Keeping Pace with Growing High Performance Computing Needs

SUSE® Linux Enterprise Server for High Performance Computing

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Challenges
Top HPC Challenges and Needs

**Increase Performance**
System performance needs to be increased amid IT budgets and staff reductions

**Control Infrastructure**
HPC is business-critical, but managed by a separate department with a scientific flavor

**Optimize Operations**
Need support and interoperability across the entire HPC stack, without dependencies on a single hardware vendor
Top HPC Market Challenges

- HPC market still developing
- Stack components provided by various vendors
- Applications need to be updated to leverage HPC
- Mix of small and big vendors
- Segmented into commercial and scientific
Market Evolution
Linux on 99.4% of the Top 500 Supercomputers

50% Linux in HPC

Half of the world’s 20 largest supercomputers run on SUSE
Growing HPC Adoption

Universities

Government

Academia & Research Institutions
Financial Services: Risk Analysis
Oil & Gas Exploration, Production
Semiconductor: Electronics
Design Automation
Life Sciences: Pharmaceutical & Biomedical
Manufacturing: Aerospace & Automotive

Departmental and workgroup compute clusters
“High Productivity Computing”

YESTERDAY
TODAY
TOMORROW

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Worldwide HPC Server Market (according to IDC)

- HPC still expected to be a strong growth market
  - Growing recognition of HPC’s strategic value is helping to drive high-end sales
  - Low-end buyers are back into a growth mode
- Recognition of HPC’s strategic and economic value will drive the exascale race
- The formative HPDA (High Performance Data Analysis) market will expand opportunities for vendors (plus machine learning, cognitive and IoT)

CAGR 2015-2019:
- 10.1% Supercomputer (> $500K)
- 0.7% Divisional ($250K-$500K)
- 9.5% Departmental ($100K-$250K)
- 8.7% Workgroup (< $100K)
Community
OpenHPC Open Source Community
openhpc.community

- Linux Foundation project – SUSE is a founding member (now 30+ full members)
- Provides common platform – standard HPC stack – for collaboration and innovation
- Provides full HPC stack (~300 packages) on top of SLES
- Build with SUSE build service: http://build.openhpc.community
- Simplifies installation, configuration, and maintenance of a custom software stack
OpenHPC Ecosystem

OEMs

Users

ISV-OSV

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Partnering with Intel

Intel distributes SUSE Linux Enterprise Server for High Performance Computing as part of the Intel HPC Orchestrator

SUSE is the commercial Linux supported by the Intel HPC stack

- Delivers a fully supported stack for HPC workloads
- Accelerates research/innovation and time to insight
- Aligns new optimized components driven by the broader openHPC.community
- Simplifies ongoing maintenance and support

https://www.suse.com/promo/intel-suse-hpc-stack
SUSE Joins Microsoft Enterprise Cloud Alliance and Test Drive Program

SUSE is the only supported enterprise Linux HPC workload on Microsoft Azure public cloud

- Cloud-based SLES, including automated updates, to enterprise customers using the Microsoft Azure cloud platform
- SLES for HPC is part of the Microsoft Azure Test Drive program, freely available via Azure Marketplace

https://www.suse.com/promo/cloud/public/azure
HPC in Practice
Highlights of High Performance Computing

SUSE
MULTI-CORE PROCESSOR SUPPORT
Intel, AMD, POWER, ARM

TECHNOLOGY
Kernel, Lustre, Ceph

COOPERATION
OpenHPC, Intel, IBM, SGI, HPE, Dell, Bull, NEC, Cray, Cisco, Fujitsu

HIGH PRODUCTIVITY COMPUTING
Total Oil & Gas

ACADEMIC AND RESEARCH
LRZ/SuperMUC, BSC/MareNostrum, Tokyo Institute of Technology/TSUBAME, Beijing Computing Center, NASA/Pleiades

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HPC Impacts Our Lives Through Space Research

Understanding how solar activity affects us on Earth

• Pleiades supercomputer simulations help explain NASA’s IRIS (Interface Region Imaging Spectrograph) solar observatory findings

• Combined with high-performance computer modeling, simulation, and analysis back on Earth, scientists hope to increase their understanding of solar dynamics

• Solar simulations through numerical modeling on Pleiades, located at the NASA Advanced Supercomputing (NAS) facility at Ames Research Center (runs SUSE Linux Enterprise)
HPC Impacts Our Lives With Better Preparation for Seismic Events

Understanding the effects of seismic activity

- Geophysicists use earthquake simulation software to investigate seismic waves beneath the Earth’s surface.
- Goal is to simulate earthquakes as accurately as possible to be better prepared for future events.
- Calculations involved in this kind of simulation are so complex that they push even supercomputers to their limits.
- Using SuperMUC, they simulated the vibrations inside the geometrically complex Merapi volcano on the island of Java.
HPC Impacts Our Lives Through Weather & Climate Forecasting

From saving lives to just planning the weekend

- National Center for Atmospheric Research (NCAR) has a new system – Cheyenne, running SUSE Linux – for advancing atmospheric and Earth science

- Helps scientists improve predictions of a range of phenomena, from hour-by-hour risks associated with thunderstorm outbreaks to the timing of the 11-year solar cycle and its potential impacts

- Cheyenne will be a critical tool for researchers studying climate change, severe weather, geomagnetic storms, seismic activity, air quality, wildfires, and other important geoscience topics
HPC Impacts Our Lives Through Oil and Gas Exploration

From getting around with our cars to just staying at home in front of a gas fireplace

- HPC accelerates oil and gas exploration with processing of seismic data and simulation of deposit fluids

- As new oil and gas reserves become more elusive, companies like Total rely increasingly on HPC to find opportunities in an ocean of seismic data.

- With SUSE Linux Enterprise Server, Total enjoys the optimal combination of performance, price and efficiency.
HPC Impacts Our Lives Through Media and Entertainment

*From action-packed cinematic special effects to games*

- **SUSE Linux Enterprise** runs on supercomputers in creating special effects in movies and video games
- All with demanding requirements for ultra-high computing for an amazing user and viewer experience
- Linux is the OS of choice for Hollywood animation and special effects departments, used in production of more than 30 blockbuster films

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HPC Impacts Our Lives Through Social Phenomena Analysis

*Used for numerous and varied purposes, from medicine to earthquake warnings, to social phenomenon analysis*

- TSUBAME touted as the “supercomputer for everyone”
- Even though its main work is research in academia, the door is also wide open for use by industry
- Predicting traffic congestion or share prices, simulating human organs, or forecasting the weather

“The excellent management that SUSE Linux Enterprise Server provides is one of the key factors behind Tsubame 2.5’s success.”
– Professor Satoshi Matsuoka, Global Scientific Information and Computing Center, Tokyo Institute of Technology
HPC Impacts Our Lives Through Medical Research

PSC’s game-changing supercomputer is being used to advance medical research

• Visualize data in a way that transforms understanding of public health issues

• Calculate the electronic structure of a large organic semiconductor molecule with applications in solar power cells

• Model the possible benefits of flu vaccine choice

• Genetic sequencing of various species

• Assemble 378 billion base pairs of bacterial DNA from the intestines of healthy patients and those with diabetes

“SUSE Linux Enterprise Server is the only distribution that supports the full capabilities of the SGI machine. It was a no-brainer for this application. We use it. We recommend it. SUSE has a newer kernel than other options, making it the best choice.”

– Jim Kasdorf, Director of Special Projects at PSC
Banking & Financial Services Rely on High Performance Computing

The ways in which research applications and financial services applications rely on Linux and HPC are in many cases quite similar

• Risk modeling in determining aggregate risk in financial portfolios
• Fraud detection in real time as millions of transactions are processed between disparate systems
  o Find suspicious patterns in related data sets
  o Create and deploy new fraud models into event flows quickly and with minimal effort
• High-frequency trading applications execute trades milliseconds before competitors – which can mean millions in additional returns
• Pricing and regulatory compliance applications
• Big data applications like customer profiling and predictive analytics

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Technical Update
The SUSE HPC Stack

• It’s SUSE Linux Enterprise Server

• New! Ceph File System supported

• New! Available as part of Intel HPC Orchestrator

• New! Microsoft Azure Test Drive includes SLES for HPC

• Recent developments:
  - ARM64 partnering with Cavium, ARM, and Applied Micro
  - Microsoft Azure w/SLES 12: RDMA and Infiniband
  - Latest hardware enablement (Intel, POWER)
The SUSE HPC Stack

SUSE Linux Enterprise Server

Hardware
The SUSE HPC Stack

Storage & File Systems
- EXT3
- BTRFS
- Ceph FS
- OCFS2
- pNFS
- IBRIX
- XFS
- pNFS
- GPFS
- NFS
- Lustre

Networking
- 10G
- OFED
- 40G
- TCP Offload

Message Passing Interface (MPI)
- MPICH
- ParTec
- openMPI
- HPE
- Intel
- SGI

SUSE Linux Enterprise Server

Hardware

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SUSE HPC Features, 1 of 2

Advanced I/O Processing

- Asynchronous I/O (AIO)
  Form of I/O processing that permits other processing to continue before the transmission has finished

- Modular I/O Scheduler
  Algorithm most suitable for workload can be chosen dynamically

- Multi-core/hyper-threading processor support
  Execute threads in parallel within each individual processor

- Intel I/O Acceleration
  Offloads the CPU towards the network card, thus allowing the system to continue processing data while I/O is taking place

Flexible/Pluggable I/O Scheduler

- CFQ
  Complete Fair Queuing, suitable for a wide variety of applications, default I/O scheduler

- Deadline I/O scheduler
  A valuable choice on a server with intelligent hardware, or if latency is the primary goal

- Anticipatory I/O scheduler
  Suitable for file servers but does not work as well for database workloads

- No-op
  Better suited for systems with storage solutions that have their own cache and their own virtualization

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SUSE HPC Features, 2 of 2

Performance and Management

• **Lustre-enabled kernel**
  Parallel distributed file system for large-scale cluster computing & optimal performance

• **CPU and system activity management**
  CPUset System, CPUset command line tool, Sysstat package, IRQbalance

• **Diagnose complex applications**
  SystemTap for diagnosing apps, LTTng 2.0, an open source tracing framework to help gain insights into system behavior

High-speed Data Transport

• **OpenFabrics Enterprise Distribution (OFED)**
  Remote Direct Memory Access (RDMA) switched fabric technologies – high-speed data transport technologies for server and storage connectivity

Non-Uniform Memory Architecture (NUMA)

• Computer memory design used in multiprocessors, where the memory access time depends on the memory location relative to a processor

• NUMA provides excellent scalability and performance for Intel Itanium and AMD Opteron architectures

• Auto-tuning available when apps aren't NUMA-aware

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SUSE Linux Enterprise Server for High Performance Computing

Harness the power of supercomputing and solve your most demanding computational and data-intensive problems.

- Accelerate innovation with a strong ecosystem of partners.
- Optimize scalability and performance with Linux clustering.
- Realize faster time to value through simplified configuration of HPC workloads.

50% Reduction in administration
20% Boost in productivity
99.999% Stable and reliable

www.suse.com/products/server/hpc.html

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Outlook
Outlook

• OpenHPC community contributions will continue
• Foster growing partner ecosystem
• Wider HPC adoption across many industries
• Increase in hybrid cloud deployments mixed with on-premise

• Coming Soon! HPC Module packaging
• Coming Soon! Support for Intel Omni-Path Architecture
High Performance Computing Ecosystem

- HPC partners leverage SLES
- Modularize HPC to focus on specific needs
- Partnering
  - OpenHPC community
  - ARM
  - Microsoft
- Intel’s enterprise HPC based on OpenHPC community & SLES

SLES is the foundation for HPC
Simplifying lives with a highly scalable, high performance open source operating system that harnesses the power of the supercomputer for your day-to-day business

Solving computational, data-intensive, or numerically-intensive tasks

Reducing the time and effort required to set up and maintain HPC clusters

Ensuring that all components of the HPC stack work together
Visit SUSE at SC16
Booth 4427!
Learn more at
www.suse.com/products/server/hpc.html

Questions?