

**SAP University Competence Center
at Technical University of Munich:
Next-generation IBM infrastructure
sharpens students' SAP skills for
Digital Transformation**





“We have been partners with IBM for many years and have had great success with previous generations of IBM Power Systems solutions. We knew from prior experience that IBM Power Systems provide an incredibly stable platform that we can rely on.”

Dr. Harald Kienegger

Post-Doctoral Researcher at the Chair for Information Systems

Technical University of Munich (TUM)

“Through our SAP S/4HANA Cloud using an SAP HANA TDI infrastructure based on IBM Power Systems, we are able to equip students with the latest tools and skills to drive the Internet of Things and Digital Transformation in the business world.”

Helmut Krcmar

Professor of Information Systems and
Academic Director of the UCC

Technical University of Munich (TUM)



SAP University Competence Center at Technical University of Munich: Next-generation IBM infrastructure sharpens students' SAP skills for Digital Transformation

About this paper

This paper describes how the SAP University Competence Center (UCC) at Technical University of Munich (TUM) uses IBM infrastructure and automation technology to provide scalable, reliable and cost-efficient cloud services to its 247 customers in the SAP University Alliance program. SAP UCC at TUM provides cutting-edge business applications including the SAP S/4HANA suite to 1,750 lecturers and 52,000 students worldwide. To achieve this, SAP UCC uses the latest IBM POWER8 servers, high-performance IBM XIV storage systems, IBM PowerVM virtualization in combination with the IBM PowerVC Virtualization Center cloud management solution, a combination of IBM DB2 and SAP HANA databases, and the IBM AIX and SUSE Linux Enterprise Server operating systems.

Customer Objectives

- *Use the available resources as efficiently as possible to provide sophisticated services with low operating costs at an attractive price.*
- *Support traditional SAP Business Suite, SAP ERP, SAP Business Warehouse applications, SAP HANA databases and the SAP S/4HANA business application.*
- *Gain trust of peers with an SAP-certified, future-proof and scalable solution that supports a wide range of workloads – from one-off, short-lived environments to permanent solutions supporting large courses with hundreds or even thousands of students simultaneously.*
- *Enable the SAP UCC at TUM to provide reliable cloud services without a large team of system administrators.*
- *Ensure high availability and redundancy across all components.*
- *Increase productivity within the team.*

IBM and SAP Solution

- *IBM® Power® System E870, IBM Power System S822*
- *IBM XIV®*
- *IBM PowerVM®, IBM AIX®*
- *IBM PowerVC Virtualization Center*
- *IBM DB2® for Linux, UNIX and Windows*
- *IBM Spectrum Protect™ (formerly Tivoli Storage Manager)*
- *IBM Tivoli® Monitoring*
- *IBM Connections™ Cloud*
- *SAP Solutions:*
 - *SAP BusinessObjects Business Intelligence*
 - *SAP Business Suite*
 - *SAP Business Warehouse*
 - *SAP ERP*
 - *SAP Extended Warehouse Management*
 - *SAP Fiori*
 - *SAP for Healthcare*
 - *SAP for Banking*
 - *SAP S/4HANA*
 - *SAP HANA*
 - *SAP Manufacturing Execution*
 - *SAP Manufacturing Integration and Intelligence (SAP MII)*
 - *SAP Mobile Platform*
 - *SAP Solution Manager*
- *SUSE Linux Enterprise Server for SAP Applications*
- *Red Hat Enterprise Linux*



Technische Universität München

Customer Benefits

- Reduced provisioning time by **80 percent** to just 30 minutes for systems running on SUSE Linux Enterprise Server for SAP Applications.
- Able to support SAP ERP environments with around **60 percent** less IBM POWER8 processor allocation compared to previous CPU generations.
- Cut storage latency substantially with a reduction of up to **75 percent**.
- IBM POWER8 provides **4x faster** memory bandwidth compared to other architectures allowing SAP UCC at TUM to run more SAP HANA instances per processor core without compromising memory performance.
- With Active Memory Expansion **factors of up to 1.8**, SAP UCC at TUM can almost double the memory capacity for some of its SAP ERP instances.
- Achieved **99.99 percent** system availability with its new infrastructure.
- Measured the read throughput of the IBM XIV Storage System and found that the new solution was **up to 500 percent** than the previous generation.
- Tested the write throughput of the IBM XIV Storage System and identified performance improvements of **up to 600 percent**.
- Maintained price stability with no need to increase cloud service fees over ten years.
- Ensures automated data protection for SAP ERP and SAP HANA environments with a single toolset.
- Meets 'on demand' requests from lecturers and students to provide reliable, scalable cloud services.
- Provides highest levels of reliability, scalability and performance for a growing portfolio of business applications.
- Supports granular and dynamic workload management for best performance and resource utilization across many logical partitions.
- Homogenous SAP HANA environment using tailored datacenter integration is much easier to manage and blends seamlessly into the overall system landscape.
- SAP Certified in Cloud Services, SAP Certified in Hosting Services and SAP Certified in SAP HANA Operations Services.
- Supports the ERPsim solution for hundreds of students simultaneously.
- Smart mix of IBM DB2 and SAP HANA databases optimizes demand for physical memory and keeps resource utilization at a very high level.
- IBM DB2 data compression reduces database sizes by **50 percent** and the highly efficient data compression of IBM DB2 with BLU Acceleration even achieves savings of **nearly 70 percent**.
- Students learn more quickly how they can use the applications and have more fun interacting with the software.
- Enables more-dynamic data analytics that can lead to new insights that were previously not easily available or possible.
- Paves the way for real-time analytics and supports new, high-speed business models.
- Encourages top executives to interact with business data directly in the central applications.
- Migration from IBM POWER7 to IBM POWER8 without any downtime.
- Allows SAP UCC at TUM to run a flexible, cost-efficient on-premises cloud platform for OpenStack.

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Background, starting point and objectives

About SAP University Competence Center at Technical University of Munich

Technical University of Munich (TUM) is one of the world's leading technical universities, combining top-class facilities for cutting-edge research with unique learning opportunities for more than 39,000 students. TUM offers 165 degree courses, encompassing medicine, engineering, natural and life sciences, business studies, and education.

TUM is a member of the SAP University Alliance program. Its Chair for Information Systems within the Department of Informatics operates an SAP University Competence Center (UCC) and acts as an educational service provider. The SAP UCC at TUM offers cloud services and educational resources and services to 1,750 lecturers and more than 52,000 students at 247 educational institutions in the SAP University Alliance community worldwide.

The SAP UCC at TUM predominantly serves higher education institutions in the EMEA region, and is increasingly working with vocational schools to equip pupils with the software skills they will need in the world of work.

As the world's first SAP UCC to support the SAP S/4HANA suite, the SAP UCC at TUM plays a leading role in the SAP University Alliance community. The SAP UCC at TUM helps other institutions to discover the innovative features of the next-generation ERP application hands-on, providing one-on-one training to lecturers, and running learning systems for courses across the globe.

Business challenges and project objectives

Succeeding in the education sector

As a service provider in the education sector, the SAP UCC at TUM is exposed to cost pressures from all sides. Its customers often have to cope with shrinking education budgets and, internally, the team needs to keep down the cost of operations to avoid overstretching its finances.

To achieve its goal of providing reliable cloud services to a wide range of institutions, the SAP UCC at TUM had to implement a truly future-proof and scalable solution that would support a wide range of workloads – from short-lived one-off introductions for lecturers to large courses with simulated business transactions running for hundreds or even thousands of students simultaneously.

Dr. Harald Kienegger, Post-Doctoral Researcher at the Chair for Information Systems at TUM, adds: "As education and research partner for SAP applications, we really needed gain the trust of our peers in order to be successful with our cloud offering. Our customers have to be confident that we can deliver a reliable service at any time for any number of students. To gain and maintain this trust, certification from SAP was essential for us to prove to everyone that we can provide mission-critical services."

Delivering a world-class cloud service

The SAP UCC at TUM quickly realized that it needed a solid, scalable foundation for its cloud solutions. As a service provider, maintaining the infrastructure and using the available resources as efficiently as possible is crucial to offering sophisticated services at an attractive price.

To ensure it could maintain the world-class quality of its services, it was imperative for the SAP UCC at TUM to renew its status as SAP Certified in Hosting Services and SAP Certified in SAP HANA Operations Services. Making sure the new solution met the high demands of the certification process would help to further boost customer confidence and strengthen the position of the SAP UCC at TUM within the community.

The general move away from traditional ERP system towards next-generation ERP solutions with real-time analytics supported by in-memory databases has increased the technical requirements for the center's infrastructure. Maximilian Barnert, PhD candidate at TUM, explains: "We knew that we needed a future-proof solution that we can extend as the number of users grows and the demands of innovative new applications rise. Lacking a big budget, our focus was on finding a cost-efficient and flexible infrastructure that would enable us to provide automated cloud services without a large team of system administrators."

For best resource utilization and to benefit from economies of scale, the team identified virtualization and automation as the keys to success. High availability and redundancy across all components were important to ensuring customers that the SAP UCC at TUM would be able to deliver the services they needed for their courses and students.

Dominik Paluch, PhD candidate at TUM, summarizes: "Having worked with IBM for six years, we have built great trust in both the technology and our partnership. Our experience taught us that we can rely on the IBM systems and support. To communicate this trust to our customers, we decided to get our SAP HANA Tailored Data Center Integration certified by SAP."

Initial IT environment

The SAP UCC at TUM started working with IBM when it deployed IBM® POWER7® servers for its SAP cloud services around 2010. The team started with two IBM Power® 750 Express servers in combination with two IBM BladeCenter® H systems equipped with six IBM POWER7 blade servers in total and IBM XIV® Storage System solutions.

The organization took advantage of IBM PowerVM®, an advanced virtualization technology, and operated its SAP application landscapes in logical partitions running the IBM AIX® operating system supported by IBM DB2® for Linux, UNIX and Windows databases.

At the time, when the team migrated from SAP MaxDB to IBM DB2, SAP UCC at TUM saw database volumes shrink by up to 40 percent - despite moving to Unicode, which usually increases data volumes substantially.

The SAP UCC at TUM relied on IBM Tivoli® Monitoring to oversee its infrastructure and ensure round-the-clock availability.

Adrian Streitz, PhD candidate at TUM, recalls: "After moving from a different server platform, we were very satisfied with the performance, ease of administration and support of the IBM POWER solution together with the reliable IBM XIV Storage System, which did not require any performance tuning or complex storage management."

Technical solution

Upgrading its IT infrastructure, SAP UCC at TUM deployed new IBM Power System E870 and IBM Power System S822 servers with IBM POWER8 processors.

The SAP UCC at TUM continues to use IBM PowerVM Enterprise Edition virtualization in combination with the IBM AIX and the SUSE Linux Enterprise Server operating systems to run a wide selection of SAP software together with IBM DB2 databases.

For data storage, SAP UCC at TUM today relies on the latest generation of the IBM XIV Storage System. The high-end, grid-scale disk storage system provides the performance needed to offer scalable cloud services.

Application landscape

SAP standard software for learning

The SAP UCC at TUM operates approximately 140 SAP systems with 108 IBM DB2 databases and a total data volume of 25 TB for its customers. Depending on the individual requirements and budgets, the team either runs dedicated instances for specific institutions and courses or provides access to shared, more cost-efficient multi-tenant systems as an alternative.

The majority of its customers use the traditional SAP ERP application and SAP Business Warehouse for their courses. However, some customers also request industry-specific software such as the SAP for Healthcare or the SAP for Banking solutions.

In addition, the SAP UCC at TUM can provide custom configurations for a special learning experience if requested. For example, the team had already implemented the SAP Extended Warehouse Management and SAP Manufacturing Execution applications specifically to support certain customers' learning goals.

Today, the on-going digitization of manufacturing processes supported by the Industrial Internet of Things (IIoT) is creating

growing demand for the SAP Manufacturing Integration and Intelligence (SAP MII) application.

Dr. Harald Kienegger comments: "We provide a wide range of SAP solutions to cover many different learning situations. We are especially excited about demonstrating digital reinvention efforts driven by the Internet of Things with applications such as SAP Manufacturing Integration and Intelligence. These tools help businesses to connect their equipment, people, and operations to their extended supply chain. As a result, they can run their businesses in real-time with tightly integrated manufacturing processes."

Hands-on experience with next-generation tools

The SAP UCC at TUM also offers the next-generation SAP S/4HANA Cloud suite powered by SAP HANA – the first SAP UCC in the world to do so. The innovative new software is designed with the role-based, responsive user experience of SAP Fiori and makes business applications seamlessly accessible across desktop and mobile devices. A pioneer in this space, the SAP UCC at TUM provides the SAP University Alliance program's global community with cloud services for conferences and with hands-on training for lecturers and students.

With current and future requirements firmly in sight, the SAP UCC at TUM also hosts SAP Mobile Platform, enabling lecturers and students to learn more about mobile business applications, empowering them to build and deploy mobile apps that keep staff connected and support the digital reinvention within businesses.

Building further on the in-memory database SAP HANA, the SAP UCC at TUM also provides its customers with the advanced analytics capabilities of SAP Business Warehouse in combination with solutions from the SAP BusinessObjects Analytics portfolio, such as the SAP BusinessObjects Business Intelligence suite.

Dr. Harald Kienegger summarizes: “We offer a very comprehensive ‘education-as-a-service’ around SAP applications – from hosting to training. Our cloud services cover next-generation SAP software like SAP HANA platform and SAP S/4HANA to give lecturers and students real experience of the business applications of the future – knowledge and skills that will be valuable when students will get their first jobs.”

Revolutionizing education with serious games

As the exclusive partner in the EMEA region for ERPsim, a groundbreaking simulation game, the SAP UCC at TUM takes another leading role in the community. To equip learners with essential skillsets, the dynamic learning platform, ERPsim, provides a risk-free environment to explore and analyze realistic business data.

Dr. Harald Kienegger elaborates: “We are seeing growing interest in ERPsim from our customers. As a cloud service provider, this means that more transactions are processed on our systems and that we need to support more parallel workloads, leading to higher performance requirements. As a result, we need all the flexibility we can get to use our resources as efficiently as possible to ensure a smooth ERPsim experience for the best, most realistic ERP training.

“With our new infrastructure in place, we want to make the simulation game ready for the next-generation SAP S/4HANA suite and take the prospect of digital reinvention and the emerging Internet of Things technology into account. Our goal is to create more complex scenarios that include big data analytics to demonstrate the power of in-memory solutions running on our IBM POWER infrastructure.”

Efficient service management and collaboration

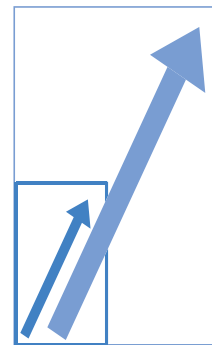
The team at the SAP UCC at TUM has also transformed internal processes by embracing IBM Tivoli Monitoring and SAP Solution Manager, streamlining and simplifying application monitoring and support. Users can now report incidents directly from within the

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Dr. Harald Kienegger

Post-Doctoral Researcher at the Chair for Information Systems

Technical University of Munich (TUM)



4x faster memory bandwidth
compared to other architectures

SAP ERP application, making it much easier to flag up issues or request support when needed. Furthermore, relevant system data is captured automatically. Support requests can then be categorized and automatically and flexibly assigned to the relevant people at the help desk.

Adrian Streitz says: “With IBM Tivoli Monitoring and SAP Solution Manager, we have significantly improved our incident management capabilities. With just a few minor customizations, we were able to adapt the standard solution to our specific requirements. Users now benefit from a quick and easy way to get in touch with us. We at the help desk have a complete solution with the Integrated Customer Solution Database, where we can rapidly search for solutions to common problems and build up a strong internal knowledge base to ensure the swift resolution of recurring problems.”

Thanks to SAP Solution Manager, the team can also easily forward messages to the SAP Support back-office if the help desk at the SAP UCC at TUM cannot solve the problem internally. Remote support integration enables application sharing between users, help desk staff, and SAP Support back-office experts. Reporting features help the SAP UCC at TUM to assess service quality and ensure customer satisfaction.

To increase productivity within the team, the SAP UCC at TUM consolidated all of its documentation onto a single platform. Dr. Harald Kienegger comments: “To facilitate knowledge-sharing within our team and have all relevant information at one place, we moved four different wiki systems onto the IBM Connections Cloud – that way, we no longer need to manage and maintain four separate systems. Instead, we can focus our services and have a single resource for all relevant documentation. This helps to ensure smooth internal processes and improve the quality of our cloud services.”

Migration project

Server and storage migration

The SAP UCC at TUM was eager to take advantage of the latest IBM POWER technology and decided to migrate its servers from IBM POWER7 to IBM POWER8®. Dominik Paluch explains: “Our data center is also a research lab so naturally we always want to get our hands on the most advanced technologies to evaluate what benefits they actually bring and how those improvements affect data center operations.”

Dr. Harald Kienegger says: “We have been partners with IBM for many years and have had great success with previous generations of IBM Power Systems solutions. We knew from prior experience that IBM Power Systems provide an incredibly stable platform that we can rely on. We also know that we can depend on IBM for top-quality support – we have a great relationship with the team and they are always ready and willing to help. Our decision to select IBM POWER8 was based on total confidence that the IBM Power Systems platform delivers all of the capabilities we need.”

The team worked together with IBM to deploy new IBM Power System E870 and IBM Power System S822 servers. Staying with the IBM POWER architecture, the SAP UCC at TUM could use their existing knowledge and experience of IBM POWER7 to prepare and complete the migration to the new IBM POWER8 servers without interrupting its services. Adrian Streitz adds: “We used the IBM PowerVM feature Live Partition Mobility to move our 140 SAP instances to the new IBM Power Systems servers without any downtime during business hours. The migration was very smooth and the procedure can be started from the graphical user interface, making the process straightforward and easy to manage.”

To minimize the risk of any effects on its users, the SAP UCC at TUM chose to migrate the system outside of peak hours, but still during term time while users were accessing the learning systems. The actual migration time of the systems depended on the size of each individual partition and took between one minute and half an

hour. Dominik Paluch says: “For an administrator, it’s as easy as pushing a button. In the background, however, the process is more complex. Live Partition Mobility basically configures a fully-automated, temporary high-availability cluster and the migration happens when the cluster switches over from one partition to the other. For our SAP applications we did not need to make any changes, we only had to adjust the CPU assignments after the migration to make full use of the increased performance of the IBM POWER8 processors.”

Upgrading its storage environment to IBM XIV Gen 3 storage systems was completed over two subsequent maintenance windows without affecting users. Over the process of migrating the storage volumes for each logical partition, each individual SAP system was only down for approximately ten minutes.

Application migration – embarking on a digital reinvention journey with SAP S/4HANA

As well as upgrading its infrastructure, the SAP UCC at TUM worked to adapt its learning environment to the next-generation SAP S/4HANA suite. The team quickly migrated its existing example company to the new solution, providing lecturers and students with the latest SAP software for their courses.

By integrating transactional and analytical features on a single platform, SAP managed to streamline and simplify the data model in SAP S/4HANA. As a result, the systems are smaller and less complex than in the past, as data no longer needs to be synchronized and stored redundantly for analytics purposes.

This convergence of operational and analytical data also lays the foundations for the digital reinvention of businesses. Maximilian Barnert explains: “We are planning to make use of the new capabilities to showcase a complete digital reinvention process with our example company. With SAP S/4HANA on IBM POWER8, we can integrate Internet of Things data from production equipment to develop more advanced business processes, for

example. Furthermore, we can take big data into account, such as data streams for social media analytics and sentiment analysis to gain new insights about the customers.

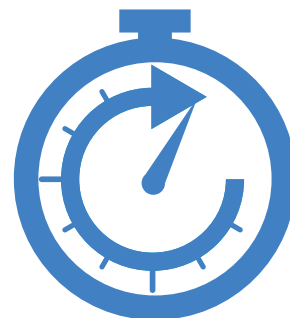
“SAP S/4HANA allows us to think about and use data within the ERP application more innovatively to enable our example company to modernize its business model. To demonstrate these capabilities, we want to show what predictive analytics means in a business context.”

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Maximilian Barnert

PhD candidate at the Chair for Information Systems

Technical University of Munich (TUM)



Reduced provisioning time by
80 percent to just 30 minutes

System architecture

Together with IBM, the SAP UCC at TUM evaluated several different options for its comprehensive SAP application landscape. While it was clear that they would be keeping the IBM POWER platform, they discussed the various pros and cons of scale-out and scale-up system architectures. To create a cost-efficient infrastructure for the SAP HANA platform and SAP S/4HANA suite, the team opted for an SAP HANA tailored data center integration (TDI).

Maximilian Barnert clarifies: “We looked at our workload and quickly decided to follow a scale-up approach with two large IBM Power System E870 servers with 40 cores each. The SAP HANA tailored data center integration simply gave us more freedom to flexibly distribute the available resources across all customer instances – SAP HANA and SAP ERP. Sometimes we need to shift capacity to a large application for a course, and later we will have

to reassign those capacities to a number of smaller systems. With IBM PowerVM, we can dynamically adjust the computing and memory allocations to always provide the best performance at the lowest cost.”

In addition, the SAP UCC at TUM also implemented two IBM Power System S822 servers, each equipped with 12 POWER8 processor cores.

As the entire team is made up of researchers, the SAP UCC at TUM has no single full-time storage administrator. One challenge was to find a solid, scalable storage system that would work without continuous manual tuning. Based on its positive experience with the technology, the team chose the new third-generation IBM XIV Storage System.

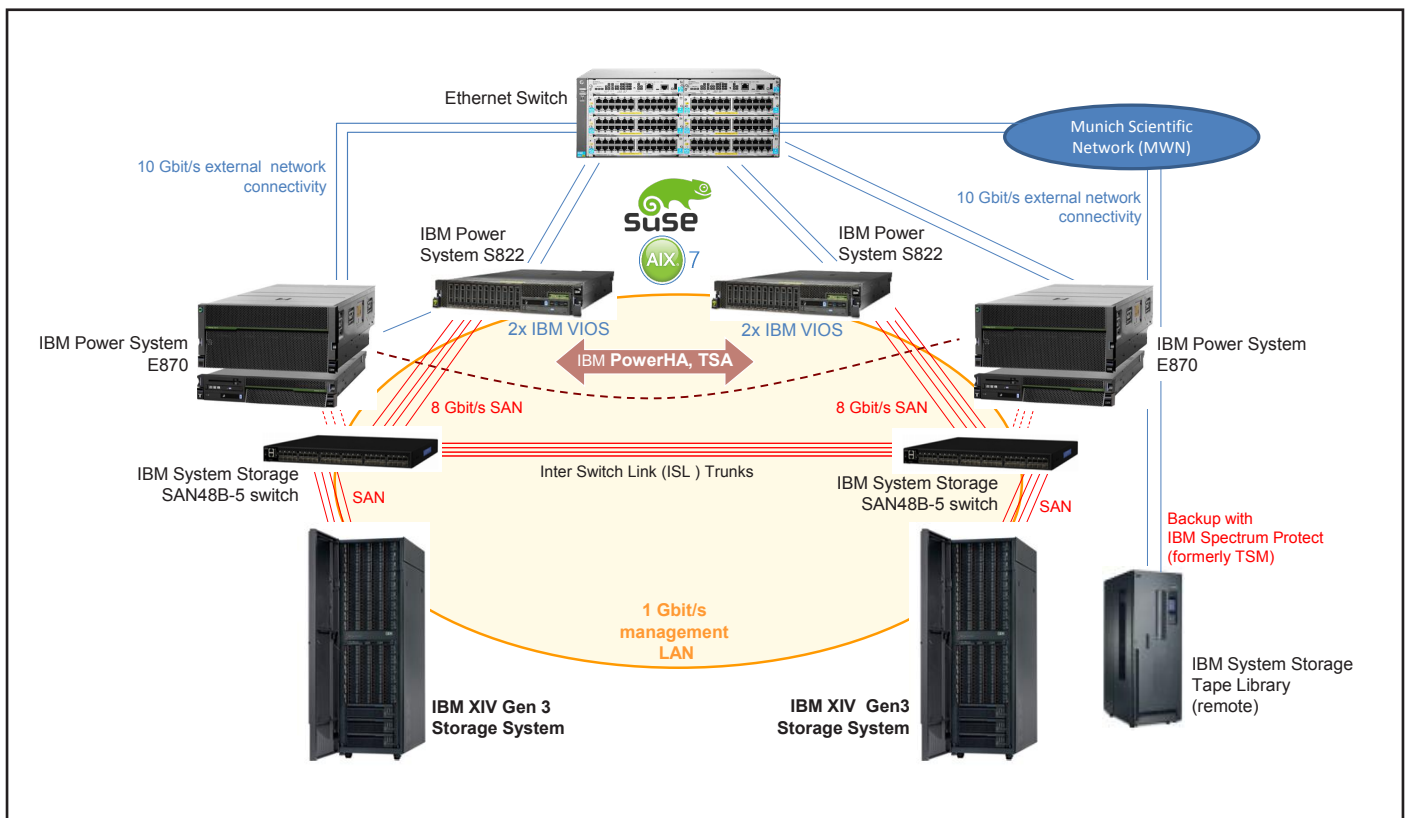


Figure 1: Overview of the new IBM solution at SAP UCC at TUM.

Flexibility enables cloud services

At the SAP UCC at TUM none of the four IBM Power Systems™ server is dedicated to a single system. All machines run a number of logical partitions (LPARs) to minimize the operating cost for all cloud services, managed with the IBM PowerVM® virtualization technology. Dominik Paluch notes: “The flexibility and scalability of PowerVM are very important for our business model. For example, for some courses we know that 8,000 students will be logging in at once and we have to make sure to provide the required capacity when it’s needed, without blocking it at times when it would be better used for other logical partitions.

“We also rely heavily on the Active Memory Expansion feature. The fact that the IBM POWER8 processor is so fast helps with the on-the-fly compression of data in memory. While we run many systems with a compression factor of about 1.3, for some systems we use up to 1.8 – almost doubling the memory capacity available to applications.”

Adrian Streitz remarks: “With our goal to keep storage administration workload at a minimum without compromising performance or availability, IBM XIV storage systems were the ideal solution. IBM XIV technology is based on a grid architecture that ensures reliability and provides redundancy out of the box. This combination allows us to operate our SAP environment without any manual storage management. To ensure the highest of availability, data is mirrored from our primary IBM XIV system to our secondary device using the standard functionality of the IBM XIV storage system. The IBM XIV systems also constantly optimize the location of data on its physical disks, providing maximum performance and redundancy fully autonomously, without the need for manual intervention.”

All IBM infrastructure components are spread evenly across two server rooms for the best redundancy and business continuity.

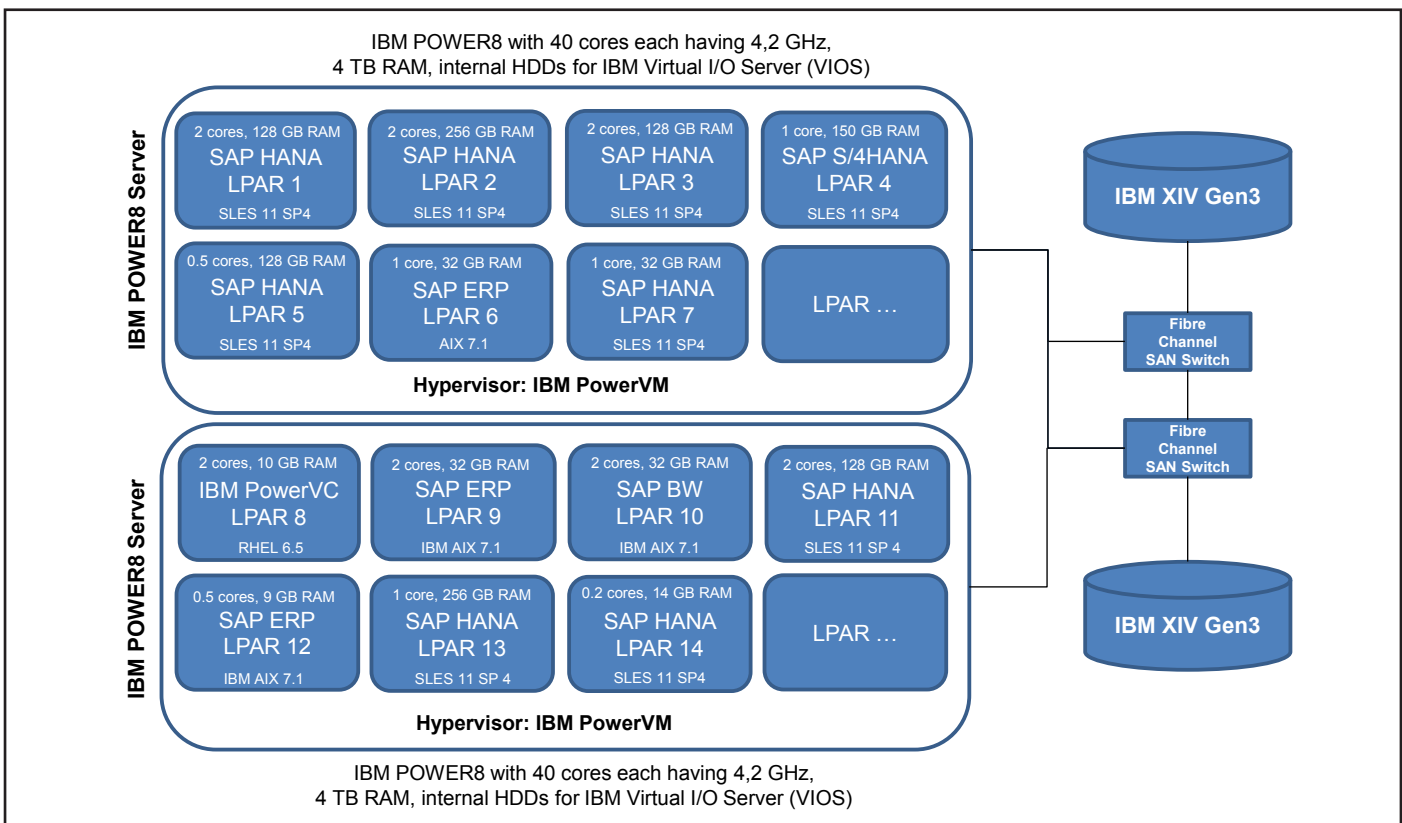


Figure 2: Logical partition setup at SAP UCC at TUM on two IBM POWER8 servers.

Taking Advantage of IBM DB2 with BLU Acceleration

Based on this experience, the SAP UCC at TUM is highly satisfied with the IBM POWER platform and runs most SAP systems for its customers in a 2-tier configuration with the SAP central instance and IBM DB2 database running in a single IBM AIX partition, a configuration committed to be supported by SAP until 2025.

The advanced autonomies features of IBM DB2 simplify operations for SAP applications and enable the team to provide fast, reliable cloud services with a low database administration workload for databases of all sizes. The integrated storage optimization functionality helps SAP UCC at TUM to manage the growing data volumes of its 108 IBM DB2 databases effectively.

Transparent data compression reduces storage space requirements by 50 percent allowing SAP UCC at TUM to host more systems without expanding its data storage. Additionally, SAP UCC at TUM utilizes BLU Acceleration on some of its IBM DB2 databases, delivering even more effective data compression – reducing data volumes by nearly 70 percent. Smaller database sizes allow SAP UCC at TUM to run more SAP applications on its IBM cloud infrastructure and also reduce backup times and volumes, contributing to further savings in operating costs.

The benefits of the sophisticated data compression go beyond pure storage savings. By working with compressed data directly, IBM DB2 processes more data more quickly, improving overall system performance and reducing the need for computing resources. Used in cloud services at scale, SAP UCC at TUM can exploit this advanced compression feature to run more databases in parallel while minimizing resource requirements for every individual instance.

The advanced virtualization features not only enable flexible scalability, they also ensure that the SAP UCC at TUM can use its resources as efficiently as possible to provide the new SAP S/4HANA Cloud cost-effectively. Taking advantage of the POWER8 servers' ability to host different operating systems, such as IBM AIX and SUSE Linux Enterprise Server for SAP

Applications, in separate logical partitions, the SAP UCC at TUM can achieve coexistence with optimal infrastructure agility and efficiency while sustaining superior performance for all its applications.

While the SAP UCC at TUM is currently running more than 80 SAP ERP and SAP Business Warehouse applications on the IBM DB2 database, the team is facing increasing demand for the S/4HANA suite, as well as for the SAP HANA platform in general.

Dr. Harald Kienegger confirms: “Only the flexibility of IBM POWER and IBM PowerVM make it possible for us to provide our cloud services at an attractive price to our customers. The solution also gives us the capability to accommodate any special requirements, like setting up a 3-tier configuration with a separate database server if needed. However, we generally always recommend the simplest and resource-efficient option, SAP ERP with IBM DB2, if there is no business case or learning goal to justify a different, costlier setup.”

Running SAP HANA on IBM POWER8 efficiently

The SAP UCC at TUM has always treated its infrastructure as a test environment to explore different configurations. As a research group, the team uses its academic freedom to evaluate configurations in its data center, even when they are not yet fully supported by either SAP or IBM.

For example, the team launched instances with varying core-to-memory ratios to find out how its systems behaved under load. This helped SAP UCC at TUM to tune its resource allocations and minimize the resource footprint for its cloud services.

Dr. Harald Kienegger says: “We provide cloud services to universities and other education institutions and they rely on our services. But we also use the infrastructure for our own research. And rightly so – our workloads are very specific, and probably completely different from the production workload of many businesses. We focused on our business case and the

optimizations we have applied to our configuration enables us to provide SAP HANA to a wide range of customers at a reasonable price. Without the freedom to tune the resource allocations to meet our requirements, we could not provide the services that we do today. Our goal is simple: to improve cost-efficiency while maximizing service quality – and to learn something about our systems along the way.”

In this context, moving its SAP HANA systems to the IBM POWER platform and running all of its SAP systems on a single platform has significantly increased flexibility and simplified management of the application landscape. Running SAP HANA on x86 servers in an unsupported configuration resulted in high maintenance effort in the past. Today, the new SAP HANA tailored data center infrastructure with IBM Power Systems servers and IBM PowerVM virtualization has proven very stable in various setups, including in combination with the SAP S/4HANA suite.

Data center operations

Managing flexible cloud services

To help optimize resources yet further, the SAP UCC at TUM takes advantage of the Micro-Partitioning feature, enabling it to assign as little as 0.05 virtual CPU capacity to a single logical partition.

The team operates all of its SAP applications in uncapped logical partitions with access to the shared processor pools. This includes the IBM AIX partitions running SAP ERP and IBM DB2, as well as SUSE Linux Enterprise Server for SAP Applications partitions running the SAP HANA platform and the SAP S/4HANA suite. Depending on the specific requirements, the team also uses static, dedicated resource assignments to guarantee the best possible performance. In addition, the SAP UCC at TUM also uses so-called ‘processor core entitlements’ to let IBM PowerVM dynamically assign the shared processor pool capacity across all relevant partitions.

This setup gives the team the flexibility to allocate a baseline capacity tailored to the expected workload to each logical partition. Spare capacity is then always available to the applications that need it most, without the team having to constantly tune the resource allocations manually when the workload changes. The processor core entitlements enable the team to scale capacity up and down without having to restart the logical partitions.

Taking load balancing across all SAP systems one step further, the team runs its SAP HANA platforms as multiple-container systems. SAP HANA multitenant database containers provide strongly isolated environments for different tenant databases. The system administrator can configure the memory and CPU consumption independently per tenant database, giving the SAP UCC at TUM another layer of fine-grained control to optimize capacity allocation.

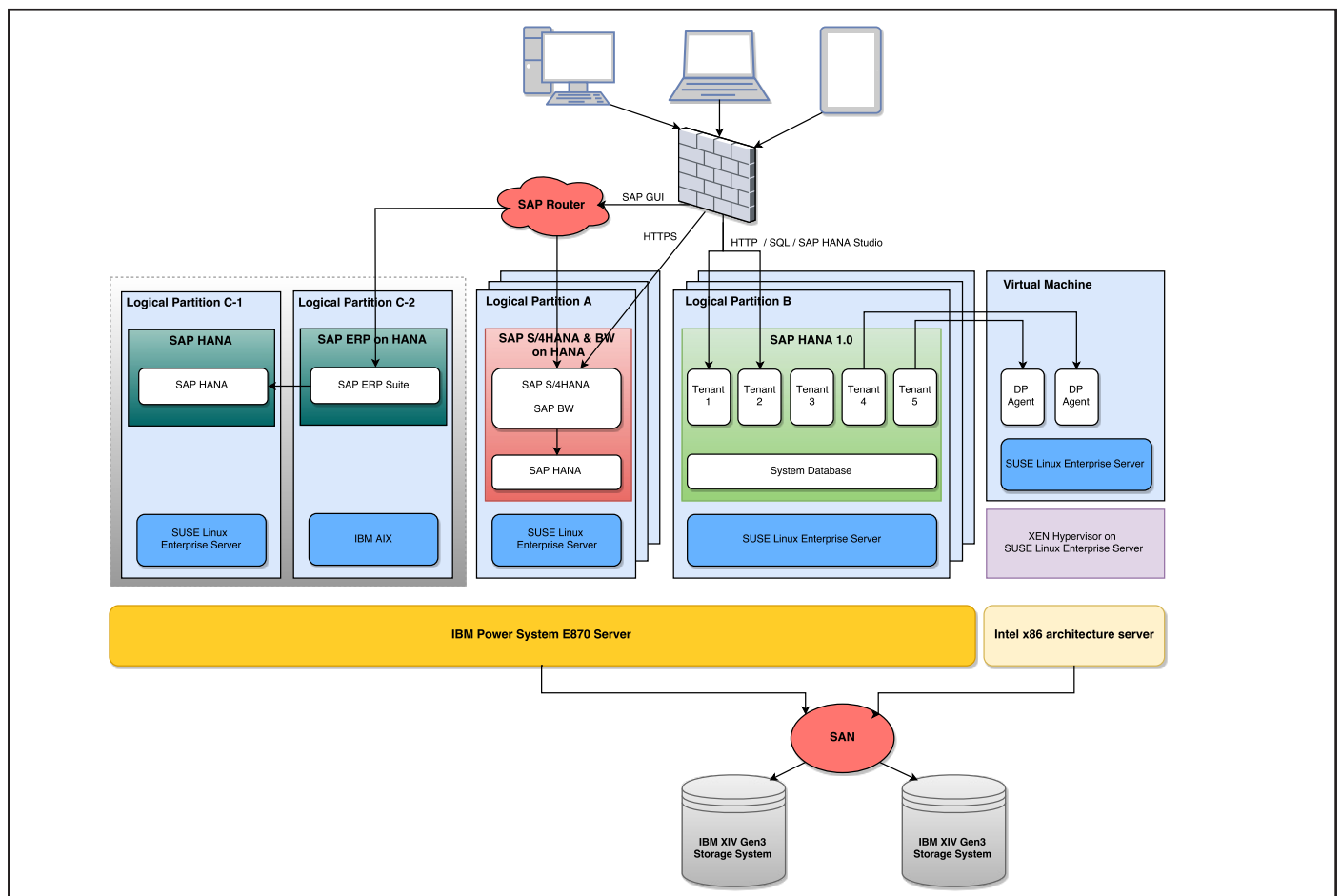
Dominik Paluch states: “The two layers of capacity allocation with IBM PowerVM for logical partitions and SAP HANA multitenant database containers for in-memory databases allow us to balance the load across our applications easily and flexibly. As a result, we can use the available resources very efficiently and make sure all applications provide the best performance for our users.”

Next-level cloud deployments

To gain even more flexibility and further accelerate deployment across its IBM Power server landscape, the SAP UCC at TUM implemented the IBM PowerVC Virtualization Center. IBM PowerVC runs on Red Hat Enterprise Linux and is an advanced virtualization and cloud management offering built on OpenStack, which provides simplified virtualization management and cloud deployments. This includes an IBM Power®-specific user interface, and IBM-specific OpenStack drivers for IBM Power Systems management interfaces, such as the hardware

By implementing industry-standard APIs that are extendable for adding on higher-level cloud capabilities on IBM Power Systems,

Maximilian Barnert says: “Our instances are highly standardized to make operations at our scale manageable. With the addition of IBM PowerVC Virtualization Center to provide simplified virtualization management, SAP UCC at TUM is able to provision new SAP S/4HANA software from a standard template in just



minutes, offering staff and students – essentially, our customers – the best possible service to keep up with growing demand for the next-generation suite.”

Standardized monitoring and backup processes

When upgrading to the new IBM POWER8 servers and the latest IBM XIV storage, the team could continue using its established monitoring tools. Adrian Streitz explains: “All of our physical systems and SAP instances are continuously monitored using IBM Tivoli Monitoring and SAP Solution Manager. Because we could continue using the same tools after the infrastructure upgrade, the whole process of integrating the new systems into our monitoring environment was a painless process.”

For data backups, the SAP UCC at TUM relies on the backup-as-a-service offering provided by the Leibniz Supercomputing Centre. Conveniently for the team, the service is based on IBM Spectrum Protect™ (formerly Tivoli Storage Manager).

Using IBM Spectrum Protect for Enterprise Resource Planning, the team ensures automated data protection for SAP ERP and SAP HANA environments with a single toolset. Dominik Paluch elaborates: “We plan our backups centrally in SAP Solution Manager. Thanks to IBM Spectrum Protect, we can use standardized backup and restore processes for SAP ERP as well as SAP HANA, enabling rapid recovery in the event of disaster.”

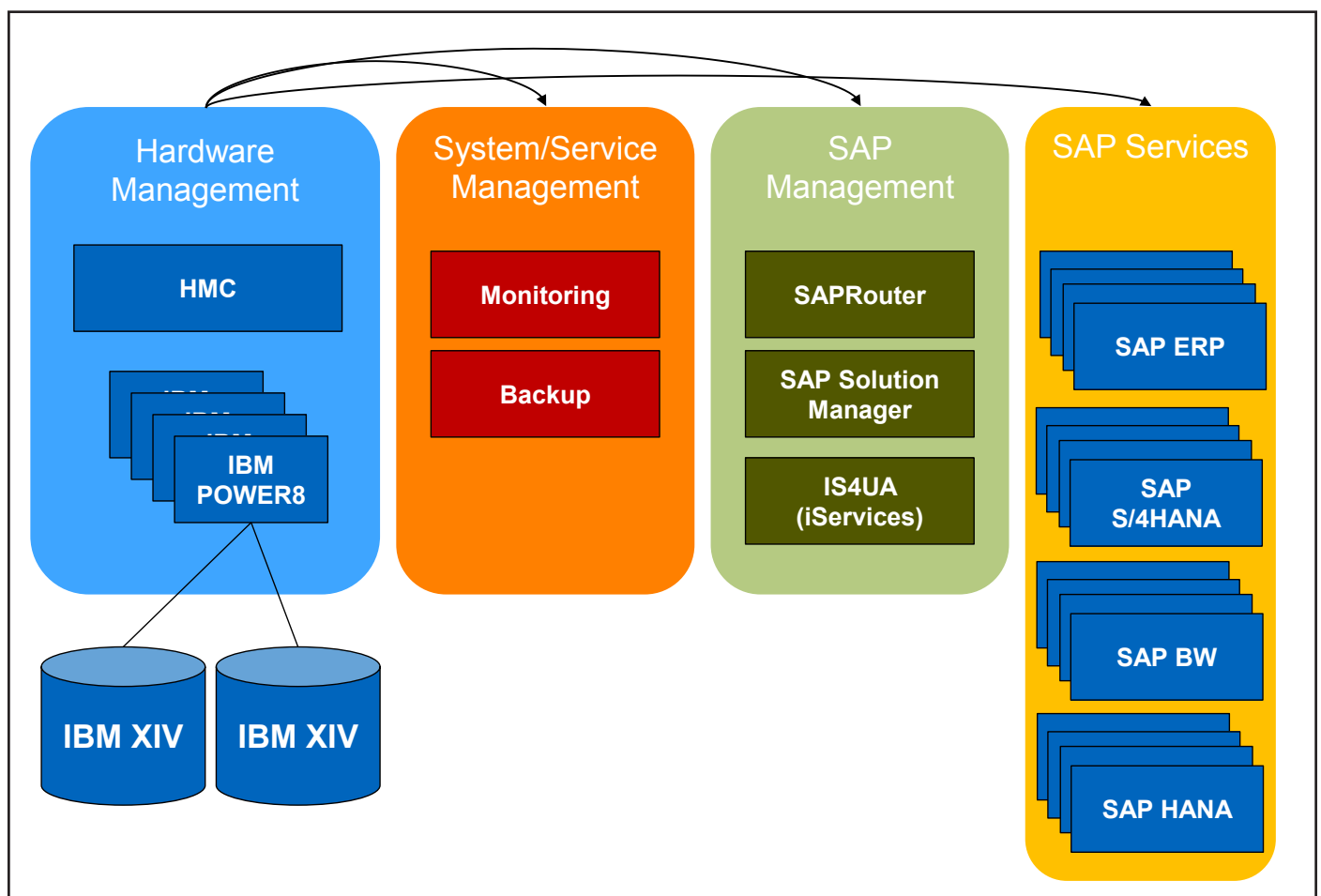


Figure 4: Virtualization and deployment at SAP UCC at TUM.

“We view it as one of our biggest achievements that we have not increased the prices of our services for over ten years. Despite the fact that performance of the infrastructure and the complexity of the applications are growing constantly, we managed to keep our prices the same – this is only possible with cost-efficient, flexible systems and a high level of automation.”

Dr. Harald Kienegger

Post-Doctoral Researcher at the Chair for Information Systems

Technical University of Munich (TUM)



Support SAP ERP environments with **60 percent** less processor allocation

Project achievements

Efficient operations

With customers in the education sector that are often tied to shrinking public budgets, the combination of price stability and low entry cost are the pillars of success for the SAP UCC at TUM. Dr. Harald Kienegger says: “We view it as one of our biggest achievements that we have not increased the prices of our services for over ten years. Despite the fact that performance of the infrastructure and the complexity of the applications are growing constantly, we managed to keep our prices the same – this is only possible with cost-efficient, flexible systems and a high level of automation.”

To run its systems with continuously low operating costs, SAP UCC at TUM needs to use its available capacity as efficiently as possible. On the infrastructure level, virtualization is the key to meeting ‘on demand’ requests from lecturers and students to provide reliable, scalable cloud services. SAP UCC at TUM can react flexibly to changing requirements thanks to the sophisticated IBM PowerVM solution that virtualizes processors, memory and I/O resources and by taking advantage of the POWER8 servers’ ability to host different operating systems, such as IBM AIX and SUSE Linux Enterprise Server, in logical partitions.

When the organization needed to expand its capacities to meet the highest levels of reliability, scalability and performance for a growing portfolio of business applications, the SAP UCC team at TUM decided to deploy SAP HANA using tailored datacenter integration methodologies based on IBM Power Systems servers and IBM XIV storage systems as the foundation for its new SAP S/4HANA Cloud offering. Dominik Paluch says: “SAP HANA tailored datacenter integration enables us to offer new, innovative cloud services without the need to maintain an additional infrastructure platform.”

Using its academic freedoms as a research organization, the SAP UCC at TUM implemented the logical partitions for SAP HANA on POWER8 in a configuration that is not fully supported by SAP. The SAP UCC at TUM then demonstrated that this dynamically scalable environment is capable of running multiple application environments, proving both stability and scalability. The team continues to experiment with new ways to run SAP HANA on POWER8 by looking at additional possibilities, such as scale-out architectures.

Maximilian Barnert confirms: “As well as migrating our logical partitions for SAP ERP and SAP Business Warehouse applications from our older IBM Power Systems servers, all our SAP HANA instances now run on IBM POWER8. Our new, homogenous SAP HANA environment using tailored datacenter integration is much easier to manage and blends seamlessly into our overall system landscape without adding complexity or different monitoring and management processes and tools.”

Quality certified by SAP

To prove the reliability and quality of its cloud services beyond the SAP University Alliance community, the SAP UCC at TUM is SAP Certified in Cloud Services, SAP Certified in Hosting Services and SAP Certified in SAP HANA Operations Services.

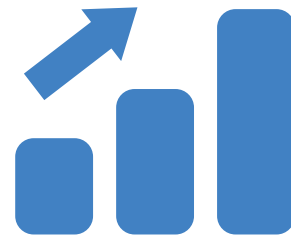
Dominik Paluch says: “To gain the trust of future customers and confirm to existing partners that we provide industry-standard service quality, it was very important for us to work with IBM and SAP to get our tailored datacenter integration setup based on IBM POWER8 and IBM XIV certified by SAP. This shows that we as educational service provider operate our cloud services with top-notch performance, just like any other SAP partner out there.”

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Dominik Paluch

PhD candidate at the Chair for Information Systems

Technical University of Munich (TUM)



Storage throughput performance improvements of **up to 600 percent**

Driving digital reinvention with SAP S/4HANA

SAP S/4HANA has been a massive leap in making business applications more accessible to a wider group of users within companies. And the move to SAP S/4HANA was completed by the SAP UCC team at TUM largely using their own resources, and the familiarity with the IBM Power Systems platform enabled the transition based on existing know-how. Additionally, the virtualized environment enables SAP UCC at TUM to run both operational and analytics processing on the same infrastructure, resulting in a reduced data footprint and leaner operations.

Maximilian Barnert explains: “We continue to innovate, for example by introducing SAP S/4HANA on mobile devices with the SAP Fiori user experience. Teachers and students can now access SAP S/4HANA from their tablet or smartphones, offering a crucial lesson in Digital Transformation.

“From our first experience in demonstrating the capabilities of SAP S/4HANA and creating training material for our courses, we clearly see that SAP S/4HANA is easier to understand. Students learn more quickly how they can use the applications, and have more fun interacting with the software thanks to the modern SAP Fiori user experience. The role-based interface design only shows the information needed for your current task – avoiding the information overflow you get with a complex interface, thus helping to focus on what is really important.”

By converging transactional and analytical data structures and features in a single suite, SAP S/4HANA allows for more flexible ad-hoc data analytics. Business users can extract relevant figures and forecasts within seconds, without the requirement for defining data aggregates beforehand. This enables more dynamic data analytics that can lead to new insights, that were previously not easily possible because of the separation between the different data usage patterns in different applications and databases.

Furthermore, the new in-memory processing also helps reduce the need for long-running batch processes. Being able to process and integrate large amounts of data directly into operational decision-making paves the way for real-time analytics and supports new, high-speed business models.

Another advantage of the sleek and simple user interface is that it encourages top executives to interact with business data directly in the central applications, with minimal formal training.

Performance improvements

Benefits of IBM POWER8

SAP UCC at TUM continues to exploit the technology advantage of the IBM POWER platform. By moving to IBM POWER8, the team now benefits from four-times faster memory bandwidth compared to other architectures.

Using the Active Memory Expansion feature, the team also makes the most of the available memory. With compression factors of up to 1.8, SAP UCC at TUM can almost double the memory capacity for some of its SAP ERP instances.

The IBM POWER8 processors also provide increased computing performance. Maximilian Barnert comments: “The IBM solution offers excellent performance. For example, we are able to support a complete SAP ERP environment for 20 of our customers with around 60 percent less IBM POWER8 processor allocation compared to previous CPU generations. Thanks to the IBM POWER8 upgrade, we now need fewer processors to run a greater number of environments – helping us to reduce costs and energy usage.”

In addition to the performance gains, SAP UCC at TUM calculates that it achieves better than 99.99 percent system availability with its new infrastructure.

Effects of the latest XIV Storage System

Besides faster compute performance, SAP UCC at TUM also boosted storage performance with its infrastructure upgrade. The new IBM XIV generation 3 solution offers greatly improved read and write performance. The team measured the read throughput and found that the new system was up to 500 percent faster than the previous generation.

To get a more complete picture, SAP UCC at TUM also tested the write throughput. The effects of the hardware refresh were even more pronounced for write access with performance improvements of up to 600 percent. The new setup also cut storage latency substantially with a reduction of up to 75 percent.

Adrian Streitz sums up: “Overall, the systems provide significantly better performance levels for the applications using the upgraded storage infrastructure.”

Rapid cloud deployment

Implementing the next-level cloud management and automation solution IBM PowerVC based on OpenStack technology, the SAP UCC team at TUM realized further time savings in its deployment processes. Maximilian Barnert confirms: “When setting up new logical partitions for development systems or new customers, we can cut provisioning time to just 30 minutes for systems running on SUSE Linux Enterprise Server for SAP Applications – an 80 percent reduction.”

Dr. Harald Kienegger concludes: “In combination with the performance improvements across all components of our computing and storage solutions, we are maximizing flexibility and efficiency while sustaining superior performance for all our customers’ applications. And this is what helps us to provide cutting-edge cloud services so cost effectively, something that becomes even more important as we are reaching out to more and more vocational schools, where budgets are even tighter than in higher education.”

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Dr. Harald Kienegger

Post-Doctoral Researcher at the Chair for Information Systems

Technical University of Munich (TUM)



Memory compression **factor**
of up to 1.8

Next steps

Business innovation with big data and the Internet of Things

SAP UCC at TUM sees its role as educating the information system and process specialists of the future. An important part of this effort is to show the implementation experts, project managers and executives of tomorrow how they can use connected manufacturing systems, digitized factories and big data analytics in real-time to the benefit of their businesses.

To uncover the transformational potential of advanced data analytics, SAP UCC at TUM founded the Big Data Innovation Center as part of its involvement with the SAP University Alliance. The aim of this new collaboration is to leverage academics and industry partners to re-invent business processes based on big data applications.

SAP UCC at TUM uses the IBM infrastructure to offer a system landscape for scientists, practitioners and start-ups to explore, design and evaluate data driven-processes in various research and application areas as smart logistics, Internet of Things, process intelligence, predictive maintenance and other contexts.

Helmut Krcmar, Professor of Information Systems at TUM and Academic Director of the UCC adds: "Through our SAP S/4HANA Cloud using an SAP HANA TDI infrastructure based on IBM Power Systems, we are able to equip students with the latest tools and skills to drive the Internet of Things and Digital Transformation in the business world.

"The Internet of Things will impact business models and industries significantly. IBM and SAP enable us to support this process by helping us to educate people to acquire the relevant skills and competencies – especially students in the fields of computer science, information systems, engineering and business administration, to name just a few. The ability to work with others across individual fields and disciplines is essential to be successful in this Digital Transformation, and it is our job to equip students with the relevant skills."

Launching the OpenPower Development Cloud

The Department of Informatics at the Technical University of Munich is also working with IBM and the OpenPOWER Foundation on the new European Developer Cloud to expand developer resources significantly. Members of the OpenPOWER Foundation in collaboration with the Department of Informatics at the Technical University of Munich announced plans to launch the European arm of the development and research cloud called Supervessel. First launched in China, Supervessel is the cloud platform built on top of POWER's open architecture and technologies. It aims to provide open remote access for all the ecosystem developers and university students.

With the importance of data sovereignty in Europe, this instance of Supervessel will enable students and developers to innovate applications on the OpenPOWER platform locally, allowing individuals to create new technology solutions while following local data regulations.

Processor Krcmar concludes: "We are very happy to see IBM continued support for the Power platform. As a next step to deepen our strong partnership further, we will team up with IBM to support the growing OpenPower Initiative. Thanks to our experience with this great computing platform, we are in an ideal position to operate an OpenPower Development Cloud and help IBM gain traction with its forward-looking IBM Power Systems Academic Initiative in the research community."

Since October 2016 the Technical University of Munich is official member of the OpenPOWER Foundation (OPF). The OPF is a global, open development membership organization formed to facilitate and inspire collaborative innovation on the POWER architecture. OpenPOWER members share expertise, investment and server-class intellectual property to develop solutions that serve the evolving needs of technology customers.



Reduces database sizes by
up to 70 percent

“We are very happy to see IBM continued support for the Power platform. As a next step to deepen our strong partnership further, we will team up with IBM to support the growing OpenPower Initiative.”

Helmut Krcmar

Professor of Information Systems and
Academic Director of the UCC

Technical University of Munich (TUM)





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Contacts:

IBM

Antonio Palacin (antonio.palacin@de.ibm.com)

Matthias Koechl (koechl@de.ibm.com)

Markus Fehling (markus.fehling@de.ibm.com)

For further questions, please contact the IBM SAP International Competency Center via **isicc@de.ibm.com**

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D-71137 Ehningen
ibm.com

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