource

> Transparently accessed from a variety of clients

> Better utilization of resources

> Access anytime from anywhere

> Virtualizes Visualization

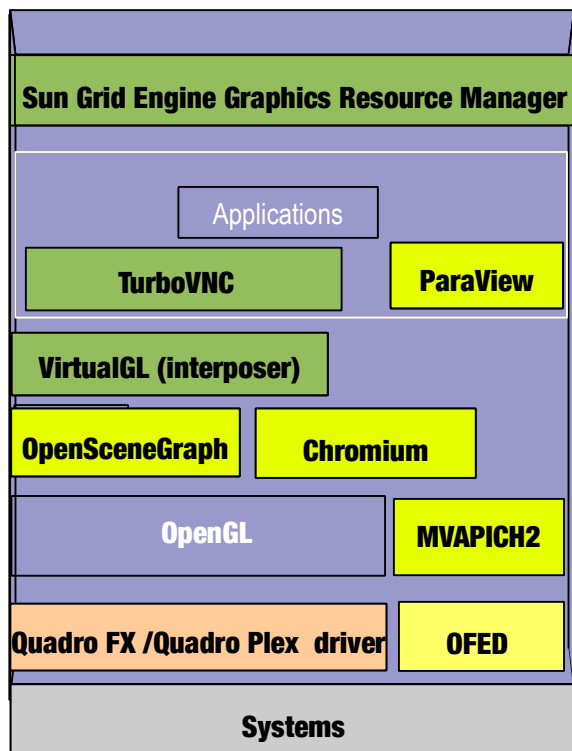**Scalable Visualization** software to combine multiple devices for

> Higher Performance

> More Resolution

> Virtual Reality

Sun Visualization Stack

Sun Grid Engine Graphics Resource Manager
Applications
TurboVNC · ParaView
VirtualGL (interposer)
OpenSceneGraph · Chromium
OpenGL · MVAPICH2
Quadro FX /Quadro Plex driver · OFED
Systems

- **Shared Visualization software stack** - visualization services to a variety of remote clients
  - **SGE** – open source scheduler extended for graphics resource management
  - **VirtualGL** – open source remote access via any client over standard IP networks
  - **TurboVNC** – open source vncviewer and vncserver that uses TurboJPEG
- **Scalable Visualization software stack**
  - **ParaView** - open-source parallel rendering application optimized for SMPs with multiple graphics.
  - **OpenSceneGraph** - open-source parallel rendering toolkit for building parallel applications.
  - **Chromium** - virtualized graphics devices for Solaris or Linux. Provides transparent parallelization for fill-rate limited applications.
  - **MVAPICH2/OpenMPI** - MPI for Linux/Solaris
  - **OFED** – IB for Linux (IB support incl in Solaris)
- **Quadro Plex** - connects graphics devices to Linux or Solaris servers over a PCI-E cable
- **Systems** - **Sun Fire x64 & SPARC systems provide scalable platforms**

Viz Stack- Download, Join, Succeed

Sun Grid Engine Graphics Resource Manager

Applications

TurboVNC

ParaView

VirtualGL (interposer)

OpenSceneGraph

Chromium

OpenGL

MVAPICH2

Quadro FX /Quadro Plex driver

OFED

Systems

- Download Visualization Stack from Sun Download Center
- Join the Visualization community on opensolaris.org
- Join one of the open source communities in the stack
  - > Grid Engine
  - > VirtualGL
  - > TurboVNC
  - > Paraview
  - > OpenSceneGraph
  - > OpenMPI

HPC Development

Sun Studio Software

- C, C++ & Fortran Compilers and Tools
- OpenMP support
- OpenSolaris, Solaris & Linux platforms
- Free license

Sun HPC ClusterTools

- Based on Open MPI
  - → Open MPI Message Passing Interface (OMPI)
  - → Open Run-Time Environment (ORTE)
- OpenSolaris & Solaris OSs
- Free license

Sun Developer Network

- http://developers.sun.com
- Downloads, technical articles, documentation, code samples
- Forums, wikis, events
- CommunityOne, Sun Tech Days

Additional Resources

- Leadership in Programming Language Standards
- NetBeans IDE
- Participation in Industry Conferences
  - → SuperComputing
  - → International SC

Sun Studio Software Overview

Integrated Toolchain

- Record-setting parallelizing C/C++/Fortran Compilers
- NetBeans-based IDE
- Stable, Scriptable, Multilingual Debugger (dbx)
- Memory Debugger- leak, access, usage (RTC)
- Application Profiling Tools (Performance Analyzer)
- Thread Analysis Tools (Thread Analyzer)
  - Data race & deadlock detection
- OpenMP v2.5 API Support
- Optimized libraries
  - LAPACK, BLAS, Sparse-BLAS, SuperLU
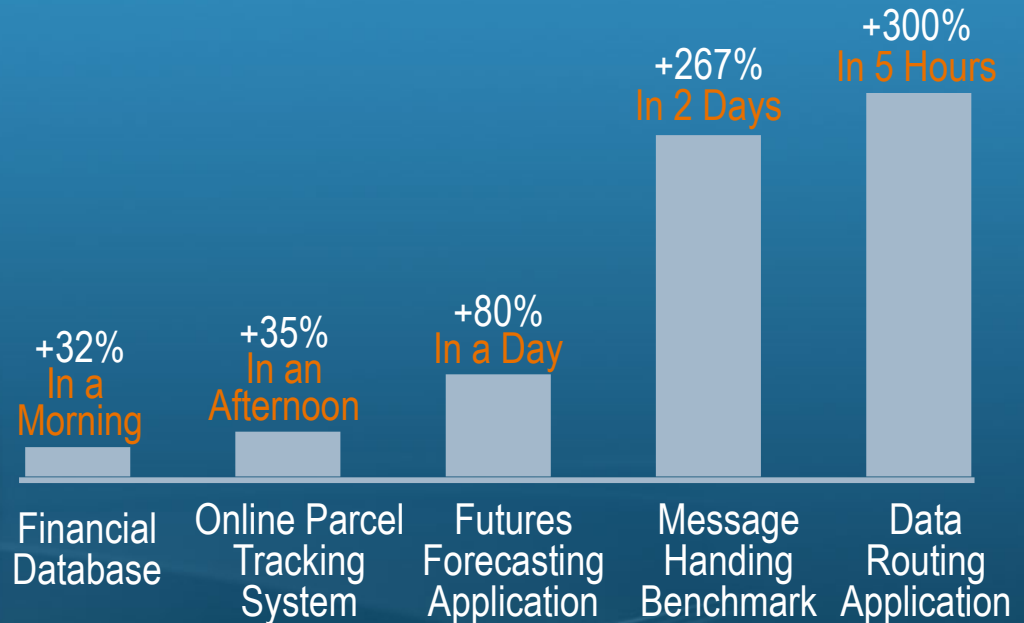 - FFT, Direct Sparse Solver, Interval BLAS routines

FREE

Solaris and OpenSolaris: DTrace

Increase Performance and Maximize Resource Utilization

- **End-to-end tracing of AJAX/Java/JavaScript Applications**
- **Monitor JVM internal state**
- **Diagnose C++ applications with Sun Studio 12 PlugIn**
- **Easy with NetBeans PlugIn**

	+32% In a Morning	+35% In an Afternoon	+80% In a Day	+267% In 2 Days	+300% In 5 Hours
	Financial Database	Online Parcel Tracking System	Futures Forecasting Application	Message Handing Benchmark	Data Routing Application

Optimize your Applications and your Systems

NetBeans- Download, Join, Succeed

- Download the IDE at netbeans.org
- Join the NetBeans community netbeans.org/community
- Subscribe to the NetBeans mailing lists
- Get news about Netbeans at netbeans.org/community/news
- Participate in the NetBeans Innovators Grants contest (deadline is March 3rd) http://www.netbeans.org/grant/
- Learn about and get the Grid Engine and OpenMPI plugins at opensolaris.org/os/project/hpc-stack/

The Open Storage Advantage
Open Source Software with Industry Standard Hardware

Empowers
Developers
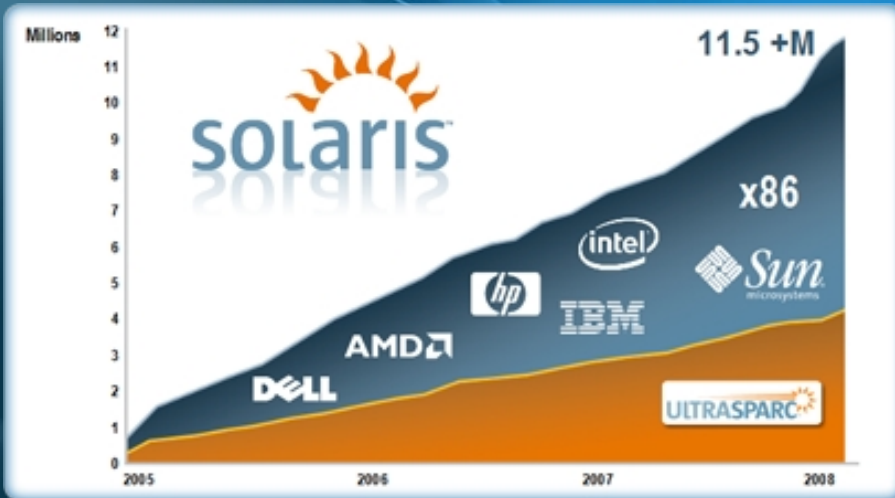to Create Storage Services Quickly Creating a Proliferation of Choice

Offers
Enterprise
Reliability and Scalability at
1/10th the Cost
of Closed, Proprietary Storage

The Open Storage Approach
Delivering Breakthrough Economics and Scalability

opensolaris

General Purpose Components

Storage Server

Network Attached Storage (NAS)

Archive

Virtualization

solaris

HPC Storage Requirements

Solutions must solve the compute and storage requirements

HPC Data Storage:

- Maximum aggregate at lowest possible costs

- Low latency, accessible by all compute nodes

- Scalable to multiple Petabytes

- Easy to install, deploy and administer

Long-term Retention & Archive:

- Deep repository for very large data multiple Petabytes

- User driven data recall from archive

- Scalable through to move data in and out of archive

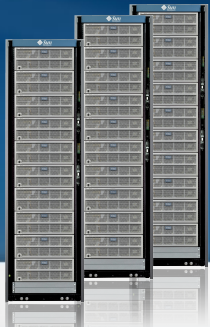- Simple to administer and deploy

Seamless Transfer

TACC Supercomputer Storage

HPC Storage Solutions

Compute Engine Data Cache

- Will scale to over
  - 72 GB/sec. sustained bandwidth
  - 1.728 Petabytes of raw capacity
    - Configuration includes
      - 72 SunFire x4500s
      - Over 3,000 500GB drives
      - 8 racks

Long-term Retention and Archive

- Will scale to over
  - 200 Petabytes of near-line
  - 3.1 Petabytes of on-line
- Configuration includes
  - 5 StorageTek SL8500s
  - 48 StorageTek T10000Bs
  - 10 StorageTek 6540s
  - 6 SunFire Metadata servers with SAM-QFS

Seamless Transfer

HPC Storage Solutions

High Bandwidth
Scalable Storage Cluster
with Lustre

Long-Term
Data Retention
with SAM-QFS

Compute Cluster

Metadata
Servers

Near Line Archive

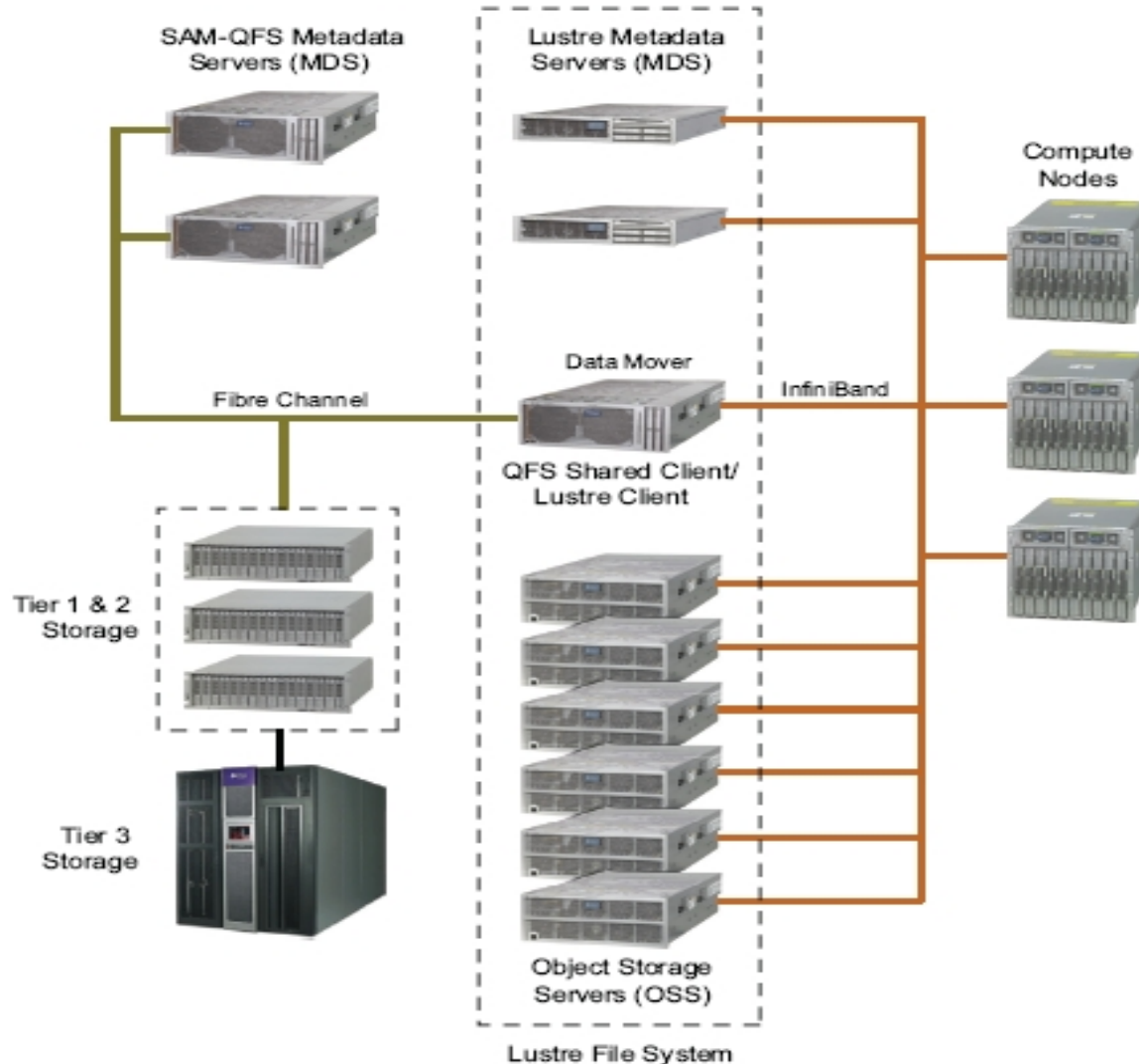IB Network

Load

SAN

Archive

Data Movers

Home Directories
Tier 1 Archive

Object Storage Farm

HPC Solution Lustre+QFS+SAM+4500

The combination of Lustre, QFS and SAM, and the Sun Fire X4500 create a truly unique and innovative storage solution that addresses the broadest range of HPC storage requirements in the industry.
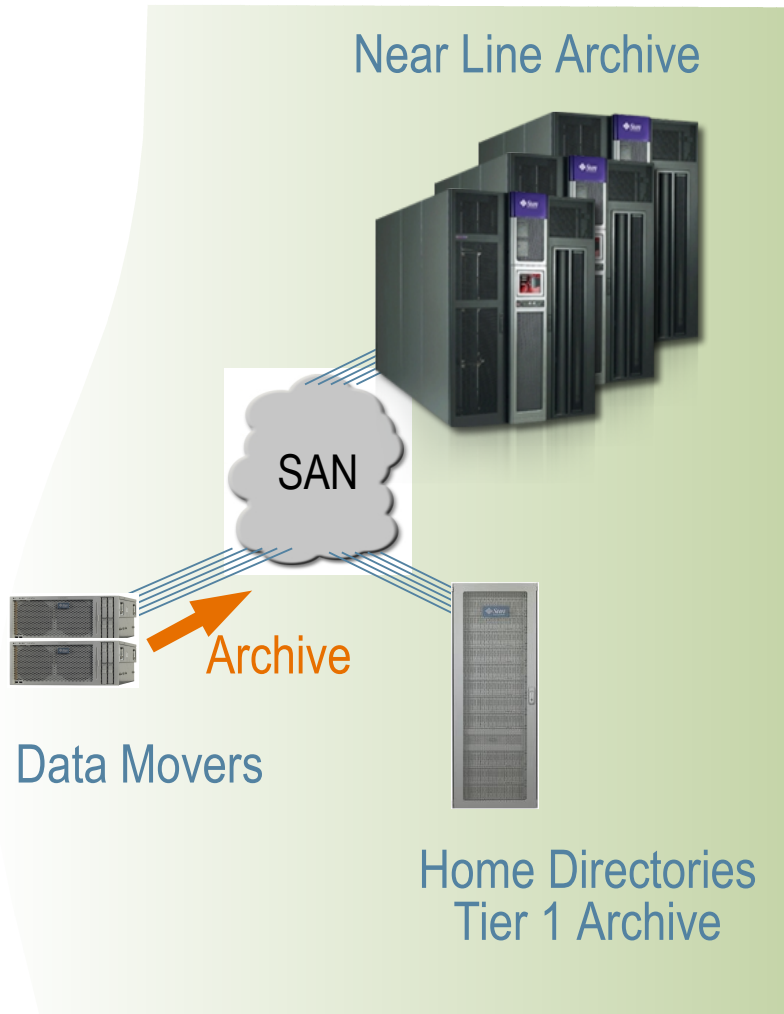
Scalable Storage Cluster
High Bandwidth Data Engine

Compute Cluster

Metadata Servers

IB Network

Load

Data Movers

Object Storage Farm
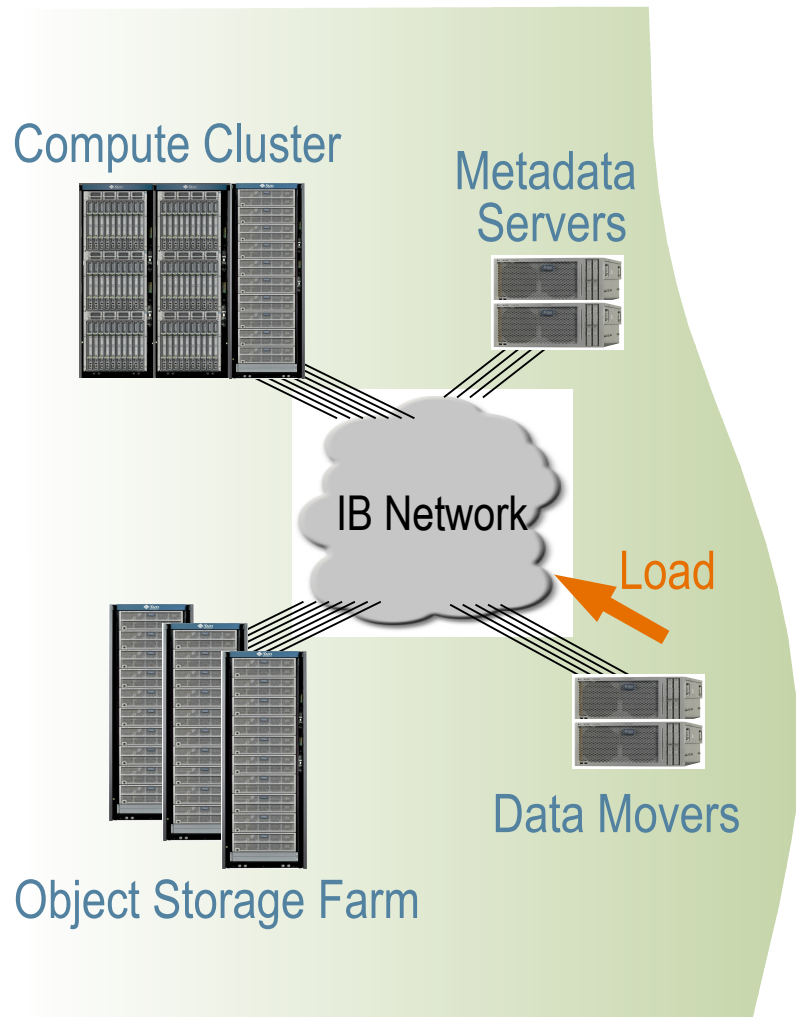
- Achieves extreme scale and aggregate bandwidth required by "Fusion" for a low price/performance

- Leverages both the **SunFire x4500 storage Servers & Lustre** - the defacto standard HPC parallel file system

- Built with industry standard open technologies Infiniband, open source software

- High speed, low-latency interconnects with simplified cabling via Magnum

- Ideal for HPC cache & temp. storage

- Pre-integrate systems – arrive at your site ready to run

Long-Term Retention & Archive
Staging, Storing & Maintaining HPC Data

Near Line Archive

SAN

Archive

Data Movers

Home Directories
Tier 1 Archive

- Provides a massive on-line/near-line repository to compliment the Scalable Storage Cluster

- Leverages Sun StorageTek Tape Libraries, Modular Arrays and **SAM-QFS**

- Policy driven engine to automate moving data sets in to and results out of the Object Storage Farm

- Enables Tape Libraries as a large near-line repository

- Stores data in open formats (TAR) allowing technology refresh and avoiding vendor lock-in

- Pre-integrate systems – arrive at your site ready to run

Sun Solution Advantages

- Lustre, QFS, SAM and ZFS are complimentary.

- X4500 advantages for price performance and density.

- SAM gives Sun automated policy based data migration for data retention.

- Sun has the best Tape Libraries and Tape drives for HPC.

- Sun now has experience delivering these solutions.

Driving Value with Communities and Open Solaris Storage Software

Opensolaris.org/os/storage

Over 3,000 current members!
- 90,000 for opensolaris
- 23 endorsed projects
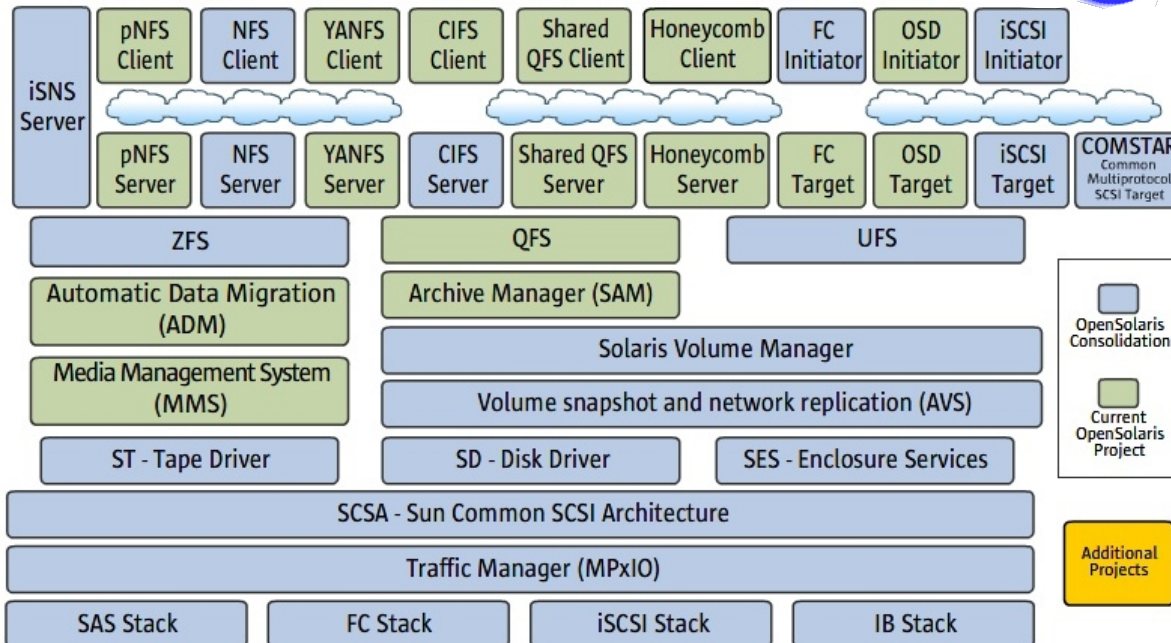
Participate in the Revolution

Get Informed!

- Watch community town hall, download white papers at www.sun.com/openstorage

- Contact your local Sun representative or authorized reseller

Get Involved!

- Join the OpenSolaris Storage Community: http://www.opensolaris.org/os/storage/

- Join the discussion: http://www.facebook.com/group.php?gid=12774638

Get Open!

- Try and Buy Sun products at: http://www.sun.com/tryandbuy

- Engage with Sun Services: www.sun.com/service/openstorage

End-to-End Virtualization Across the Infrastructure

Services

OS and Network Virtualization

solaris

Desktop Virtualization

solaris — Microsoft Windows

Sun xVM
Virtualization Platform

Storage Virtualization

solaris

Server Virtualization (Virtual Machines)

solaris — Microsoft Windows

Virtualization Partners
VMware
Citrix/Xen
Microsoft
Intel
AMD
IBM
Red Hat

Infrastructure Management
Sun xVM Ops Center

Sun's xVM Key Components

SUN xVM VIRTUALBOX	SUN xVM SERVER	SUN xVM OPS CENTER
• Datacenter automation • Physical and virtual resource management • Manage thousands of hardware and software entities	• Hypervisor family inherits scalability, availability, manageability, observability and security from Solaris • Consolidates Windows, Linux, and Solaris	• Developer desktop virtualization platform • Enables desktop or laptop PCs running Windows, Linux, Mac or Solaris to run multiple operating systems side-by-side • Ease of switching between platforms

Complete Virtualization and Management Solution

2008: Innotek Joined Sun

- Extending Sun's virtualization to the desktop
  - > Ideal for developers to setup multiple virtual machines to develop and test their multi-tier or cross-platforms applications; all on a single laptop or desktop
  - > Inherits scalability, availability, manageability, and observability from Solaris and OpenSolaris
- Expanding Innotek's capacity to deliver global service and support
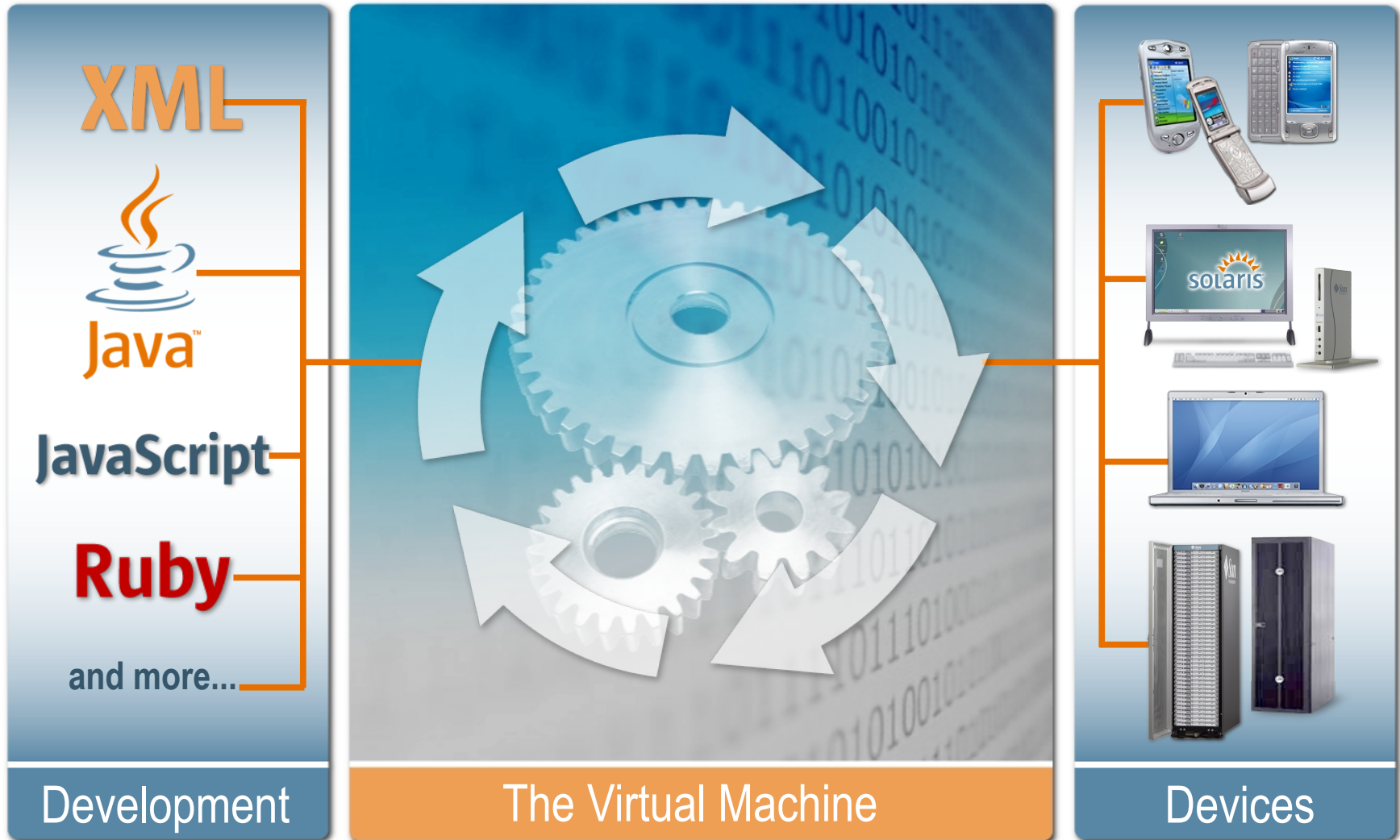
Open Source Desktop Virtualization

Virtual Box- Download, Join, Succeed

openxVM

- Check out openxvm.org

- Register to join: openxvm.dev.java.net

- Participate in hypervisor development at opensolaris.org

- Download VirtualBox at virtualbox.org/wiki/downloads

- Sign up for mailing lists at openxvm.dev.java.net

Java.net

The meta-community for Java Developers

*Source: Sun 2/08 – See website for latest stats

Home of OpenJDK, GlassFish, Mobile and Embedded, Java FX, and other large and small communities and projects

Over **400,000*** registered members, 15% have role(s) in projects

Over **4,500** Projects, 134 JUGs, 20 Communities

Community-building infrastructure

Java Champions, JUG Leaders, and other key Java™ leaders participate

Java Virtual Machine: Flexible, Scalable

Development

XML

Java

JavaScript

Ruby

and more...

The Virtual Machine

Devices

solaris

OpenJDK- Download, Join, Succeed

- Join the conversations at java.net
- Download the JDK at openjdk.java.net
- Join OpenJDK mailing list discussions at mail.openjdk.java.net
- Participate in the OpenJDK Community innovators challenge at openjdk.java.net/challenge
- Check out the Planet JDK blogs at planetjdk.org

Join the community building the World's Apps and Devices

GlassFish: Serving your Applications Faster

- 4 Million downloads since July 2006
  - > Double the downloads of JBoss on a weekly basis
- Dozens of external committers
- Over 7,000 members
- Glassfish(TM) v2 / Sun Application Server set world performance records SpecJAppServer
- Handle business-critical applications and the rigors of production environments

GlassFish- Download, Join, Succeed

- Download GlassFish:
  glassfish.dev.java.net

- Register and participate in the GlassFish community

- Enter GlassFish Awards Program
  http://wiki.glassfish.java.net/

- Subscribe to the GlassFish blog:
  http://blogs.sun.com/theaquarium/

Sun is Committed to Developer Communities

Building Open and Free Communities

Java	Solaris	SPARC

Building a Vibrant Ecosystem: Sun is the Largest Commercial Contributor to Open Source Communities

Community	Infrastructure	Ecosystem

The Sun Developer Network Community

Sun Developer Network – 3.1M Strong
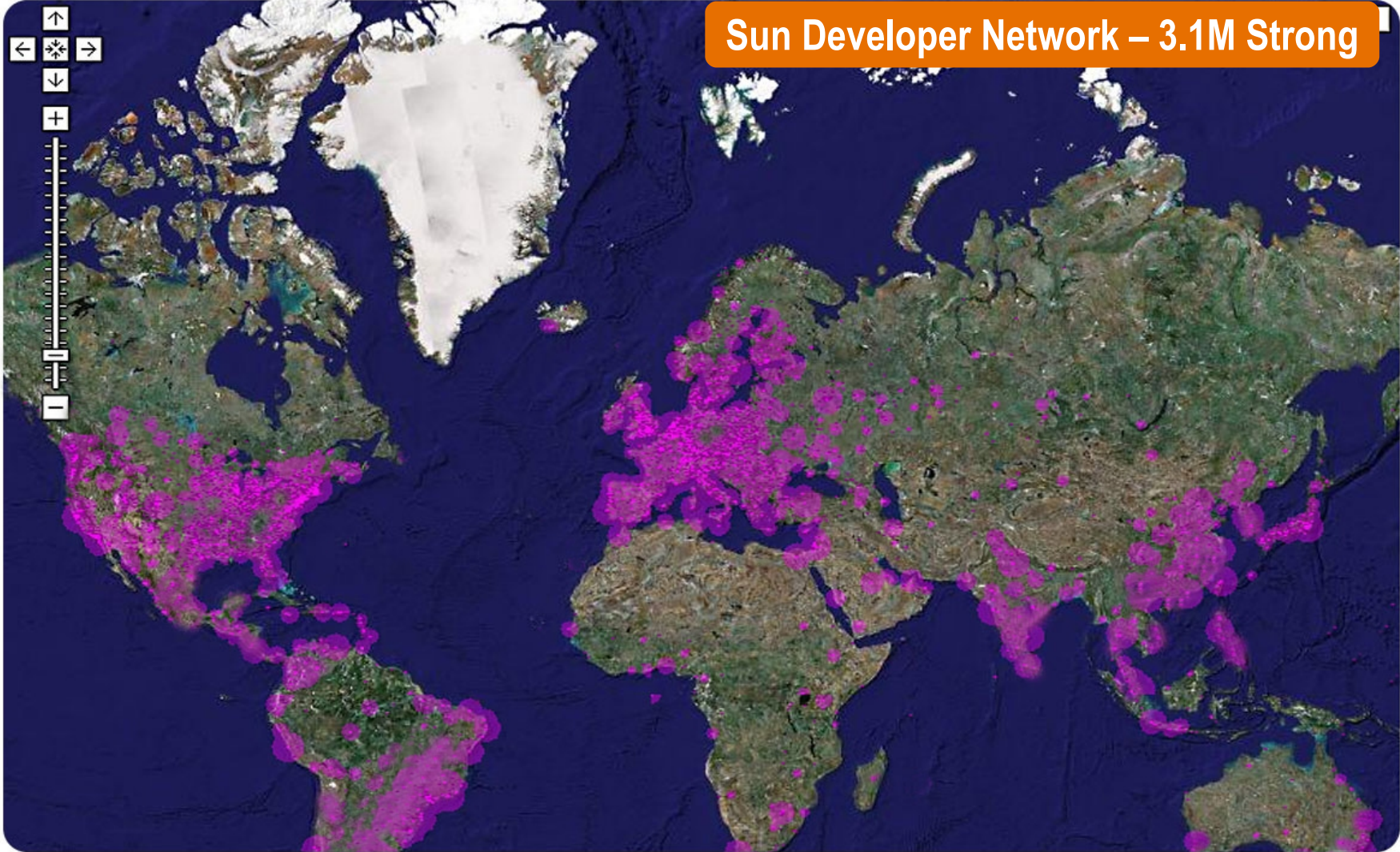
Data as of 1/08

Participate, Learn, Thrive

Make the Jump

- **Download** the Tools
- **Leverage** the Technologies
- **Join** SDN developers.sun.com
- **Participate** in the Open Source Communities
- **Build Innovative** Applications
- **Accelerate** Your Career

Thank You.

The Network is the Computer.™

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