Technical Case Story

University of São Paulo Launches Region's Biggest Cloud Computing Project with Intel Xeon Processors and NetApp

Another NetApp solution delivered by:

ABOUT THE CUSTOMER

The University of São Paulo (USP) is one of the largest institutions of higher education in Latin America, with approximately 105,000 enrolled students and eight campuses in the state of São Paulo. It is the largest Brazilian university and the country's most prestigious educational institution. SIR World Report 2013 from SCImago Institutions Rankings classified the university in 12th place in the world.

Abstract

In late 2012, the University of São Paulo began an initiative called Cloud USP to give teachers, students, and staff access to a dynamic IT infrastructure. Based on Citrix CloudPlatform, the private cloud runs on a FlexPod® architecture, which includes NetApp® storage systems powered by Intel® Xeon® processors as well as Cisco® Unified Computing System™ (Cisco UCS®) Blade Servers and Cisco Nexus® switches.

Cloud USP will eventually incorporate all the university's corporate systems and also provide a scalable computing platform for researchers, teachers, and students to conduct their work. Each user at the university can access a set of services through their USP ID and password. USP is the first university in Latin America to launch an institution-wide cloud computing system.

Business Context

Before moving services to the cloud, the university experienced challenges such as rising IT costs, lengthy delivery times for IT projects, and difficulty meeting performance, availability, and data security requirements. Maintaining 150 separate, distributed IT infrastructures, including approximately 100 separate e-mail systems organization wide, was no longer practical. Because IT resources were not centralized, it was not feasible to provide enterprise-class performance, reliable failover, and regular backup for all systems. The university was not able to leverage economies of scale to gain better pricing, and the average cost for a new IT project was BRL200,000 (US$85,100).

New systems and services took as long as one year to budget, approve, and deploy, making it difficult for departments to undertake new research and generate results. Today, USP is responsible for 30% of all scientific research published in Latin America. As a major research university, it competes with other top-tier educational institutions and must provide fast access to IT resources to be first to market with research findings.

The university wanted to consolidate services in the cloud for performance, availability, security, centralized data protection, and cost savings. The resulting initiative, called Cloud USP, is allowing the university to evolve to a secure cloud computing model at its own pace, gaining greater flexibility and efficiency without needing to replace its entire existing infrastructure.

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Cyrano Rizzo
Director of Vertical Data Center, University of São Paulo

Cloud USP services are divided into three areas:

- **Corporate.** E-mail services, payroll, human resources, management of fields of study and grades for students, issuing diplomas and certificates, and managing agreements and contracts. The services can be deployed on mobile devices and computer terminals (thin clients) at branch offices and campuses.
- **Educational.** Services focused on undergraduate, postgraduate, research, and extension education, including digital content management.
- **Scientific.** Services to enable activities related to scientific research, with an emphasis on mass storage (data instrumentation, collections of work, and so on) and computational-intensive processing. Cloud USP will allow for more flexible information gathering and faster time to science.

Says USP's Chancellor, Prof. Dr. João Grandino Rodas, "Cloud USP is part of a strategic decision regarding investment in various areas of the university. Regarding computing, our goal is to elevate our institution to be among the great universities of the world."

New Infrastructure: A Flexible Foundation for Learning

The Cloud USP solution was designed and implemented by the university's technical IT team, led by Luiz Natal Rossi, director of IT, and Cyrano Rizzo, director of Vertical Data Center, with integration assistance from Solve System. The university wanted the best technology available in the global market for cloud solutions, including storage, processing, and data management.

Compute Environment

Cloud USP is deployed across six data centers in a FlexPod environment, a solution bundle prepackaged and tested by Cisco and NetApp that includes Cisco UCS blade servers and Cisco Nexus switches, all of which are powered by Intel Xeon processors. All told, Cloud USP is comprised of 576 physical servers with a total of 10,752 Intel processing cores, 386,640 graphic processing cores, and 268TB of memory.

Citrix CloudPlatform powered by Apache CloudStack provides application-centric cloud orchestration for all Cloud USP workloads, including the university's Zimbra® e-mail platform, internally developed ERP and payment systems, Microsoft® SharePoint®, Sybase, unified communications, and Java® tools.

"The partnerships and integration between NetApp, Intel, Cisco, and Citrix give us a lot of confidence," says Rizzo. "Support has been excellent, although we haven't had to use it much. The FlexPod solution components are designed to complement each other, and they work together perfectly."

Storage

The university wanted a storage platform that would help it maintain security, accommodate growth, and provide 24/7 availability for Cloud USP data and services. It deployed 16 NetApp FAS6240 and 8 FAS3270 storage systems with Intel Xeon processors E5500 series with a mixture of SAS, SATA, and solid-state drives (SSDs) at six data centers. The university also deployed a NetApp MetroCluster™ configuration with two NetApp FAS3270 storage systems for synchronous replication between the six data centers on the main USP campus. The NetApp systems run the Data ONTAP® operating system, designed to enable the software-defined data center.

With current storage capacity at around 15PB, Cloud USP can support 1.5 million IOPS, providing the necessary storage I/O for performance-intensive applications. NetApp also provides multiprotocol support, allowing USP to use CIFS, NFS, Fibre Channel (FC), and Fibre Channel over Ethernet (FCoE) to meet varying workload requirements.

"NetApp stays on the leading edge of storage technology and offers efficiencies in a private cloud environment that other vendors can't provide or are just beginning to offer with unproven technology," says Rizzo.

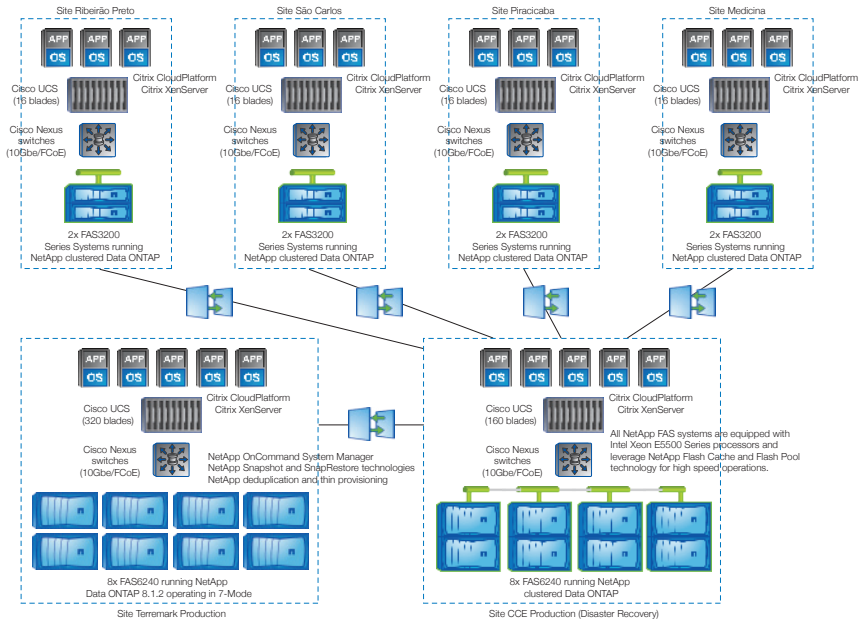

Figure 1) Cloud USP infrastructure.

Why NetApp and Intel?

USP's 10GbE network includes more than 2,000 network interface cards. Intel 10GbE Ethernet on the host is aligned with Intel 10GbE Ethernet on the storage, helping to optimize Ethernet performance. "All of the Cloud USP processing is handled by Intel processors," says Rizzo. "The environment has been very stable, and we haven't had any issues with compatibility."

NetApp and Intel together deliver enterprise-class high availability in the NetApp storage platform. Intel has integrated advanced storage features into the chip, providing data protection (AES-NI data encryption) and high availability (memory parity, ADR) without sacrificing performance, as well as nontransparent bridging. NetApp RAID-DP® protects against double disk failures, while the Intel Xeon processor integrates a hardware RAID engine that offloads the RAID calculations from the processor.

Optimizing Performance and Costs with NetApp Virtual Storage Tier

NetApp storage controllers supporting Cloud USP have 1TB and 512GB NetApp Flash Cache™ PCIe cards installed, speeding data access through intelligent caching of recently read user data and NetApp metadata. Flash Cache is effective at reducing latency and improving I/O performance for random read-intensive workloads such as virtual server environments. Using Flash Cache in conjunction with high-capacity SATA drives improves storage efficiency by 60% and reduces USP's IT costs by BRL67,500,000 (US$28,700,000).

The university also uses NetApp Flash Pool™ technology to automate storage tiering between RAID-protected SSD and HDD at the aggregate level. Flash Pool accelerates write-intensive workloads (with the availability of overwrite caching) and is enabled for specific datasets, while Flash Cache provides systemwide acceleration. When deployed on the same storage system, caching for specific data volumes is performed by one or the other technology.

"The combination of NetApp Flash Cache and Flash Pool makes it seem like all of our storage is SSD, even though it is not," says Rizzo.

Centralized Data Protection and Disaster Recovery

Data within Cloud USP is protected with NetApp Snapshot™ copies, which provide near instantaneous, low-overhead data protection, with fast restores enabled by NetApp SnapRestore® technology. More than 6,400 Snapshot copies are taken each day, allowing IT staff to easily restore lost or corrupted data from a recent point in time. NetApp SnapMirror® software replicates compressed data between the six Cloud USP data centers, while built-in high availability and data encryption features in the Intel Xeon processors provide added data protection without sacrificing performance.

"NetApp and Intel give us a variety of useful options for protecting our data," says Rizzo. "We were able to improve our backup service levels without investing in more infrastructure."

Efficient Storage, Simplified Management

To maximize storage efficiency and utilization for Cloud USP, the university uses NetApp deduplication and thin provisioning, supported by Intel Xeon processors. By eliminating redundant data blocks, NetApp deduplication reduces Cloud USP storage requirements, while NetApp thin provisioning increases capacity utilization and reduces administrative, hardware, power, and cooling costs.

SUPPORTING 24/7 CLOUD SERVICES WITH NETAPP AND INTEL

NetApp and Intel together provide enterprise-class high availability in the NetApp FAS6240 storage platform:

- The NetApp FAS6240 includes high-availability features such as Alternate Control Path and persistent NVRAM write logs.
- NetApp FAS6240 service processor diagnostics proactively monitor the system to help maintain system health and high availability.
- NetApp RAID-DP protects against double disk failures.
- The Intel Xeon processor within the NetApp FAS6240 storage solution offers high-availability features such as nontransparent bridging (NTB), which connects storage systems over PCI Express and allows data sharing over the NTB link so one system can operate in the event of a failure of the other system.
- The Intel Xeon processor integrates a hardware RAID engine that offloads the RAID calculations from the processor.
- Asynchronous DRAM Self-Refresh (ADR) in the Intel Xeon processor automatically flushes memory controller buffers into system memory and places the memory into self-refresh mode in the event of a power failure.

"Because of deduplication, we buy 90% less storage for our virtual server volumes and 30% less for our data volumes," says Rizzo. "And we are achieving an overallocation ratio of six to one for Cloud USP with thin provisioning."

The energy-efficient performance and multicore architecture of the Intel Xeon processors provide the compute power required for deduplication, compression, thin provisioning, and other compute-intensive storage processes, without increasing the watts needed to run these high-performance systems.

OnCommand® System Manager reduces administrative overhead for Cloud USP by delivering comprehensive monitoring and management, allowing the IT staff to track storage performance metrics and utilization statistics.

Current Use Cases

Supported by a reliable, high-performance storage infrastructure, USP is better positioned to improve its already high standing among leading universities worldwide. The main benefits include savings from centralized purchasing of equipment, maintenance costs, and allocation of computational resources, as well as address sustainability issues such as obsolescence of equipment, power consumption, security, and digital assets.

"Our total capital investment in Cloud USP was less than one year of our previous annual IT expenditures," says Rizzo. "Our FlexPod solution generated 100% payback in the first year of deployment. Our FlexPod and Citrix infrastructure represents a strategic investment that will keep generating value for years to come."

The Cloud USP infrastructure enables/supports:

- **Cost savings of at least BRL200,000 per IT project.** "It's much less expensive for us to provide services in the cloud because we don't need to provide a separate infrastructure for each project," says Rizzo.
- **Reduced data center energy consumption.** "The energy efficiency of NetApp storage and Intel processors is helping us be better stewards of the environment while saving money at the same time," says Rizzo.
- **Centralized management for data protection, security, antivirus, software upgrades, and license compliance.** "Cloud USP gives us a platform to consolidate all the university's computational systems within a structured, organized infrastructure," says Rizzo.
- **Improved performance, availability, and security.** "Our users notice and appreciate the performance and stability of Cloud USP," says Rizzo. "We're offering higher quality services. Previously, we were not able to provide redundancy for applications, and any failure made them unavailable."
- **Enhanced collaboration and file sharing with academic "briefcase," integrated calendars, and task lists.** Faculty can easily book rooms, reserve audiovisual equipment, and access resource schedules. Periodic activities such as staff or department council meetings can be entered and updated and automatically appear on the calendars of the faculty, staff, and students involved. Teachers can share files with students without the use of e-mail attachments.

COST SAVINGS FROM NETAPP AND INTEL EFFICIENCY

CAPABILITY	STORAGE SPACE SAVINGS	ESTIMATED COST SAVINGS
NetApp deduplication supported by Intel Xeon processor	Up to 90%	BRL11,250,000 (US$4,800,000)
NetApp thin provisioning supported by Intel Xeon processor	Overallocation ratio of 6:1	BRL22,500,000 (US$9,590,000)

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- **E-mail access from any device, with full search capabilities.** The Cloud USP Zimbra e-mail service offers tenfold greater mailbox sizes and includes modern antispam tools, user customization, and backup and recovery mechanisms.
- **Digital IPTV channel to share and stream lectures and other content in real time.** "We can broadcast to anywhere in the world with an Internet connection, which will help the university offer more online classes and distance learning alternatives," says Rizzo.
- **Easy access to social networks and file preview utilities.** "We're saving time for users, because they don't have to switch between tools to view content," says Rizzo.
- **Virtual servers and storage on demand, enabling timely deployment of new services.** "Instead of asking departments and faculty to wait up to a year for deployment, we can give them the resources they need right away," says Rizzo.

Although USP does not charge a fee for internal use of Cloud USP services, it plans to leverage the infrastructure to securely provide cloud services to outside organizations as a new source of revenue.

Next Steps

Looking ahead, the university will continue to leverage NetApp and Intel technology to scale to meet the needs of thousands more Cloud USP users. "Within a year, 99% of university systems will be operating within Cloud USP," says Rizzo.

To provide even greater scalability and availability for Cloud USP, the university is migrating to the NetApp clustered Data ONTAP 8.2 operating system, which will provide a unified cluster architecture that can scale to thousands of volumes. USP plans to create storage virtual machines within clustered Data ONTAP to complement the multi-tenancy capabilities of Citrix CloudPlatform, giving end users maximum control over their individual environments within Cloud USP.

"The capabilities of NetApp clustered Data ONTAP leave us speechless," says Rizzo. "We will be able to service and upgrade our storage without downtime and move workloads around on the fly to optimize capacity and performance. It's a wonderful enabling technology for cloud environments."

Best Practices

The following are best practices we have learned from implementing NetApp storage with Intel processors to support Cloud USP:

- Make use of NetApp Snapshot, SnapRestore, and SnapMirror technologies to automate and simplify data protection and disaster recovery.
- Use deduplication to conserve capacity and improve storage efficiency. The Intel processors in the NetApp storage systems provide the CPU performance needed to support deduplication.
- Try using flash storage technologies to overcome I/O bottlenecks and deliver the necessary IOPS while keeping your storage footprint as small as possible.
- Take full advantage of NetApp storage efficiency technologies. For future test and development efforts, we will use NetApp FlexClone® data provisioning—thin clones—to reduce costs and speed time to market. We're also investigating using the NetApp Snap Creator™ Framework to standardize backup and DR for our diverse database environment.

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For More Information

Learn more about the University of São Paulo:
www5.usp.br

Learn about NetApp solutions for education:
www.netapp.com/us/solutions/industry/education.aspx

Read about Intel Architecture's place in the scale-out storage world:
www.intel.com/content/www/us/en/storage/scale-out-storage-esg-paper.html

About NetApp

NetApp creates innovative storage and data management solutions that deliver outstanding cost efficiency and accelerate business breakthroughs. Discover our passion for helping companies around the world go further, faster at *www.netapp.com*.

SOLUTION COMPONENTS

FlexPod Components
NetApp FAS6240 and FAS3270 storage systems with Intel Xeon processors E5500 series

Cisco Unified Computing System with Cisco UCS blade servers

Cisco Nexus switches

Virtualization Components
Citrix CloudPlatform powered by Apache CloudStack

NetApp Software
NetApp Data ONTAP 8.1.2 operating in 7-Mode

NetApp MetroCluster

NetApp OnCommand System Manager

NetApp Flash Cache

NetApp Flash Pool

NetApp Virtual Storage Tier

NetApp deduplication

NetApp Snapshot and SnapRestore technology

NetApp SnapMirror replication technology

NetApp thin provisioning

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