



White Paper

How SUSE Helps Pave the Road to S/4HANA

Sponsored by: SUSE and SAP

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August 2017

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IDC OPINION

According to SAP, there are now 6,800 SAP customers that have chosen S/4HANA. In addition, many more of the software company's customers still have to make the decision to move to S/4HANA. These customers have to determine whether they are ready to migrate their database for mission-critical workloads to a new database (SAP HANA) and a new application suite (S/4HANA). Furthermore, SAP HANA runs on Linux only, an operating environment that SAP customers may not have used extensively before. This white paper discusses the choices SAP customers have for migrating to S/4HANA on Linux and looks at how SUSE helps customers along the way.

SITUATION OVERVIEW

Among SAP customers, migration from traditional databases to the SAP HANA in-memory platform is continuing steadily. IDC's *Data Analytics Infrastructure (SAP) Survey*, November 2016 (n = 300) found that 49.3% of SAP customers in North America are running SAP HANA today. Among those that are not on SAP HANA, 29.9% will be in two to four years and 27.1% in four to six years. The slower adopters say that they don't feel rushed, stating that there's time until 2025 to make the decision, and that their current databases are performing adequately.

While there is no specific order that SAP customers need to follow to get to S/4HANA, historically businesses have often migrated to SAP Business Warehouse (BW) on SAP HANA first as BW is a rewarding starting point for SAP HANA for two reasons: there is an instant performance improvement and migration is relatively easy since BW typically does not contain core enterprise data that is business critical. By some estimates, close to a third of the SAP customers worldwide have switched to BW on HANA; most of these deployments are now live and in production.

For SAP customers that took this route, the next step is just around the corner, namely moving their transactional business applications to HANA. They can run SAP Business Suite on the SAP HANA database, which will provide them with all functionalities that their traditional ERP Central Component (ECC) delivered with HANA in-memory acceleration for a select number of use cases. However, SAP customers can also opt for a significant functionality boost with SAP's new flagship solution, S/4HANA, which was written from scratch to take full advantage of HANA's in-memory acceleration.

Consequently, more and more customers are skipping SAP Business Suite on HANA and leapfrogging to S/4HANA. S/4HANA provides innovative integration and simplification with distinct business benefits by being re-architected to take advantage of HANA. In its 2Q17 financial report, SAP stated that S/4HANA adoption grew to more than 6,300 customers, up by more than 70% year over year.

A survey by the independent SAP Users Group ASUG in December 2016 found that 33% of respondents (n = 577) have purchased S/4HANA, while 28% of respondents expect to purchase S/4HANA soon.

Why S/4HANA?

It is not surprising that the shift to S/4HANA is being driven as much by the business side within many organizations as by IT leaders who, aside from IT-related advantages of S/4HANA such as consolidation, see the business benefits of S/4HANA. S/4HANA facilitates real-time analytics on massive amounts of transactional data and empowers the line of business (LOBs) with real-time simulation of business scenarios based on this data – a critical competitive tool.

The interface of S/4HANA is also more user-friendly and potent, and the solution features numerous new business functionalities. Furthermore, the software and data layers are significantly simplified compared with Business Suite, and the integration with other SAP applications is much more effective. S/4HANA has a greatly simplified database layout that enables faster processing of data insertions and modifications. Thus reporting is speedier, more dynamic, and more impactful.

Advantages that IT will appreciate are that maintenance is easier, and – as SAP says – customers can expect an overall lower cost of operations on S/4HANA. S/4HANA has a lower data footprint, thanks to its columnar store and compression, and therefore requires less hardware. SAP claims that using such techniques as data aging and archiving, a 10TB ERP system can be reduced to a 1TB S/4HANA footprint in the main memory of the database layer. This has additional benefits such as faster backup and restoration of active business data.

There is also an opportunity for landscape consolidation. For example, combining basic ERP with APO (Advanced Planning and Optimization) and with PP/DS (Production Planning and Detailed Scheduling), which are at the heart of SCM (Supply Chain Management); or running basic and SAP Extended Warehouse Management, which integrates complex supply chain logistics with your warehouse and distribution processes on one system; or migrating some processes to the cloud, for example, moving SAP SRM (Supplier Relationship Management) to SAP Ariba, SAP's cloud-based network for buyers and suppliers.

Nevertheless, there may be hurdles. For example, businesses that run a traditional SAP ECC environment that is deeply integrated with other applications and/or extensively customized prefer to launch S/4HANA differently. The direction they choose for the new implementations is to minimize or even eliminate customizations to S/4HANA, resist trying to reproduce past business practices, and leverage S/4HANA process improvements. They will be migrating their data to repositories with different data temperatures. The ASUG survey has found that of those businesses that have purchased S/4HANA, 21.2% of the businesses are running one or more active S/4HANA proof-of-concept projects. Businesses with little integration or customization find it easier to perform a straightforward S/4HANA migration. The Core Data Services layer ensures that for them compatibility with existing applications and data structures is maintained.

The Opportunity with S/4HANA

Overall, S/4HANA should be seen as SAP's next-generation business application suite, designed to enable an organization's digital transformation, enabling near-real-time access to critical business information. S/4HANA is available in various deployment scenarios, including as a public cloud, managed private cloud, infrastructure as a service (IaaS), or on-premise deployment. It is also extensible via the SAP Cloud Platform. SAP appears to be actively driving its S/4HANA customers to the various cloud options rather than the on-premise approach.

Stated Benefits from S/4HANA

Some of the technological benefits that SAP has stated businesses can achieve from S/4HANA versus running Business Suite on a traditional database are:

- 3-7x higher throughput
- Up to 1,800x faster analytics
- Unlimited workload capacity
- HANA multitenancy
- SAP Cloud Platform extensions
- All data: Social, text, geo, graph, and processing
- Reduced locking contention, parallelism for throughput
- Integrated suite of applications across business process domains and functions
- Less than one-tenth of data footprint compared with a traditional database (a traditional database of 100GB is reduced to 20GB in HANA and 7GB in S/4HANA)

For LOBs, these technical benefits translate into business benefits across all business functions – from finance to supply chain to asset management, human resources, and R&D. Some examples are:

- Finance – cost management
 - SAP HANA provides a centralized data repository that represents a single version of the truth. SAP HANA accelerates processes, reporting, and transactions. It also accelerates modeling, simulation, and predictive analytics processes of SAP Net Margin Analysis and financial performance software.
- Finance – accounts receivable
 - In-memory technology enabling real-time access and assembly of complex data for a payment and working capital dashboard
 - Acceleration reducing the need for overnight batch runs
- Finance – accounts payable
 - Real-time insight into the business based on large numbers of invoices providing finance the ability to analyze and act on insights based on very large (several million records) data sets of complex accounts payables processing records
- Basic warehouse management
 - Automate warehouse operations with RFID and sensors with IoT framework for integration
 - Automate picking, shipping, labeling, and automated retrieval and put away
 - Mobile inventory management and warehouse applications via SAP Fiori
 - Improved inventory management and transparency via real-time processing of inventory postings

- Extended warehouse management
 - Extended functionality of S/4HANA Warehouse Management with no data reconciliation
- Health and safety management
 - Real-time insight to action through embedded analytics (e.g., for root cause analysis of incidents)
 - Improved transparency and monitoring of emissions calculations in real time

The Road to S/4HANA

Businesses that are contemplating migration to S/4HANA to take advantage of these benefits face several decisions, depending on where they are on the journey. Many organizations may already be running Business Suite on SAP HANA and are now preparing to move to S/4HANA. They will need to determine which customizations of Business Suite to carry forward. Others may be running SAP on a different database, such as Oracle, DB2, or SQL server – their road to S/4HANA leads via a database change from the traditional database to SAP HANA.

And then there are those businesses that, today, have no SAP in the datacenter at all, and for whom S/4HANA is a brand-new environment that requires them to bring in a different database and different business applications. In a recent survey, IDC has found that businesses that intend to start investing in SAP software are currently running their business and analytics software, including ERP, on one or a combination of databases (see Table 1).

TABLE 1

Percentage of Respondents Using Current Databases

Current Database	Respondents (%)
Teradata	26
MongoDB	27
Cassandra	34
Oracle database	45
MySQL	45
DB2	54
Microsoft SQL	63

n = 300

Note: Respondents are from North America only.

Source: IDC's *Data Analytics Infrastructure (SAP) Survey*, November 2016

This data also demonstrates that as organizations consider various migration scenarios, other options, potentially more affordable ones, present themselves as well. Open source databases, for example, are gaining popularity, as are open source analytics applications. Already 27% of survey respondents said they were using MongoDB and 34% use Cassandra, in most cases not for ERP but certainly as part of their overall business analytics environment. Furthermore, the possible complexity and cost of a move to S/4HANA are giving some businesses – quite literally – a pause. IDC has found that the top 7 reasons out of a total of 12 why non-HANA SAP users have not migrated to SAP HANA (yet) or will not be migrating to SAP HANA in the next 24 months are (in order of prevalence):

- **No need:** SAP applications perform well on our non-HANA database.
- **No urgency:** SAP supports non-HANA databases until 2025.
- **Too costly:** Cost associated with migrating to HANA is too high.
- **Database preference:** We prefer our current database for performance reasons.
- **Too risky:** Our business depends on the database that supports our SAP landscape; migration could disrupt operations.
- **Too complex:** Our SAP landscapes are too entangled with the current non-HANA database.
- **Operating system switch too complex:** We currently run our SAP landscapes in a non-Linux environment, and don't want to migrate the database to Linux (yet).

Businesses that are eager to reap the benefits of S/4HANA sooner rather than later will be evaluating the following considerations:

- Purchasing new, SAP-certified server and storage hardware
- Migrating to a new database (if they were not on HANA yet)
- Bringing in a new operating system for the database (if they were not on Linux yet)
- Starting on new business applications (if they weren't running SAP applications yet) – SAP has reported that 30% of recent sales of S/4HANA have been to organizations that are new SAP customers
- Deciding on various migration options to get to S/4HANA (on-premise versus various cloud options such as HANA Enterprise Cloud [HEC – a private cloud service], IaaS, or public cloud – or a combination)
- Determining how fast they want to get to S/4HANA via Business Suite on HANA or directly
- Based on the industry they are in, synchronizing how the time to move to S/4HANA with SAP's road map as S/4HANA functionalities for different verticals are planned for release over time

The Switch to Linux

Across all IT functions and worldwide, the march toward Linux as the server operating environment of choice continues unabated. IDC forecast that in 2020, Linux will represent 59.3% of all paid shipments of server OS worldwide versus Windows' 40.2%, which essentially means that the shares between Linux and Windows will have flipped compared with 2016. Linux is well established as the foundation for cloud architectures and is closely associated with next-gen applications, OpenStack, and a vast amount of open source applications.

Nevertheless, for businesses that are moving to SAP HANA or S/4HANA, the switch to Linux is not trivial. IDC has found that among businesses that are currently running SAP software, 31.8% run Windows, 27.7% run Linux, 20.9% run Unix, 14.9% run iOS, and 2.1% run z/OS. In other words, 68.2% of these SAP customers do not run their SAP environment on Linux today. Unfamiliarity with

Linux means that systems administrators need to get acquainted with new operational procedures, including maintenance and the applications of patches and updates.

It also means that availability and disaster recovery will be different and possibly more complex, as all the layers in the infrastructure are changing. Unfamiliarity with new operational procedures across all levels of the stack means that providing for failover and recovery of the operating system, database, and applications could be challenging. Businesses will want to automate these operations as much as possible, or they may want to consider contracting with an SAP service company (or with SAP themselves when on HEC) that can provide availability services with SLAs that cover all the necessary levels.

Security, which has risen to the top of major concerns among businesses worldwide, for a S/4HANA environment will require advanced identity management as users increasingly want access from multiple devices, sophisticated threat detection (increasingly businesses choose to perform threat detection with cognitive/AI software), and strong encryption technologies, ideally for both data at rest and in flight.

And, finally, choosing the right hardware for S/4HANA will be of critical importance, including establishing the system parameters for this database-intensive workload as well as determining how to optimize the environment. Anticipated and unanticipated usage changes must be considered to avoid the system from choking on peak demand. There are various hardware options to consider, including architecture (x86 or IBM Power), appliance model or tailored datacenter integration, converged or non-converged, configuration (sockets and memory), desired virtualization (PowerVM or VMware) and, of course, anticipated capex.

As to the latter, the numbers can seem daunting. IDC has found that among businesses that do not run SAP software but plan to in the next 24 months, the capex for servers running their current databases as well as business and analytics software ranges from \$245,536 for businesses with fewer than 500 employees to \$1,701,389 for businesses with more than 2,500 employees. Some of these servers will need to be replaced with S/4HANA installation, if S/4HANA is to be deployed on-premise; however, as mentioned earlier, S/4HANA has a much smaller footprint, which could mean significant reductions in capex for these organizations. Furthermore, many of these businesses elect that move to the cloud, avoiding new capex entirely.

For businesses that do run SAP on-premise today, the average capex for servers running their current databases as well as business and analytics software ranges from \$624,390 (<500 employees) to \$1,709,318 (>2,500 employees). These businesses will be more inclined to remain on-premise and will incur some new capex from their move to S/4HANA.

HOW SUSE HELPS ALLEVIATE SOME OF THESE CHALLENGES

SUSE and SAP have collaborated for many years and codeveloped technologies, best practices, and templates that help organizations with many of the previously mentioned challenges they face when migrating to S/4HANA. Four critical hurdles that SUSE aims to address with SUSE Linux Enterprise Server (SLES) for SAP applications are deployment, high availability (HA), performance, and the switch to Linux.

S/4HANA Deployment Options with SUSE

The deployment options for S/4HANA are manifold – on-premise, managed private cloud (HANA Enterprise Cloud), public cloud/SaaS, and IaaS. Public cloud/SaaS is a shared deployment of the application, while the others are dedicated. SUSE Linux Enterprise Server for SAP applications is available across these various deployment scenarios. The difference is important, however, when it comes to how much customization of an organization's existing SAP applications can be brought forward. The public SAP S/4HANA cloud editions, for example, are only available as standardized packages – SAP allows only limited modifications to them, which for many organizations are not an issue.

On-Premise and HANA Enterprise Cloud

The on-premise edition, which is also used in the managed private cloud HEC, consists of the entire functional scope of S/4HANA (unlike the public cloud editions), with annual updates for software fixes and new features, and can be significantly customized, which for some organizations is essential. It is also ahead in offering the full range of industry solutions compared with the cloud editions.

Organizations that prefer a private-managed cloud service can opt for SAP HANA Enterprise Cloud, SAP's own comprehensive platform-as-a-service (PaaS) and SaaS offering, which runs primarily on SUSE. HEC was designed to help SAP customers reduce their infrastructure and make it easier for businesses to move to S/4HANA. HEC runs OpenStack on SUSE, providing an open, dynamic, and reliable platform that scales effortlessly. The SUSE Linux Enterprise High Availability Extension (detailed in the following sections) manages automated system replication in HEC, which SAP credits for HEC's 99.999% availability.

Public Cloud

Businesses that run HANA on SUSE on-premise and that want to migrate to S/4HANA are not restricted to an on-premise S/4HANA deployment with SUSE as SUSE supports all S/4HANA public cloud deployment options. This allows for a smooth transition from an on-premise approach to a cloud strategy or a combination of the two on the same operating system.

SAP Cloud Platform

SAP Cloud Platform (formerly known as SAP HANA Cloud Platform) is SAP's PaaS, first offered from SAP datacenters and then from partner datacenters. SAP Cloud Platform is an in-memory cloud platform that provides access to a development environment in the cloud, with services for integration, enterprise mobility, collaboration, and analytics. It allows businesses to build, deploy, and manage cloud-based enterprise applications that complement and extend their SAP or non-SAP solutions, either on-premise or on demand. It frees users from infrastructure and IT costs and provides availability, scalability, and multitenancy. Businesses can develop new cloud applications, on-premise extensions (for businesses with extensive on-premise infrastructure), and portable cloud extensions to other cloud products.

Bringing SAP Cloud Platform to Non-SAP Operated Cloud Infrastructure

SUSE is focused on collaboration with SAP around OpenStack – the infrastructure-as-a-service layer – and CloudFoundry, specifically the Cloud Provider Interface (CPI) project, which enables applications that are developed on CloudFoundry to be deployed in various environments – Amazon Web Services, Microsoft Azure, enterprise environments, OpenStack, or providers of cloud-based SAP solutions such as T-Systems. SAP and SUSE have set up a cloud lab staffed by both companies' employees for testing, benchmarking, and developing reference architectures. SAP and SUSE say that they intend to deploy the SAP Cloud Platform outside of SAP datacenters.

IaaS

Working with major cloud service providers has been a high priority for SUSE. The company has heavily focused on Amazon Web Services and Microsoft Azure (which together control about 90% of the market). Microsoft Azure, specifically, has been a focal point for SUSE due to the large percentage of Windows' customers – the first point of entry into a cloud deployment for HANA is and will be Microsoft Azure.

Microsoft Azure

Microsoft and SUSE have been collaborating on interoperability solutions between SUSE environments and Azure for many years. On Microsoft Azure, customers can opt for Azure virtual machines running SUSE, which allow them to scale their HANA applications to 3.8TB of RAM. They may also choose purpose-built hardware with SUSE that is tuned for SAP HANA and facilitates scaling to 20TB on a single node and 60TB on multinode configurations.

Azure offers multiple configurations that have been optimized for OLTP, including SAP Business Suite on SAP HANA or S/4HANA. These range from 2 Intel Xeon E7-8890 v3 processors with 768GB RAM and 3TB storage to 4TB of RAM and 16TB of storage on Intel Xeon E7-8890 v4 processors. M series virtual machines for S/4HANA are also available, and Microsoft states that new, larger environments, all the way up to 20 processors, 20TB of RAM, and 46TB of storage, will be "coming soon."

These are rather large chunks, which mean that for some customers rightsizing will be tricky. It may also be difficult to determine if performance is truly optimal due to IT having less visibility on the underlying infrastructure in a cloud compared with an on-premise deployment.

SUSE Linux Enterprise Server helps strengthen the reliability and security of an S/4HANA environment on Azure, thanks to the full integration with Azure, including patches and support that are delivered directly from SUSE. Replication and disaster recovery are built in and, according to SUSE, comparable to on-premise replication and reliability on SUSE, as is performance.

Amazon Web Services

SUSE has also been working with Amazon on Linux for several years, and Amazon began offering SAP HANA in 2013. Since then, larger instance types for a bring-your-own license (BYOL) deployment mode have been offered, including for Business Suite on HANA and S/4HANA on SUSE, both production and nonproduction. SUSE states that this is a popular offering that represents a sizable revenue stream for the company.

In 2016, SUSE released SAP HANA HA/DR resource agents for Amazon, together with the new X1 instances that Amazon made available. Resource agents had to be specially developed as the AWS infrastructure is different than a typical on-premise infrastructure. X1 was added to the Amazon EC2 memory-optimized instance family for running large-scale, in-memory applications and in-memory databases in the AWS cloud, certified by SAP to run production environments of HANA and S/4HANA. SAP S/4HANA is supported on single-node/scale-up configurations with up to 2TB of memory.

Overcoming Unfamiliarity with Linux

The maturity of enterprise-grade Linux has by now been broadly acknowledged. Linux is available on virtually every architecture, from low-cost, low-power ARM processors to x86-based devices of all sort to IBM z Systems (mainframes), IBM Power, and OpenPOWER systems. In the cloud, Linux has become a de facto standard.

SUSE Linux Enterprise Server 12 Service Pack 2 provides enterprise-grade, mission-critical system reliability and security and comes with a long list of features that help enterprises run, manage, and innovate their infrastructure, including:

- **Security:**
 - FIPS 140-2 certification level 2, which provides alerts when cryptographic keys have been compromised
 - Support for Trusted Platform Module 2.0, a hardware-based secure cryptoprocessor standard
- **HA and reliability:**
 - SUSE Linux Enterprise High Availability Extension offers HA clustering as well as geoclustering across any distance
 - Reliability features that exploit RAS features of the server hardware
 - Full system rollback: Take system snapshots, including kernel files, and roll back
 - Live patching: Update security patches without rebooting
 - Mission-critical support for systems such as IBM z System and LinuxONE, IBM POWER8, and mission-critical x86 and ARM servers
 - SolidDriver to identify compatible software code in new technologies, reducing the risk of deploying kernel drivers
 - Network teaming that combines network connections for performance and redundancy to increase network uptime
 - Support for NVDIMMs which retain data and allow for immediate data restore after a power outage
- **Virtualization:**
 - Virtualization with built-in support for Xen and KVM and containers as well as optimization for VMware vSphere and Microsoft Hyper-V
 - Support for VMware drivers and tools
 - New network function virtualization capabilities
 - Support for Docker in production environments
- **Installation, configuration, and migration:**
 - YaST to quickly customize a system during and after installation, and AutoYaST to automatically upgrade groups of servers
 - Salt configuration management integrated
 - Wicked for complex network configurations (VLAN, bridging, bonding, and IPv6)
 - "Skip service packs" that let customers skip upgrades of prior service packs and go straight to SP2 from SLES 12. SUSE already had a rollback feature
 - Cloud images that make migration from on-premise to cloud easy
- **Support and Windows interoperability:**
 - SUSE customer center provides a complete window on all SUSE subscriptions, information, and support
 - Samba 4 for easy interoperation in Windows and integration with Windows Active Directory Domains

A Closer Look at Some Critical SUSE Features

Windows Interoperability

A large SAP customer segment today is running SAP on SQL server, and for these Windows customers, a migration to SAP HANA on Linux is a double migration, which is potentially further complicated by a lack of Linux's skill sets. SUSE is addressing the needs of these Windows customers with the previously mentioned Service Pack 2 in the form of features integration with Windows desktops and Windows servers.

SUSE has stated that it will release additional features that make it less complex for on-premise Windows customers to make the switch to Linux by making Linux easier to use; covering more workloads, including an automatic setup for clustering; and providing migration support to administrators. Another example is that SUSE has developed a guide to execute common Windows commands in Linux. Plus, its enhanced active directory integration supports both Linux and Microsoft user IDs and passwords, so users don't have to rebuild user accounts. Of course, for those Windows users who want to stay in familiar terrain, S/4HANA on SUSE Linux Enterprise Server for SAP applications on Microsoft Azure can serve as an alternative.

Applying Patches and Updates

SUSE helps reduce downtime with its live Linux kernel patching capability for SUSE running SAP HANA or S/4HANA, which means users can install security and stability patches without interrupting their mission-critical workloads, in-memory databases, or lengthy simulations. This feature, built on open source technology kGraft, also provides cost savings. SUSE expects this feature to be adopted in significant numbers as some SAP HANA and S/4HANA systems can be quite large, possibly 6TB or even 12TB of main memory, and currently, certain Linux patches require a reboot, for example, if there's a kernel bug. Rebooting and then writing back 12TB of memory can take hours, far exceeding any SLA that a datacenter has with its lines of business or a hosting company or managed services company with its customers.

Availability/Disaster Recovery

When SAP introduced the in-memory SAP HANA database, many customers wondered about its availability. If the server goes down (say, the power goes out), will you lose data? This became especially acute when SAP HANA became the underpinnings for a transactional system (SAP Business Suite), not just a data warehouse (BW). Today, new customers moving to S/4HANA may not have prior experience with SAP HANA, as they may be on another database, and they may be worried about data loss.

SAP does provide system replication; however, a failover for disaster recovery needs to be done manually by the administrator, which can take anywhere from a few minutes to an hour or longer. Also, while VMware HA covers a server outage, it does not recognize what application was running in the container.

SUSE HA is application aware, meaning that the HA framework knows whether the SAP application or S/4HANA is running or not. SUSE has collaborated with SAP to integrate its SUSE HA capability into SAP HANA and enable automated failover rather than manual. SAP provides system replication capabilities within SAP HANA, which SUSE leverages to automate failover between two nodes (scale up) or multiple nodes (scale out). Scale out is somewhat more complex, with clusters consisting of potentially dozens of systems on one site being duplicated to another site.

These technologies have been made part of SUSE Linux Enterprise Server for SAP applications; they're not available as standalone products. They are accompanied by additional SUSE software to initiate connectivity to the SAP system. The SUSE software "talks to" SAP NetWeaver or SAP HANA to interpret the signals from these systems before making decisions.

Performance

SAP's requirements for hardware certification are very demanding with regard to a system's performance. SUSE's approach to performance enhancement is through optimization. SUSE provides certification support to its hardware partners, with SUSE engineers working alongside a hardware vendor at SAP's headquarters throughout the certification process to address any performance issues and ensure the greatest possible performance on the vendor's system. The company is also involved with deep engineering efforts in collaboration with hardware vendors outside the SAP certification process.

Furthermore, SUSE develops new features that can help boost performance. One example is the memory cache control capability called Page Cache Management, which provides customers with a high level of control as to how much memory the SUSE OS can access. This functionality (which had been known in Unix environments) allows IT to fine-tune how much memory the OS can use for caching and swapping to prioritize the ERP software's performance over the Linux filesystem.

Security

Security on SUSE is achieved with a wide range of features, certifications, and guides. Recent additions are the earlier mentioned FIPS 140-2 certification, which alerts admins when cryptographic keys have been compromised, and Trusted Platform Module 2.0, a hardware-based secure cryptoprocessor standard.

SUSE also supports AppArmor, a Linux kernel security module that allows an administrator restrict the capabilities of applications by assigning them individual profiles that regulate the amount of network or socket access they are allowed, as well as whether they can read, write, or execute files on matching paths. Another security feature is the Advanced Intrusion Detection Environment (AIDE), which helps perform extra checks on a regular basis to make sure that the administrator still controls the system. While there are other ways to check for undesirable changes to the files in a system, AIDE enables a very targeted verification by allowing an admin to tell which files and attributes should be checked. AIDE can be run completely independently from the installed system.

SUSE incorporates the Linux audit framework, which is a CAPP-compliant (Controlled Access Protection Profiles) auditing system. It gathers information about any security-relevant event on a system, providing admins with the means to determine in detail what is happening on the system and take subsequent action, if necessary.

SuSEfirewall2 is a script that protects a system from network attacks by rejecting or dropping unwanted packets that reach the network interface.

Finally, the SUSE *Security and Hardening Guide* provides 80 pages of detailed recommendations for building a secure environment on SUSE.

FUTURE OUTLOOK

IDC expects that Linux will continue to grow in the datacenter and overtake Windows by 2020. The OS is already dominant in the cloud. At the same time, traditional databases and transactional systems are under assault from various angles, including open source alternatives and SAP. While the former represents an open ecosystem and the latter offers a closed and proprietary environment, both rely on the Linux operating environment. SAP customers that move to SAP HANA and/or S/4HANA have no choice but to adopt Linux, which, today, may still be considered a hurdle, but by the SAP deadline for SAP HANA, adoption in 2025 should not cause any difficulty. By then, avoiding Linux-based applications will simply not be an option anymore for businesses small and large. There is too much to be gained from bringing Linux skill sets in-house.

Nevertheless, we do expect that S/4HANA deployments as PaaS will help businesses avoid the complexities of migrating. SAP is pushing hard for SAP's customers to take this route, and IDC expects that many will opt to forego the heavy lifting of server and OS migration and pay for an S/4HANA cloud service instead. This will give them less control over the environment and more concerns about the security of the deployment. While IDC expects security to become as strong in the cloud as it can be on-premise today, we are not there yet. Having said that, a PaaS deployment does avoid needing in-depth Linux familiarity on-premise, while still enjoying the Linux features that an SAP-certified provider such as SUSE makes available in the cloud.

S/4HANA in the cloud, especially when fortified with such elements as SUSE's HA extension, will also encourage businesses to leapfrog SAP HANA and move straight to the completely rewritten transactional-analytical system that provides the many innovations described earlier in this document. Certainly, smaller businesses and businesses with little customization in their SAP landscape will reap the benefits from this approach.

CHALLENGES AND OPPORTUNITIES

Customers

- **Challenge:** Establishing a smooth transition from where they are to S/4HANA, given the large number of moving parts
- **Opportunity:** Consolidating their business OLTP (with some analytics/read/query) on a much smaller footprint that runs on a continuously improved operating environment that is based on open source innovation and optimized for S/4HANA

SUSE

- **Challenge:** Helping Unix, z/OS, and, especially, Windows customers make the leap to Linux for their S/4HANA migration – the former will be skeptical of Linux capabilities for mission-critical SAP landscapes, while the latter will be concerned about needing to understand a new operating system and how that integrates in their overall Windows environment
- **Opportunity:** Bringing in large numbers of new customers by making the transition as easy as possible for them

CONCLUSION

With SAP HANA and S/4HANA, SAP has brought forth impactful innovations for database and business applications in terms of new functionalities and vastly greater performance that businesses can benefit from. The adoption of S/4HANA is growing steadily both among existing and new SAP customers, and SAP continues to roll out more industry-specific S/4HANA functionalities. But the impact is also felt by the infrastructure team in these businesses that manages the hardware and operating environment that they run their databases and business applications on – server and storage hardware must be SAP certified, and SAP HANA only runs on the Linux operating system. Businesses that are ready to make the switch will be heartened by the many S/4HANA deployment options available to them, from on-premise to IaaS to SaaS to PaaS. They can also take comfort in the extensive work that SUSE has done in collaboration with SAP to build a comprehensive operating environment underneath S/4HANA, both on-premise and in various cloud scenarios. Not only has SUSE brought high availability, security, performance, and hardware optimization features to these deployments, the company is also intensely focused on making the switch to S/4HANA easy for Linux and non-Linux users alike. Features like Windows interoperability are very useful for current Windows users. IDC believes that the close collaboration between SAP and SUSE has led to an optimal environment for making the switch to S/4HANA.

About IDC

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