

## SUSE and SAP HANA on POWER

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# Agenda

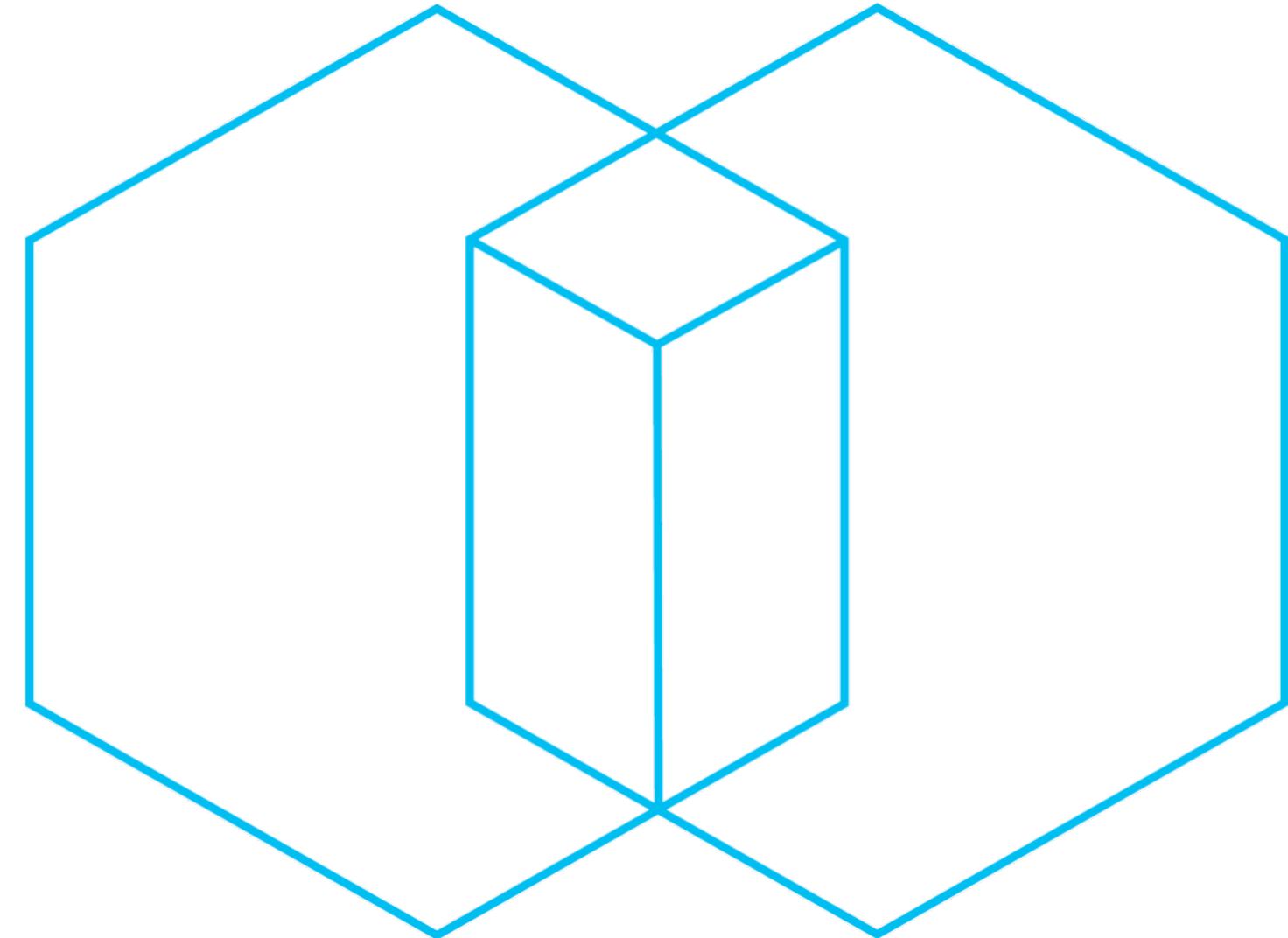
- SUSE Company update & Portfolio
- SUSE + IBM
- SUSE + IBM + Power
- SLES for SAP
- Why SAP HANA for SUSE on POWER?
- Moving from AIX to Linux for SAP HANA
- SAP deployment scenarios
- SAP environments management with SUSE Manager for POWER
- Competitive analysis



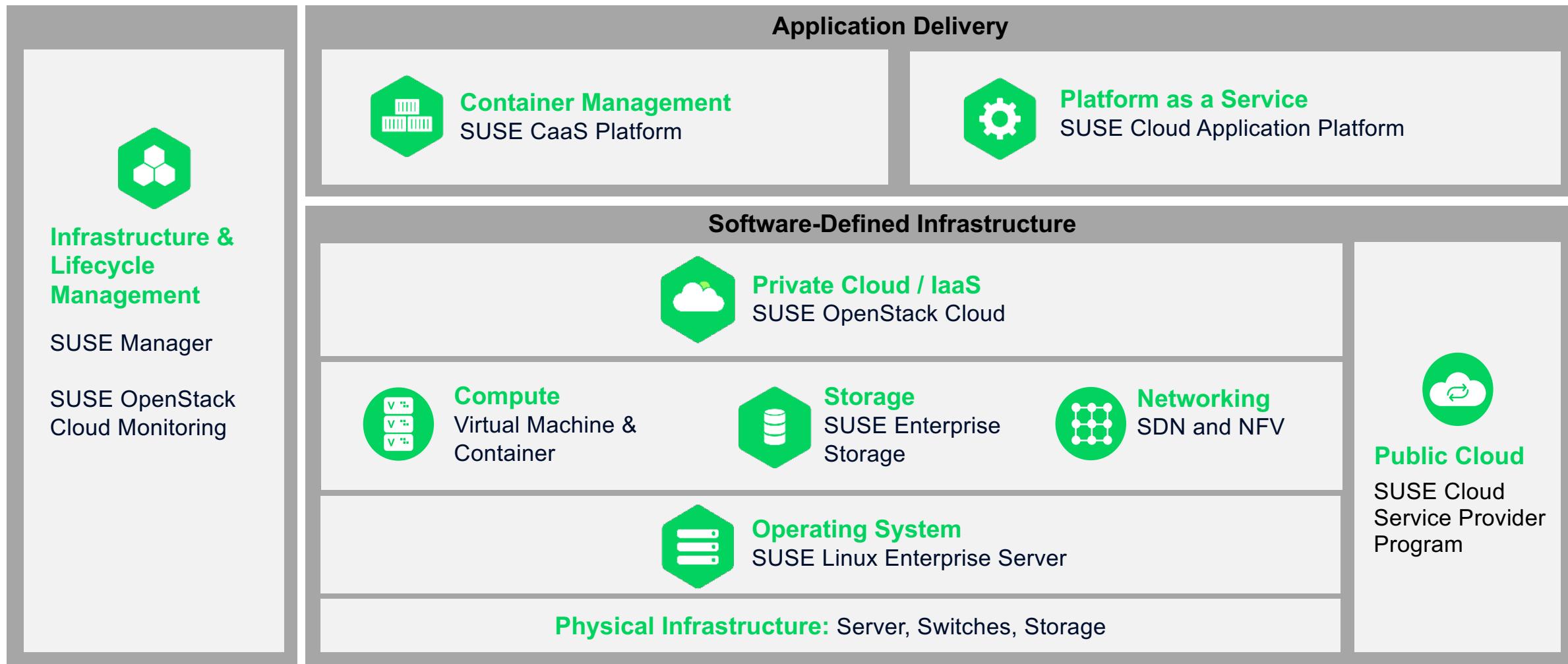


# SUSE Today

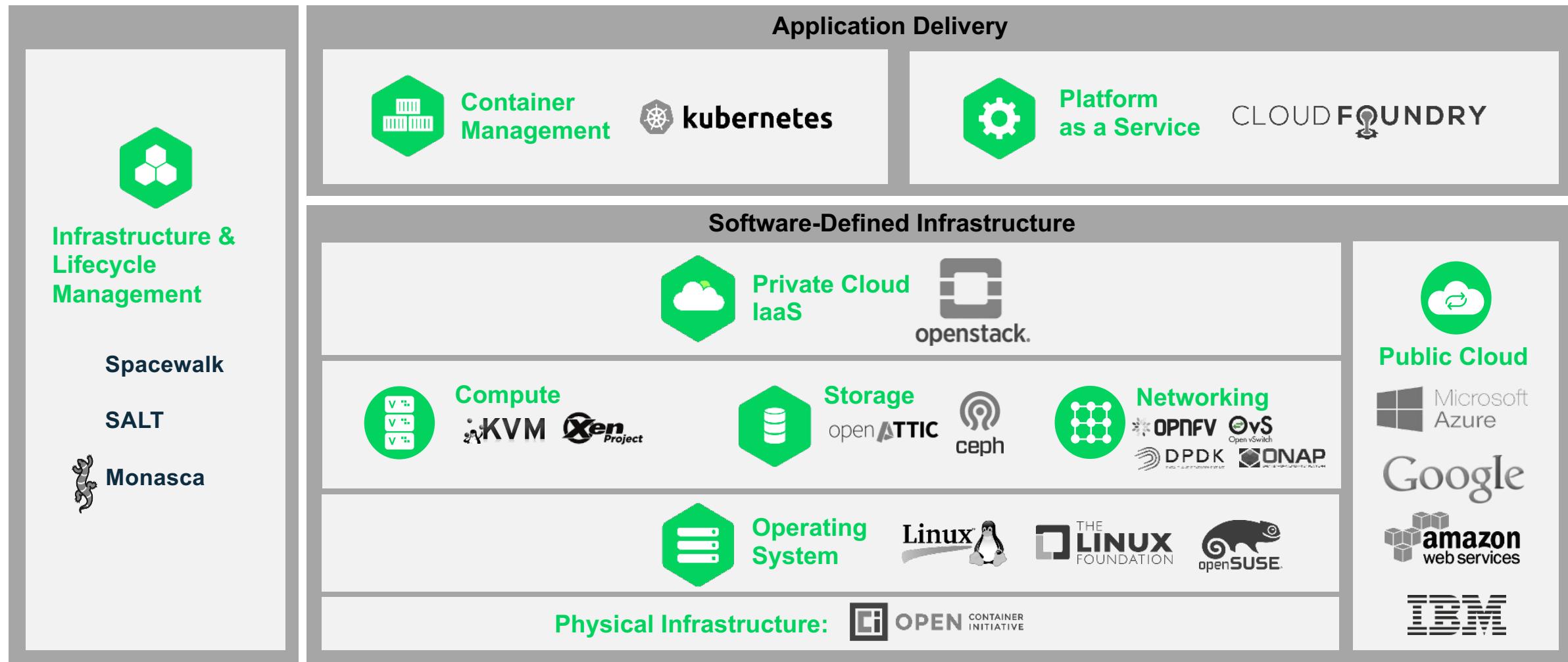
Company update & portfolio



# SUSE Software-defined Infrastructure and Application Delivery Approach



# Open Source at the Heart of Our SDI and Application Delivery Approach



# Product Portfolio

## Server and Desktop

- SUSE Linux Enterprise Server
- SUSE Linux Enterprise Server for System z and LinuxONE
- SUSE Linux Enterprise Server for POWER
- SUSE Linux Enterprise Server for ARM
- SUSE Linux Enterprise Server for SAP Applications
- SUSE Linux Enterprise Server for High Performance Computing
- SUSE Linux Enterprise Real Time
- SUSE Linux Enterprise Server with Expanded Support
- SUSE Linux Enterprise Point of Service
- SUSE Linux Enterprise Desktop

## Server Extensions

- SUSE Linux Enterprise High Availability Extension
- GEO Clustering for SUSE Linux Enterprise High Availability Extension
- SUSE Linux Enterprise Workstation Extension
- SUSE Linux Enterprise Virtual Machine Driver Pack
- Long Term Service Pack Support
- SUSE Linux Enterprise Live Patching

## Cloud, Containers, Storage and Management

- SUSE OpenStack Cloud
- SUSE Enterprise Storage
- SUSE Manager
- SUSE Manager Management Pack for Microsoft System Center
- SUSE Containers as a Service Platform
- SUSE Platform as a Service<sup>1</sup>
- SUSE Studio

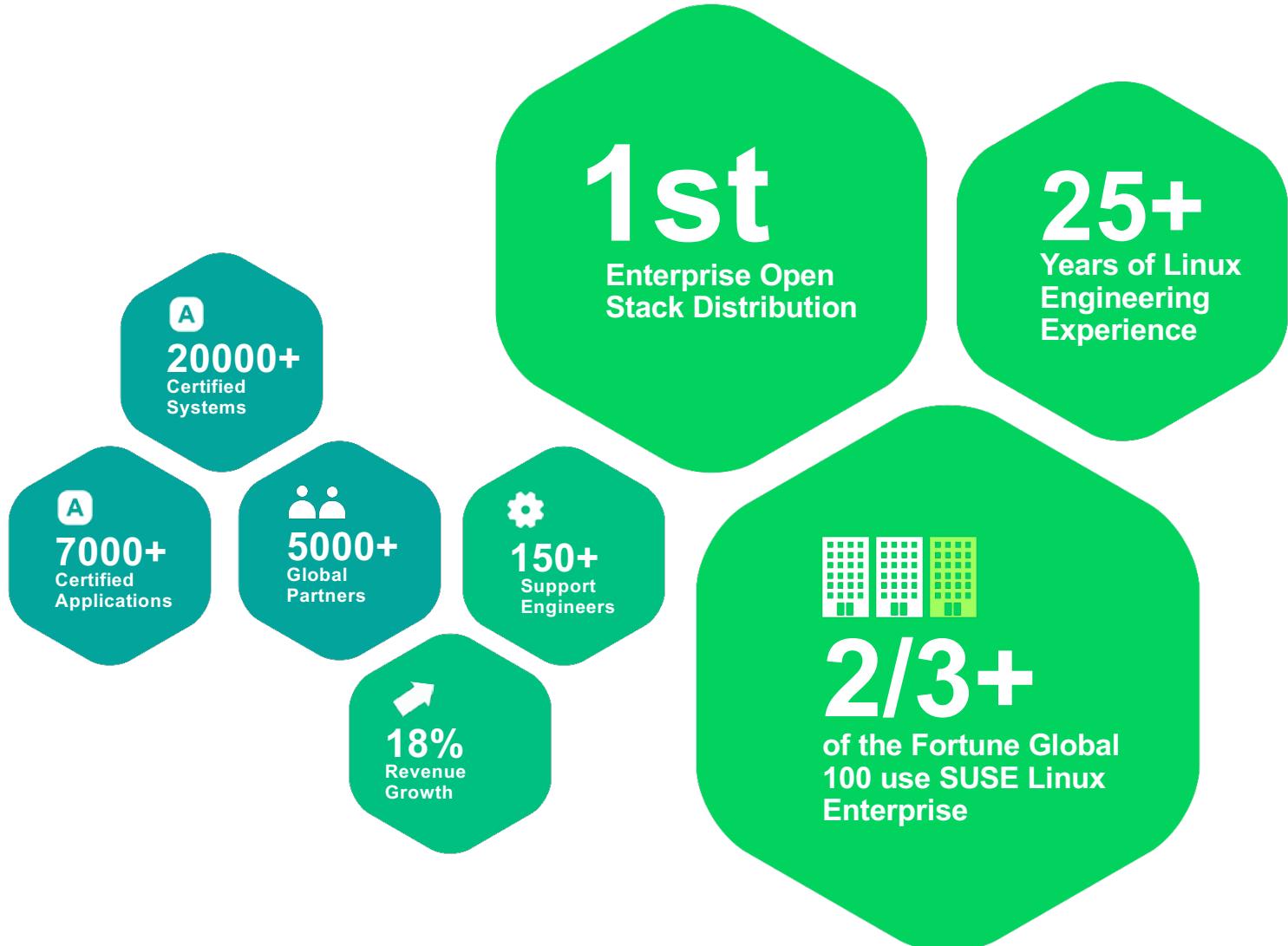
# Leading Technology Innovation

## SUSE has been the first to:

- Develop enterprise Linux on SAP HANA, AWS and Azure public cloud
- Lead development of the commercial Linux market by delivering the first commercially supported Linux distribution
- Allow instant rollback of operating system changes
- Pioneer continuous availability through live patching for mission-critical systems, including SAP HANA environments
- Deliver a Linux high availability solution that supports geographic mirroring with a broad set of redundancy configurations
- Champion for simplified single system Linux configuration and management
- Deliver the first commercially supported OpenStack distribution
- Bring an innovative approach to simplify the deployment of configurable infrastructure (OBS)
- Give consistent support on multiple system architectures by using a common code base
- Provide efficient multiple systems software and asset management built on leading open source technology such as Salt
- Facilitate DevOps adoption through inclusion of Docker technology in SUSE Linux Enterprise Server
- Create the Portus project to simplify and secure management of Docker registries



# SUSE at a Glance



# Where SUSE Leads

70% 

## SAP on Linux

70% of all SAP applications running on Linux run on SUSE

95% HANA systems based on SUSE

x10 

## Linux in Telecom

10 of the largest telecommunications carriers rely on SUSE

x10 

## Linux in Automotive

10 of the largest global automobile mfgs. are active SUSE customers

15+ 

## Mainframe Linux

Over 15 years of mainframe Linux market share leadership

80% 

## Linux in Large Enterprise

Over 80% of the Fortune Global 50 are active SUSE Customers

7/10 

## Linux in Pharma

7 out of 10 of the largest pharmaceutical companies use SUSE Linux Enterprise

50% 

## Linux in HPC

Half of the world's 20 largest super computers run on SUSE

4/5 

## Linux in Finance

4 out of 5 of the world's largest banks use SUSE Linux Enterprise

9/10 

## Linux in Aerospace

9 out of 10 of the largest aerospace companies rely on SUSE

7/10 

## Linux in Retail

7 out of 10 of the largest retailers in the U.S. are active SUSE customers

7/10 

## Linux in Manufacturing

7 out of 10 world's largest manufacturers use SUSE Linux Enterprise

# Community Involvement

|  |   |   |  |  |  |
|--|---|---|--|--|--|
|  <b>OPEN CONTAINER INITIATIVE</b> |  <b>mozilla FOUNDATION</b> |  <b>QEMU</b>                   |  <b>spec</b>            |  <b>GNOME™</b>                |  <b>openHPC</b>                             |
|  <b>iVISOR PROJECT</b>            |  <b>YaST</b>               |  <b>openstack</b>              |  <b>KVM</b>             |  <b>Spacewalk</b>             |  |
|  <b>OPEN MAINFRAME PROJECT</b>    |  <b>X.Org</b>             |  <b>openSUSE.</b>              |  |  <b>HighAvailability</b>      |  <b>open build service</b>                  |
|  <b>MariaDB</b>                 |  <b>OPNFV</b>           |  <b>openinventionnetwork</b> |  <b>Xen™</b>           |  <b>THE LINUX FOUNDATION</b> |  <b>ceph</b>                               |
|  |   |   |  <b>CLOUD FOUNDRY</b> |  <b>ESDA</b>                |  <b>Electronic System Design Alliance</b> |

# Micro Focus International



**7th**

Largest pure-play software company in the world.

**5,000+**

Partners

**40,000**

Customers

**2nd**

SW company in Europe

**\$4.4B**

Annual Revenue

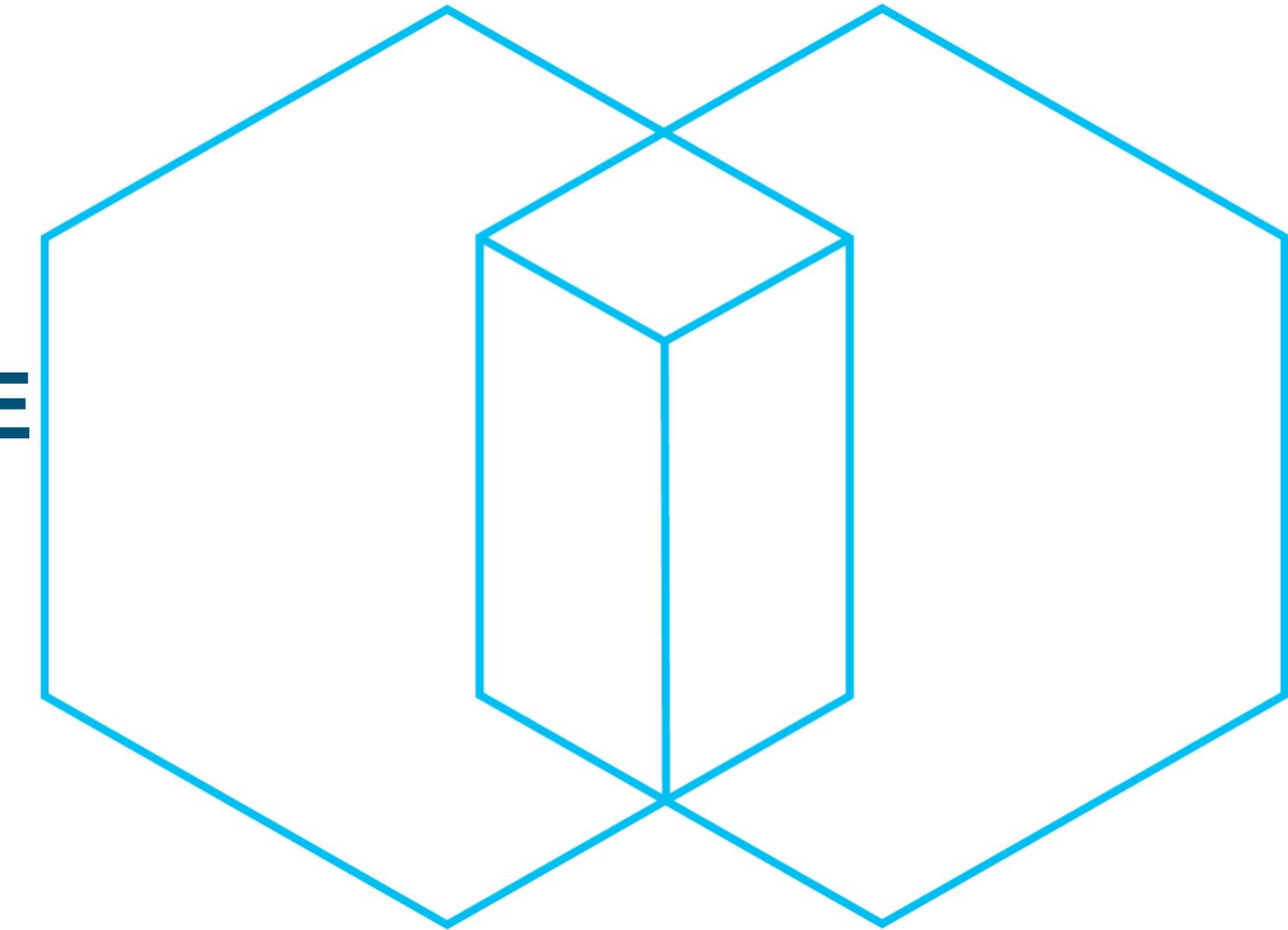
**45+**

Countries



# IBM + SAP + SUSE

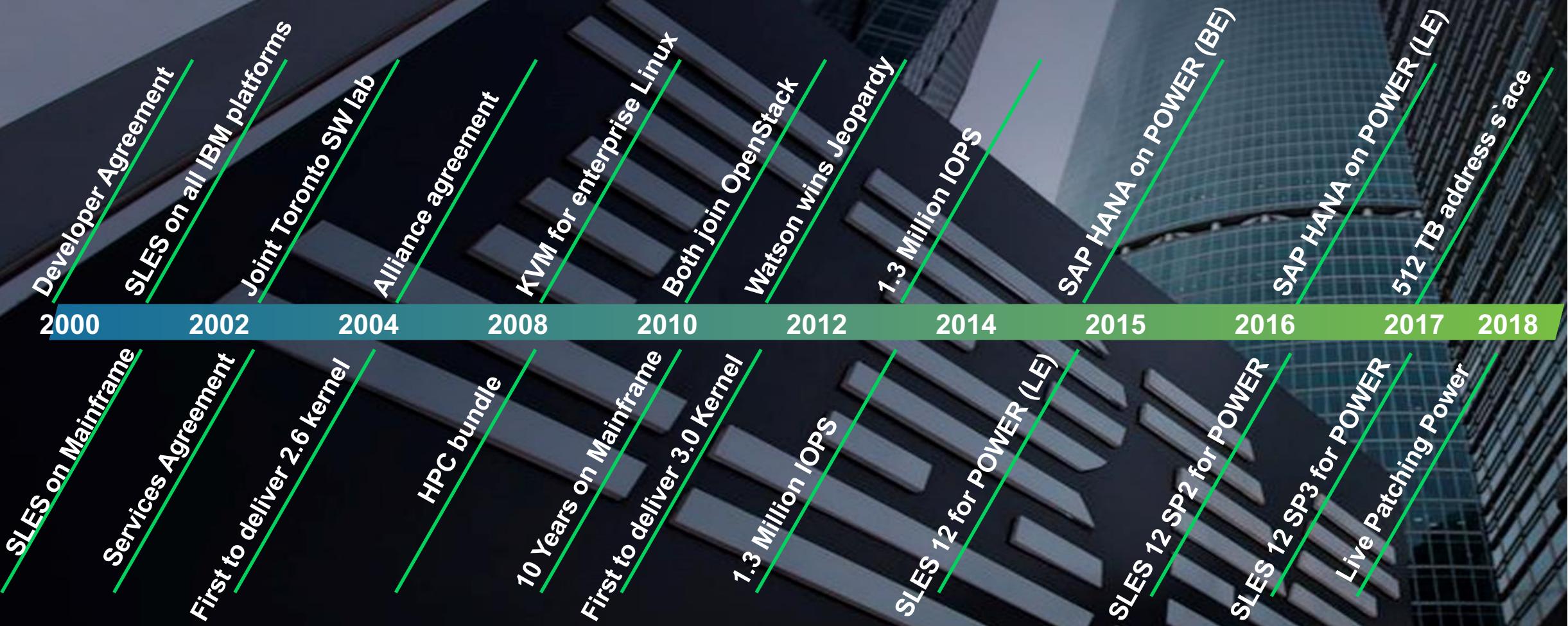
More than partners!





## Enabling Advanced Data Center Solutions for More Than 20 Years

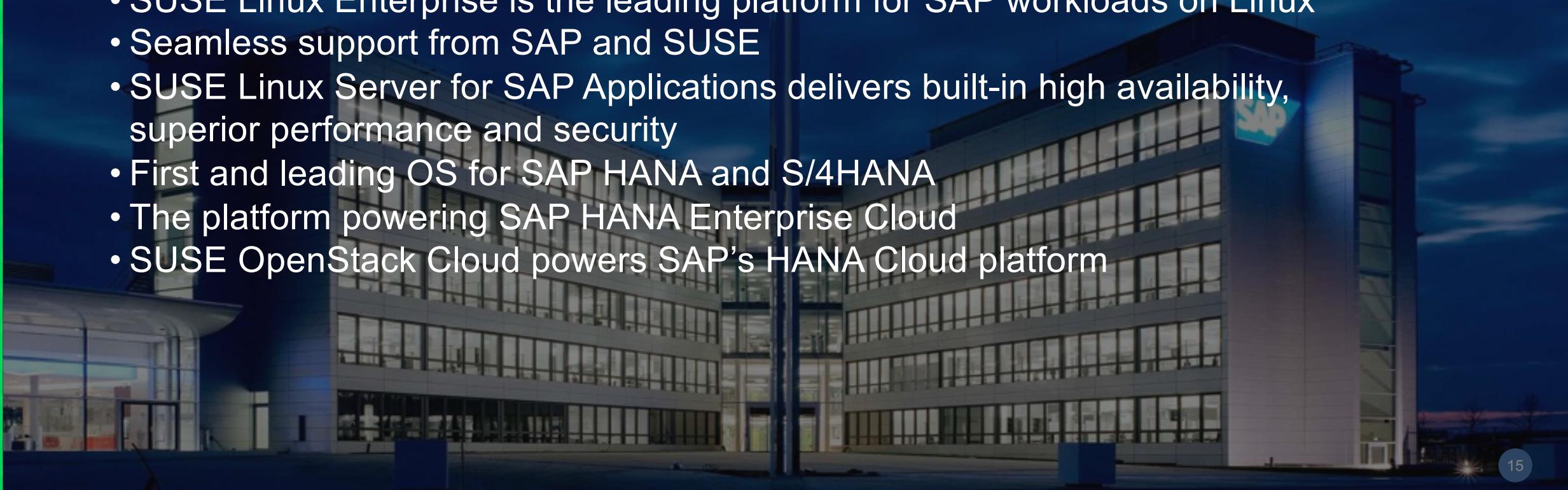
- 20 years of Linux collaboration and leadership for zSystems and LinuxONE
- First to bring enterprise Linux to Power
- SUSE Linux Enterprise Server for SAP Applications is the default distribution for SAP HANA and H/4HANA on IBM Power Systems
- Only distribution with z/VM and KVM support in SUSE OpenStack Cloud
- Tight integration between IBM and SUSE engineering





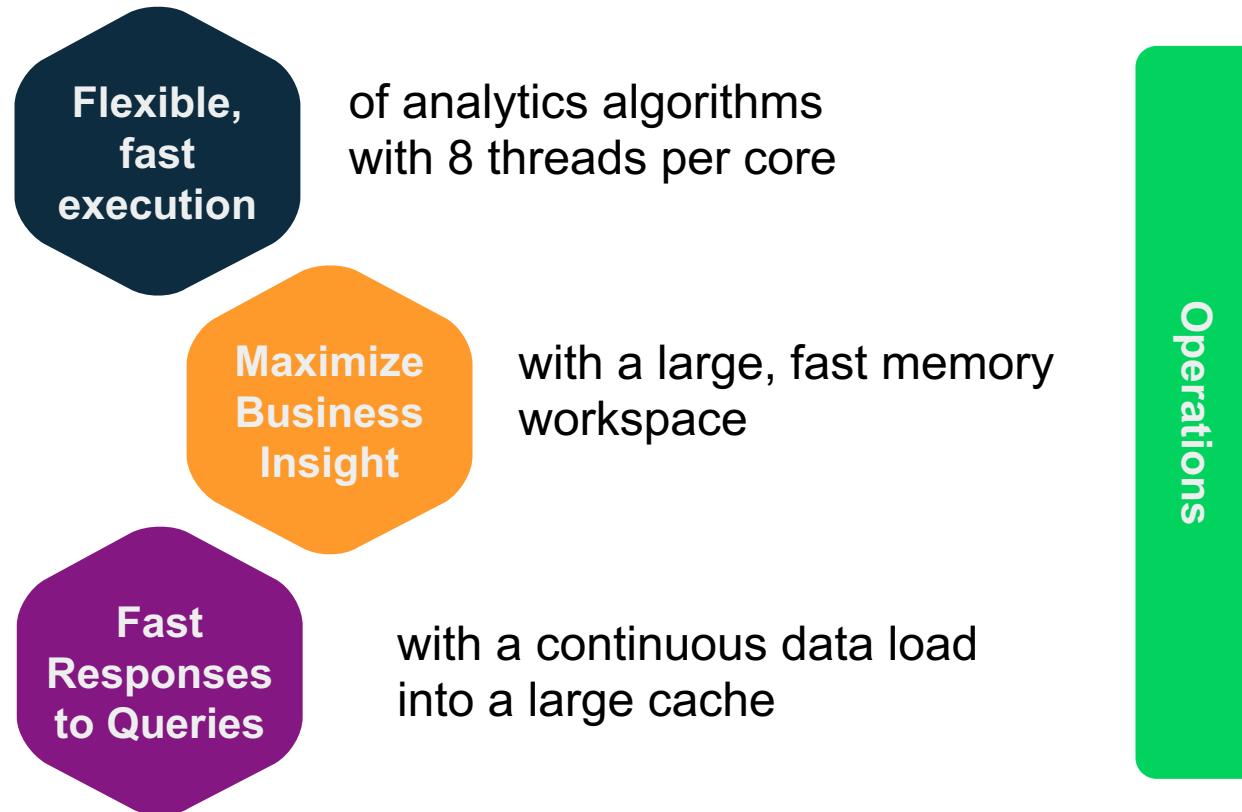
## **Unrivaled Relationship Making SUSE the Smart Choice for SAP Workloads**

- 17+ years of joint testing and development at the SAP LinuxLab
- Joint collaboration on Cloud Foundry
- SUSE Linux Enterprise is the leading platform for SAP workloads on Linux
- Seamless support from SAP and SUSE
- SUSE Linux Server for SAP Applications delivers built-in high availability, superior performance and security
- First and leading OS for SAP HANA and S/4HANA
- The platform powering SAP HANA Enterprise Cloud
- SUSE OpenStack Cloud powers SAP's HANA Cloud platform



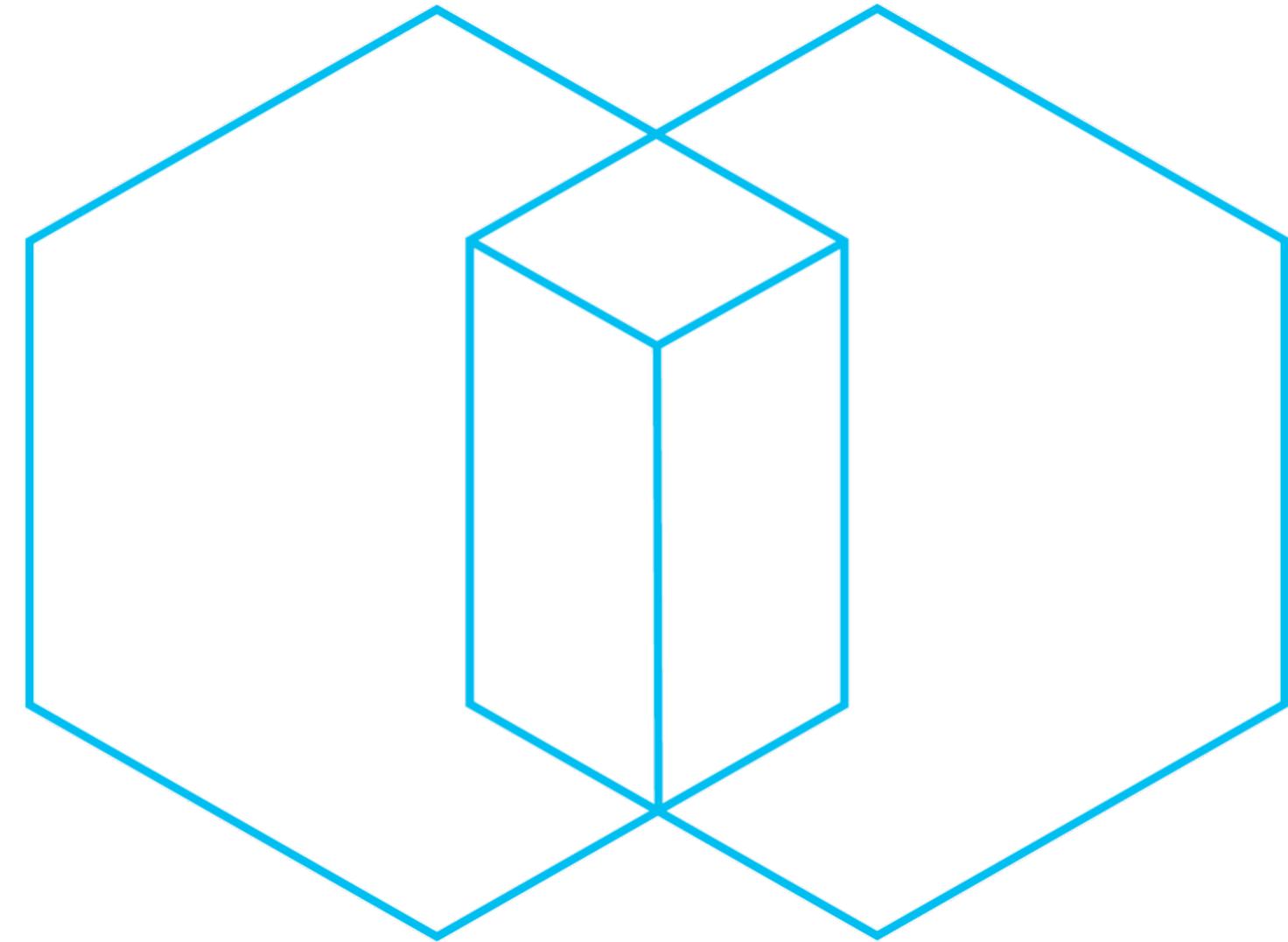
# SAP + SUSE beyond x86

## SUSE and IBM Offer a Solution for Fast and Reliable SAP Architectures





# SUSE for POWER



# SUSE Linux Enterprise Server for POWER



Optimized for IBM Power Systems to deliver outstanding reliability, performance and faster innovation for data-intensive, mission-critical workloads.

- **Increase reliability** and reduce costs for mission-critical applications.
- **Deliver a high-performance platform** with improved application performance and instant access to data.
- **Accelerate innovation and improve deployment times** for a broad choice of open source and partner solutions.

**99.999%**

System Availability  
Supporting Smooth  
Operations

**60%**

Faster Business  
Processing

**75%**

Shorter  
Development  
Times

# Recent history of SUSE Linux on POWER



## (2016) Bigmem kernel for SLES for SAP Applications 11 SP4

- Increased memory support to 32TB with up to 2058 processors for SAP HANA

## (2018) Live Patching for Power

## (2016) SUSE Linux Enterprise Server (SLES) 12 SP2 for POWER

- High Availability Extension
- Support for Power LC systems
- Package Hub for SLES for POWER LE

## (2017) SLES for SAP Applications 12 SP3 for POWER

- 512TB address space
- POWER9 enablement

## (2017) SUSE Manager server on Power

## (2018) Support for Nutanix Hyperconverged solution

- CS821 CS822 certified for SLES 11 SP4 and SLES 12 SP3

## (2017) SUSE Manager Server on POWER

## (2016) LTSS for SLES 11 SP4 (big-endian)

- Extends subscription life to March 2022



# The ideal solution for SAP landscapes

## Run Simple



- One Linux OS for SAP HANA, S/4HANA and NetWeaver
- Automated set-up of SAP landscapes



- Consolidate and reduce the number of systems to eliminate complexity, minimize points of failure, reduce latency and simplify management

## Run Fast



- Optimized for faster processing
- Sustained high performance of SAP applications

- Make business decisions faster even for complex analytics
- Maximize performance and response with latest POWER8 and enablement for POWER9

## Run Smart



- Built-in resilience for mission-critical SAP systems
- Data security

- On premise, elastic computing with Capacity on Demand
- Migrate workloads before failures



# POWER9 Exploitation

## POWER9 enabled in SLES 12 SP3

- Only Linux running in POWER9 mode

## More exploitation planned for SLES 12 SP4 and SLES 15

- Additional performance and debugging capabilities



# Support for Nutanix Hyperconverged solution for Power

- CS821 CS822 certified for SLES 11 SP4 and SLES 12 SP3



# **Increased Process Address Space**

**Many SAP HANA customers noticed the system runs out of virtual memory due to virtual memory fragmentation. x86 supports up to 128TB**

**Prior to SP3, SLES 12 on POWER only supported 64TB process virtual address space.**

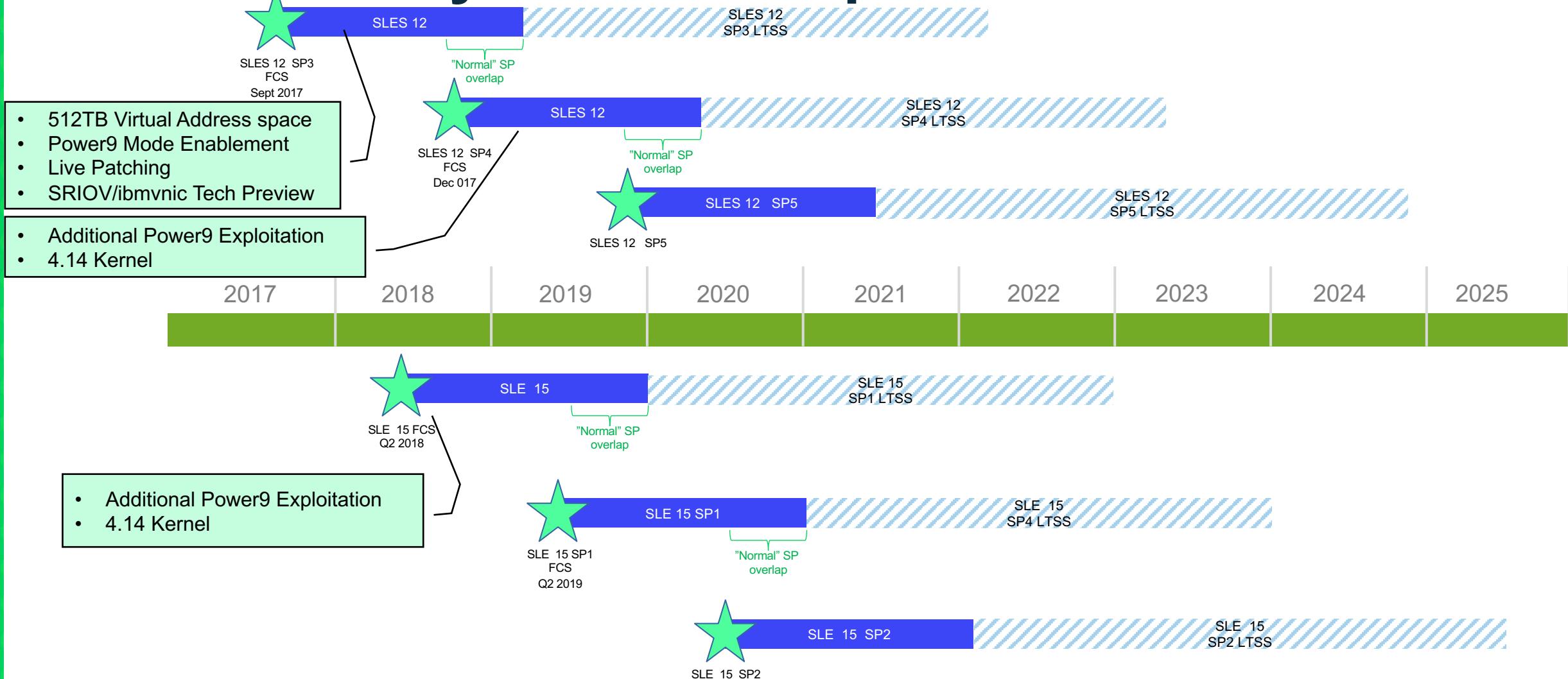
**Solution: SLES 12 SP3 increases address space to 512TB**

And we increased SLES 11 SP4 to 128TB with the Bigmem kernel

<https://kruemcke.wordpress.com/2018/02/06/sap-hana-on-power-feeling-a-little-cramped-128tb-support-for-sles-11-sp4-can-help/>

<https://www.suse.com/support/kb/doc/?id=7018408>

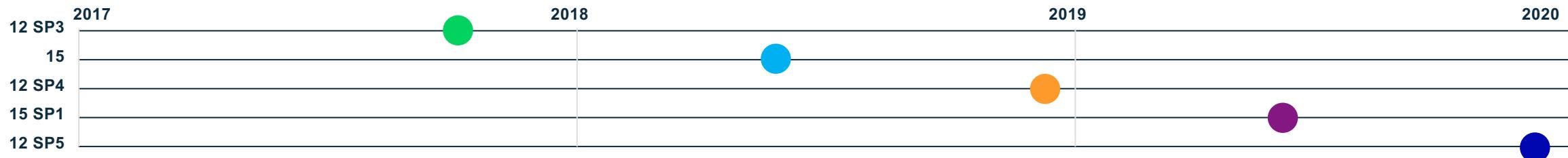
# SLES Lifecycle Roadmap\*



\*NOTE: All future dates are estimates for illustration purposes and are not intended as committed dates.



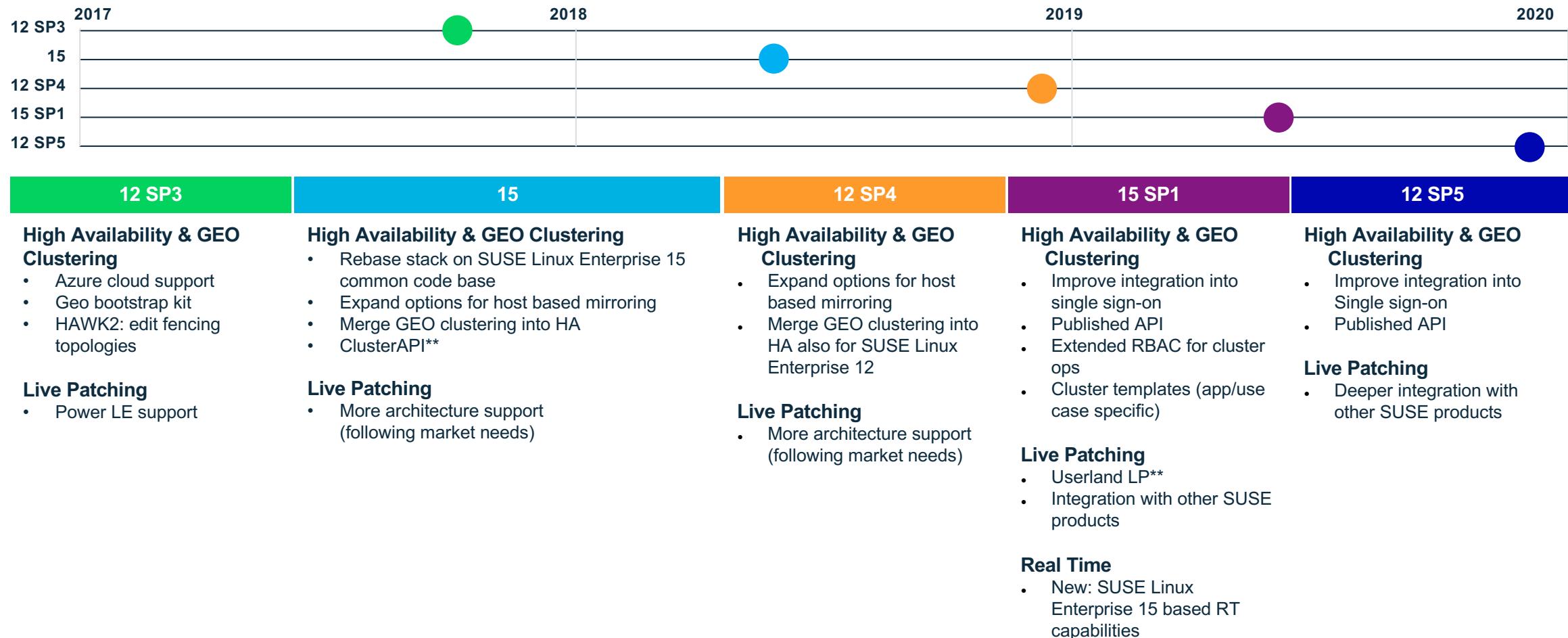
# SUSE Linux Enterprise—Base OS / Modules



| 12 SP3  | 15   | 12 SP4   | 15 SP1   | 12 SP5  |
|---|--|--|--|---|
| <b>Base OS</b> <ul style="list-style-type: none"><li>SUSE &amp; partner selected HW enablement, including driver updates</li><li>Improved performance</li><li>Common code base with SUSE Container as a Service Platform</li><li>Foundation for SDN/NFV</li></ul> <b>Modules</b> <ul style="list-style-type: none"><li>Toolchain update</li><li>Salt software stack in the Advanced Systems Management module</li><li>HPC module for x86-64 and arm</li></ul> | <b>Multi mode OS delivery SUSE Linux Enterprise Server and Desktop, SUSE Linux Enterprise Server for SAP Applications + Modules + Extensions</b> <ul style="list-style-type: none"><li>General purpose OS versions</li><li>Multiple use cases (physical, virtual, containers)</li><li>Full set of deployment, management options; Full control of the installed packages, updates, upgrades</li><li>Continue major version upgrade support including auto-upgrade</li></ul> <b>Common Code Base</b> <b>Architecture/platform support</b> <ul style="list-style-type: none"><li>Arch64, x86-64, ppc64le, s390x</li><li>Designed for physical, virtual, clouds &amp; containers - Ready for IoT</li></ul> <b>Security</b> <ul style="list-style-type: none"><li>Cryptography (TLS 1.3), trusted computing, prepared for certifications</li></ul> | <b>Base OS</b> <ul style="list-style-type: none"><li>HW enablement via Kernel version update, following upstream</li><li>Update of the graphics stack, not including Gnome</li></ul> <b>Modules</b> <ul style="list-style-type: none"><li>Toolchain update</li><li>Refresh of module packages according to separate lifecycle of modules</li></ul> | <b>Base OS</b> <ul style="list-style-type: none"><li>SUSE &amp; partner selected HW enablement, including driver updates. NVDIMM!</li><li>Improve "system roles"</li><li>Finalize common criteria certifications and FIPS 140-2 validation</li><li>Migration from SUSE Linux Enterprise 11 SP4 to SUSE Linux Enterprise 15 SP1</li><li>Improve SAML2 single sign-on framework</li></ul> <b>Modules</b> <ul style="list-style-type: none"><li>Enhancements to Developers Module according to customer and partner demand</li></ul> <b>Ease of use</b> <ul style="list-style-type: none"><li>Quarterly updates of installation media</li></ul> | <b>Base OS</b> <ul style="list-style-type: none"><li>Last service pack for SUSE Linux Enterprise 12 (tentative)</li><li>Consolidation release</li><li>Constant user land (minor version upgrades by need or business case)</li><li>Reuse kernel from SP4 + very selected hardware innovations (including graphic stack)</li></ul> <b>Modules</b> <ul style="list-style-type: none"><li>Latest GCC version in the Toolchain module</li></ul> |
| <b>Hardware Architectures:</b> Intel 64 / AMD64 – IBM z and LinuxONE – IBM Power – arm<br><b>SUSE Linux Enterprise Server for SAP Applications</b> inherits features from BaseOS and modules. Available on Intel/Arm and IBM Power  |  |  |  |   |

\* Information is forward looking and subject to change at any time.

# SUSE Linux Enterprise—Mission Critical

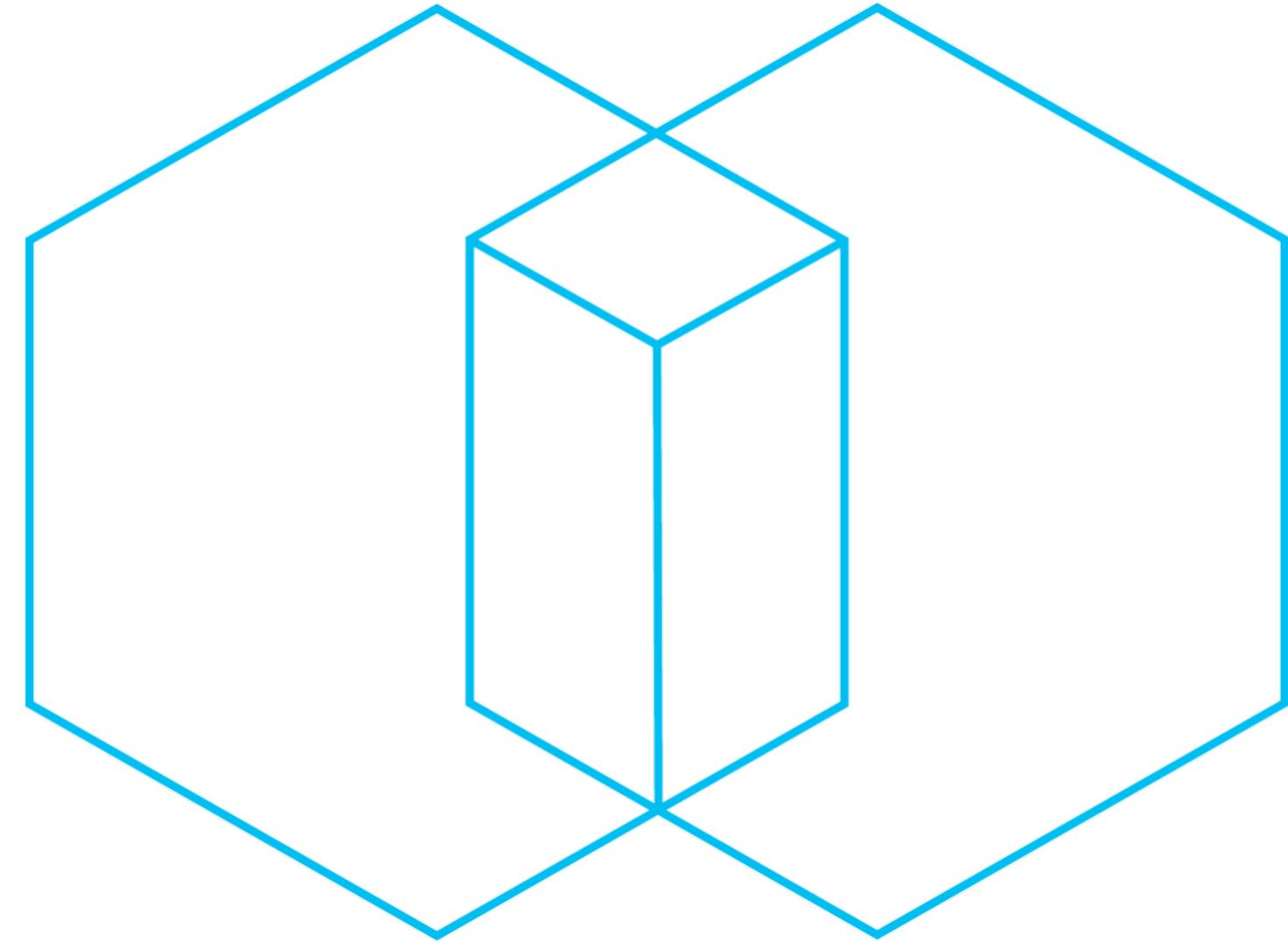


\*\* Items are tech preview

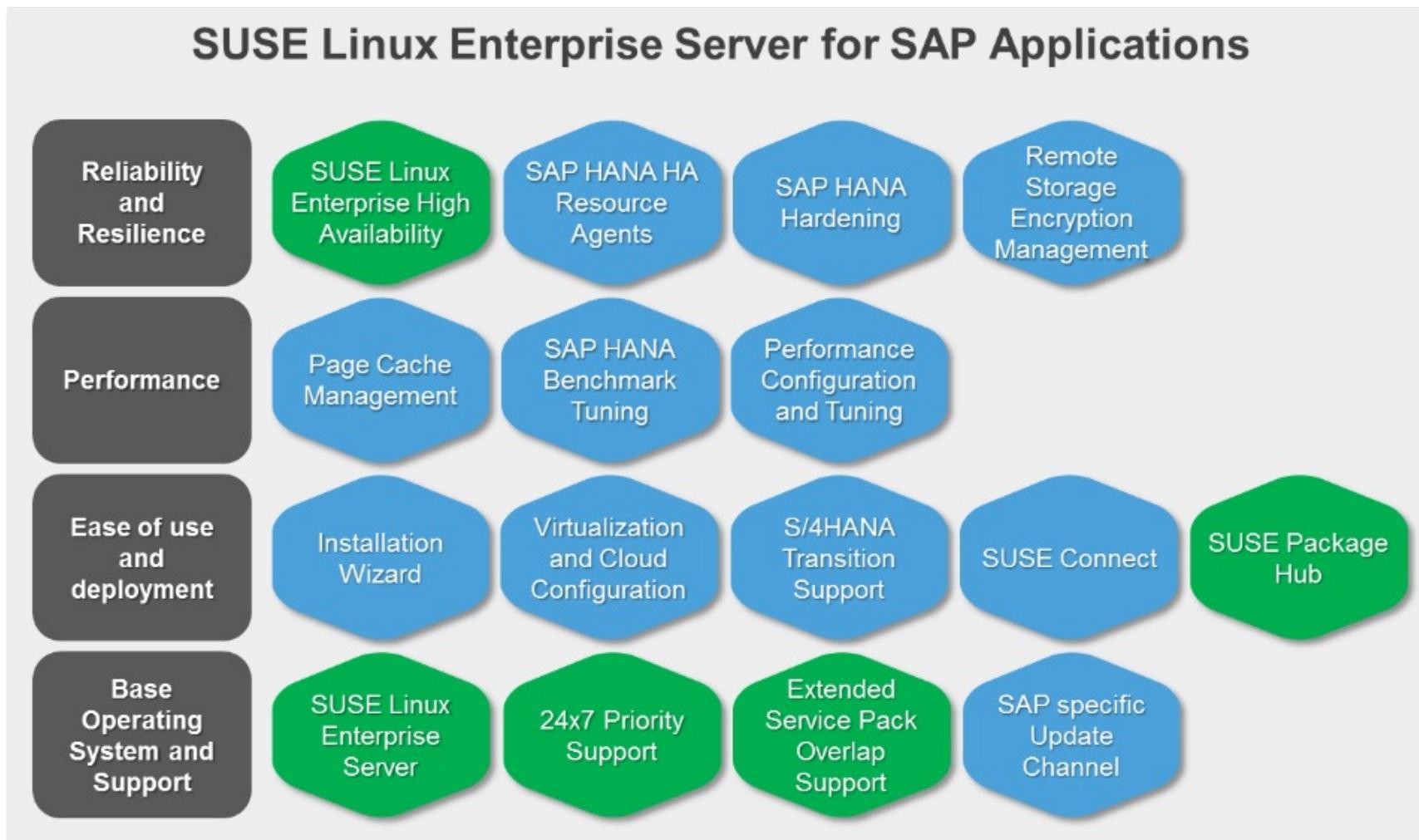
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# SLES for SAP



# SUSE delivers the ideal platform for SAP landscapes



SUSE products and services



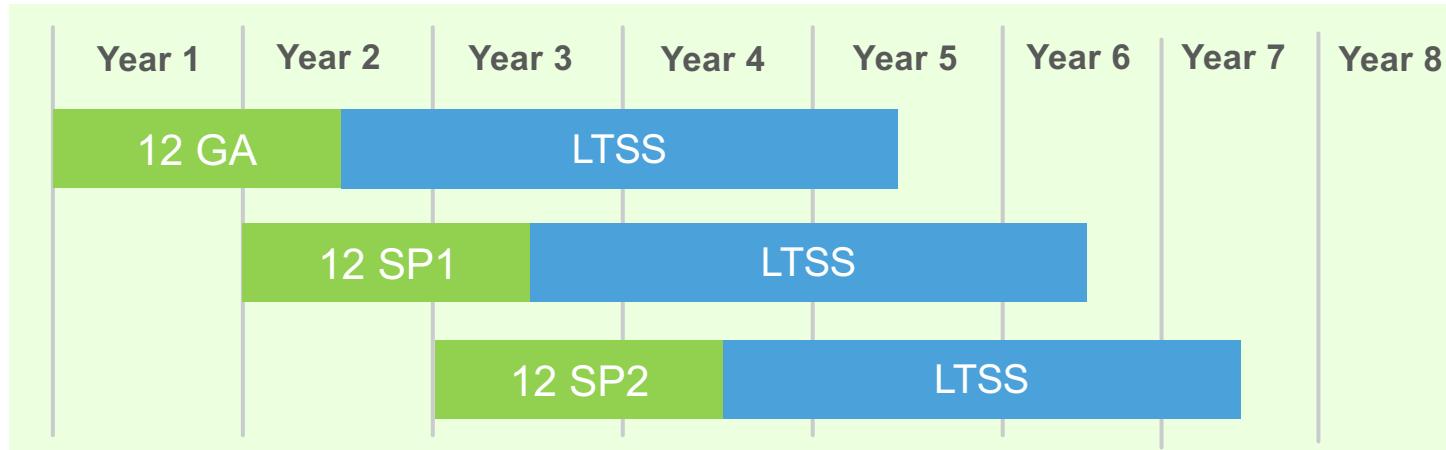
SUSE features for SAP systems

| Technology / Feature                          | SUSE Linux Enterprise Server for SAP Applications                   | SUSE Linux Enterprise Server                                 |   |
|---|---|--|---|
| Operating System                              | Core Distribution   | Core Distribution  | Core Distribution   |
| System management / Patching / Load balancing | Core Distribution   | Core Distribution  | Core Distribution   |
| High Availability and Disaster Recovery       | Included  | Add-on (SUSE Linux Enterprise High Availability Extension)   |   |
| Automated SAP HANA Failover and Recovery      | Included  | Not available  |   |
| SAP HANA Firewall                             | Included  | Not available  |   |
| Remote Disk Encryption                        | Included  | Not available  |   |
| Page Cache Management                         | Included  | Not available  |   |
| Installation Wizard                           | Included  | Not available  |   |
| Automated configuration and tuning            | Included  | Not available  |   |
| SAP S/4HANA Transition Support                | Included  | Not available  |   |
| Support options                               | 24 hours x 7 days (Priority)  | 12 hours x 5 days (Standard) or 24 hours x 7 days (Priority) |   |
| SUSE Level 3 Support Direct Access            | Included  | Not available  |   |
| Update Support                                | 1 year + Add-on (Long Term Service Pack Support)                    | Add-on (Long Term Service Pack Support)                      |   |
| SUSE Package Hub                              | Core Distribution   | Core Distribution  |   |
| SUSE Connect                                  | Included  | Not available  |   |
| Server platform support                       | x86-64, ppc64, ppc64le  | x86-64, ppc64, ppc64le, s390x                                |   |
| Systems Management                            | Add-on (SUSE Manager)   | Add-on (SUSE Manager)  |   |
| Live Kernel Patching                          | Add-on (SUSE Linux Enterprise Live Patching)                        | Add-on (SUSE Linux Enterprise Live Patching)                 |   |
| Public Cloud Templates                        | Amazon Web Services, Google Compute Cloud, BlueMix, Microsoft Azure | IBM  | Amazon Web Services, Google Compute Cloud, BlueMix, Microsoft Azure |

# 1 additional year of Service Pack support for SAP systems



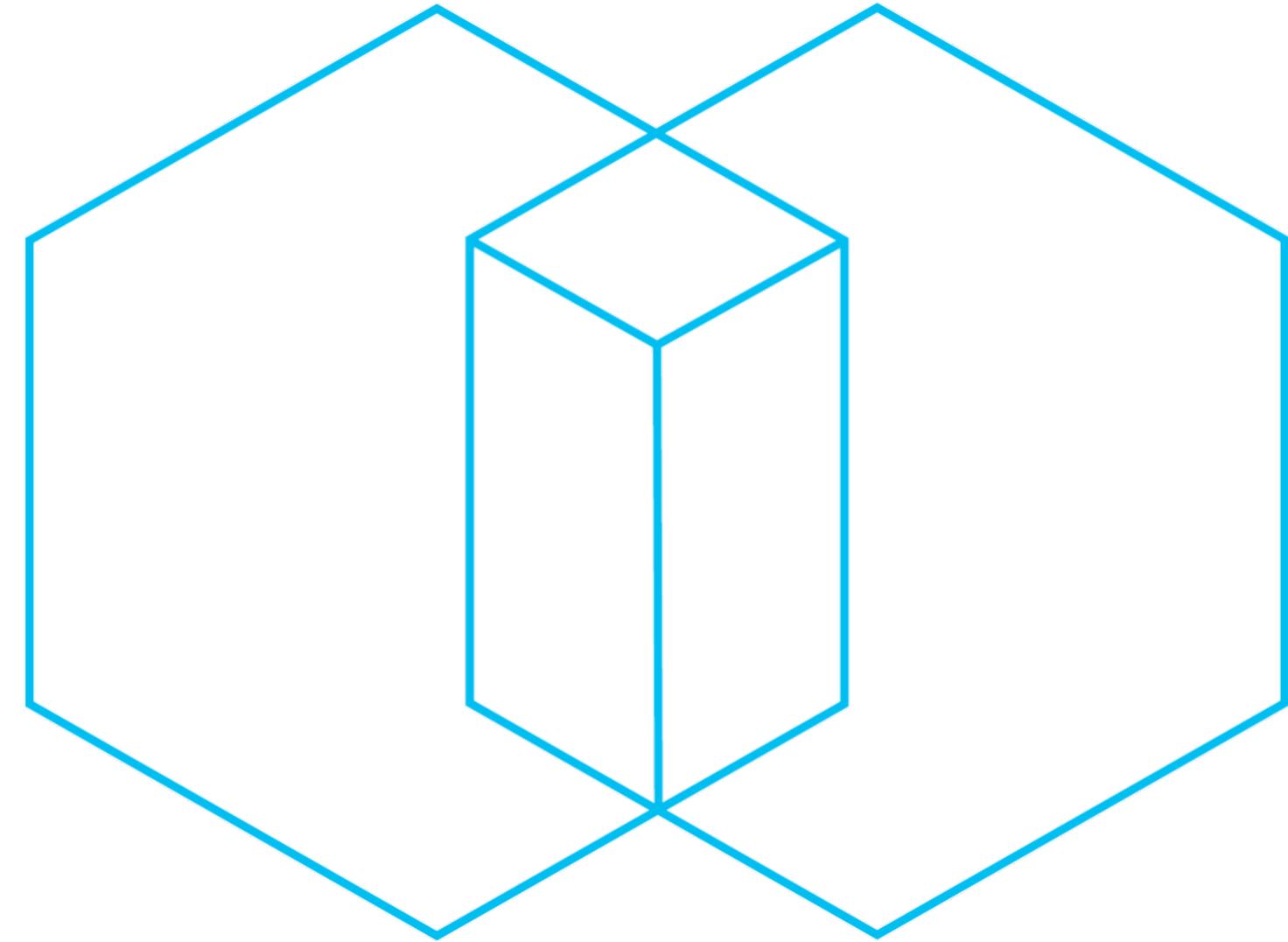
4.5  
years  
of support



4.5  
years  
of support

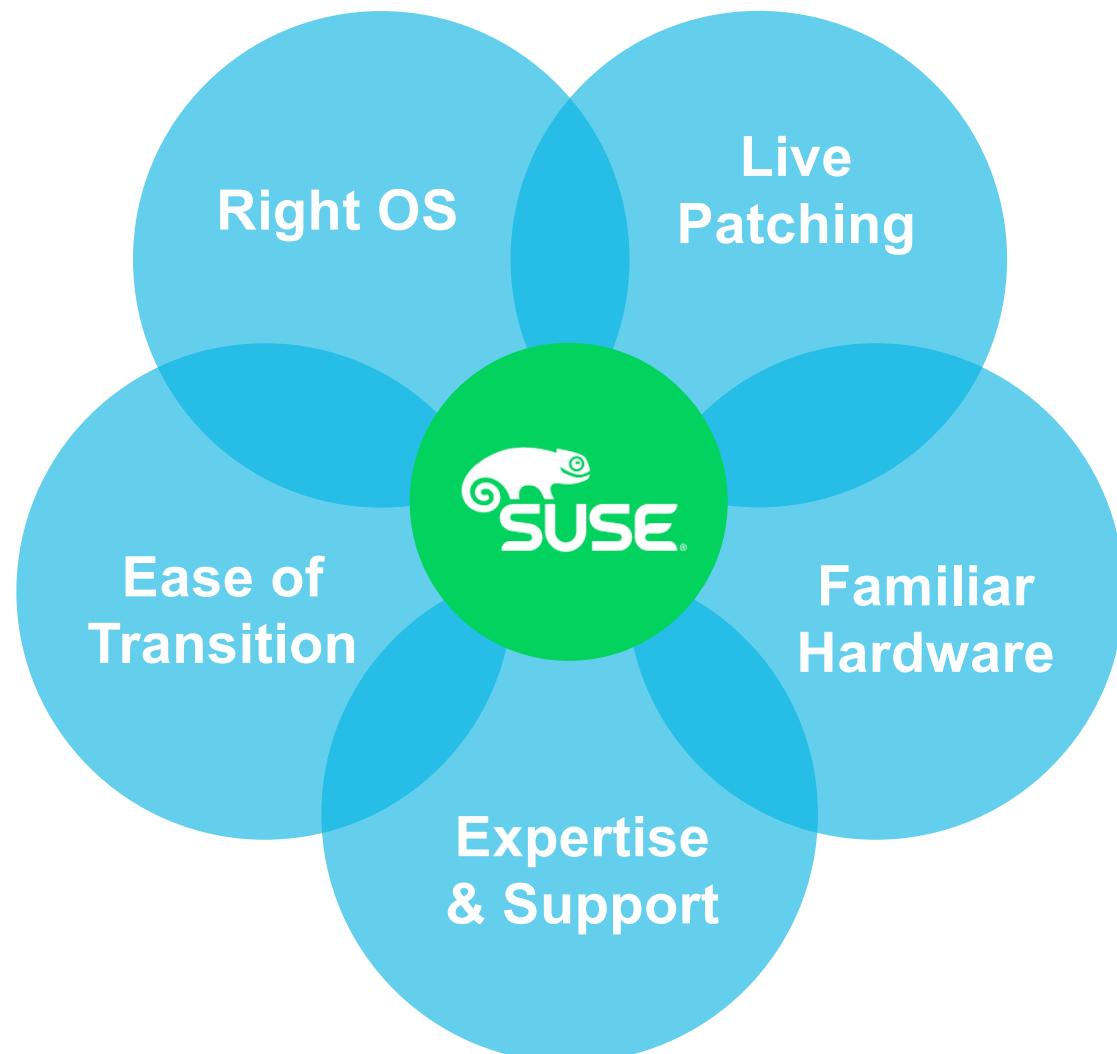


# Why SAP HANA for SUSE on POWER?



# Why Bring SAP HANA to SUSE on IBM Power Systems?

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## And why should all we care?

- Push on POWER architecture and benefit from POWER 9 momentum
- About \$1B every quarter – IBM Power Systems revenue
- Of which, increasingly larger chunk is Linux
- Of that, 70-80% is SAP HANA related deals
- SUSE's SLES for SAP is integral to this huge chunk of revenue, and to the success of those SAP implementations

# Rapid adoption of SAP HANA on Power Systems

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Acceleration: **0 to 1000+**  
clients in **24 months**



**4 out of the top 10**  
Fortune 500 Global



**17 out of the top 135**  
European Companies



**30+ CSP/MSP** using IBM  
Power for **SAP HANA Clouds**



**60% faster** from  
procurement to go-live  
(e.g. 2.5 months instead of  
6)

# IBM Power Systems + SUSE: Our Advantage

## Flexibility without compromise

- An efficient hypervisor allowing you to do more with your system
- Ability to grow as you need

## Performance your business demands

- Top of the line multithreading and memory to handle performance spike
- Optimized for SAP Workloads

## Trusted, Reliable, Differentiated

- Tight alignment with SAP for decades, always united on releases and roadmap
- A partner you can rely on to continue to support your business demands; Roadmap for the future aligned with big data/in-memory workloads
- SUSE Live Patching

## Easy to Deploy and Manage

- Pre-tested, pre-integrated
- SUSE Installation Wizards
- SUSE Manager

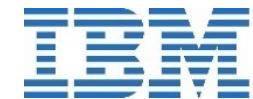


# Get the Benefits of SUSE Linux Enterprise Server for SAP Applications



## Tailored for SAP Application

- Tuned For SAP HANA And Business Suite Performance
- Built-in High Availability
- Fast HANA Recovery
- Database Security
- Superior Support



## Optimized for IBM POWER Systems

- Multi-threaded Operations
- POWER Virtualization Support
- Performance Enhancements
- Price Parity With x86-64

# Customer Benefits

## Blazing Fast Analytics

- Unrivaled performance

## Zero Downtime

- Only platform that gives you mission critical peace of mind

## Deploy in Half the Time

- Accelerate Your Journey to Real Time Business Insights

# With IBM Power Systems and SUSE You Can



**Optimize  
Performance**

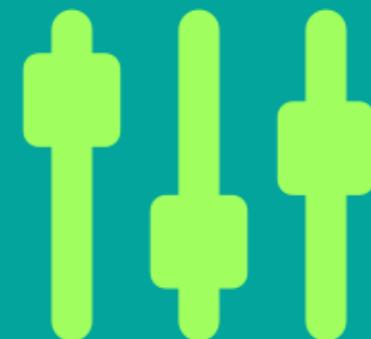


**Reduce  
Downtime**



**Innovate  
Faster**

# Top 7 Reasons Why SUSE Linux Enterprise Server is the Gold Standard for SAP on IBM Power



# 1. First Linux on IBM Power Systems and Still the Best



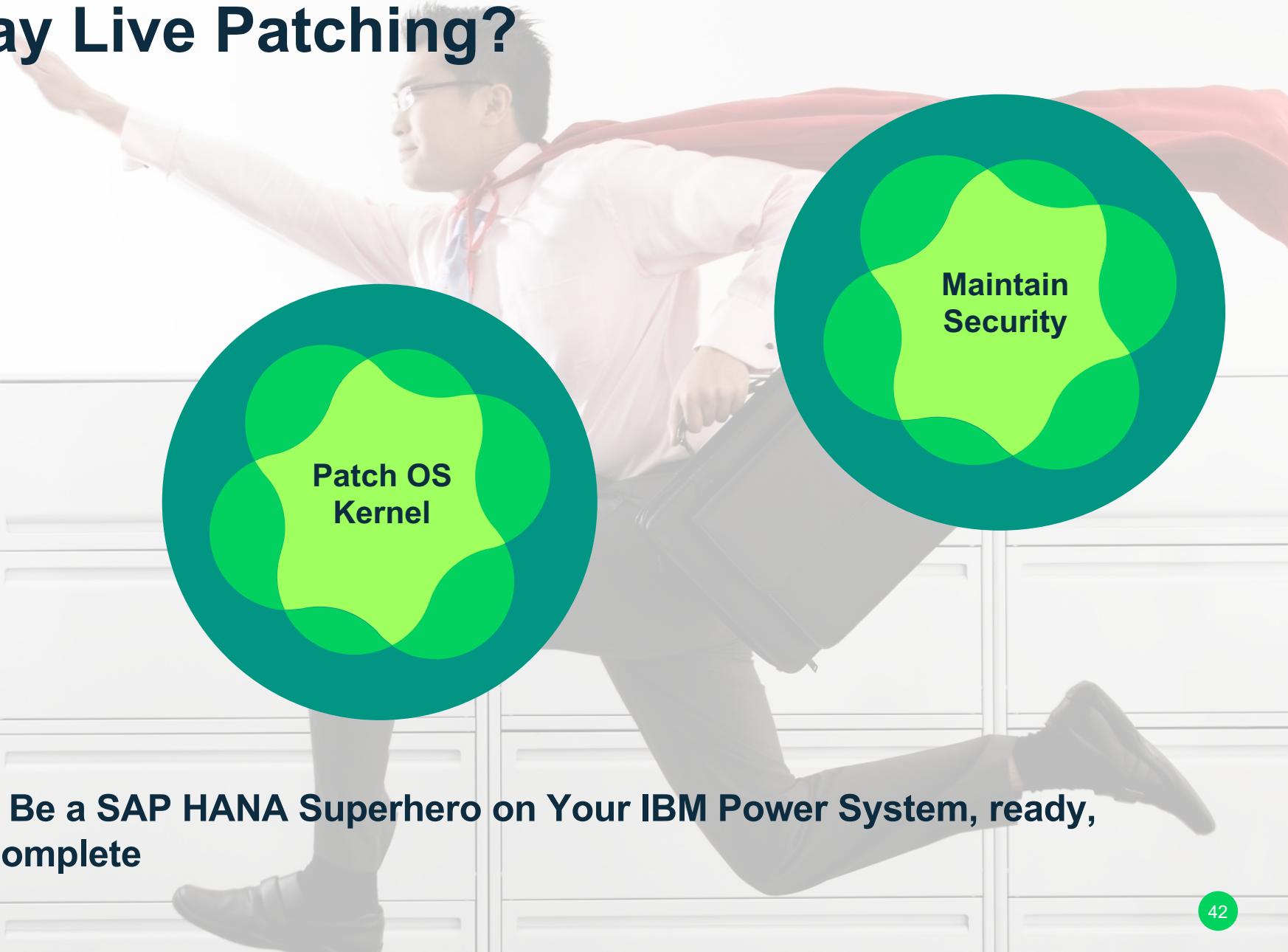
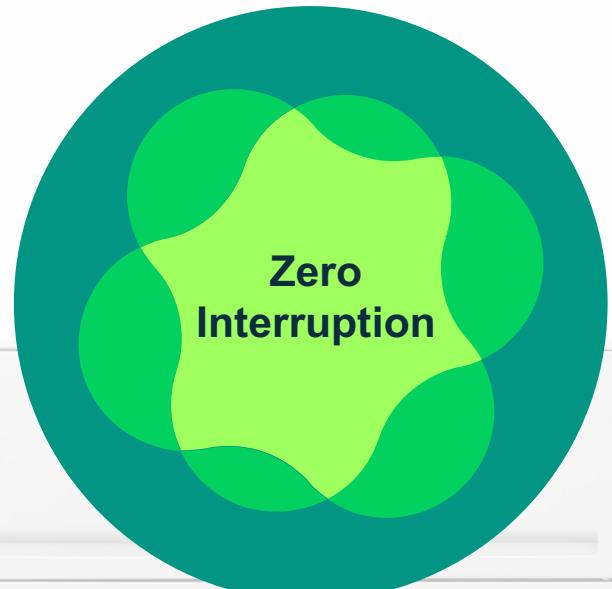
#1 Recommended OS for SAP HANA with superior availability and reliability

## 2. Thousands of Customers Can't Be Wrong



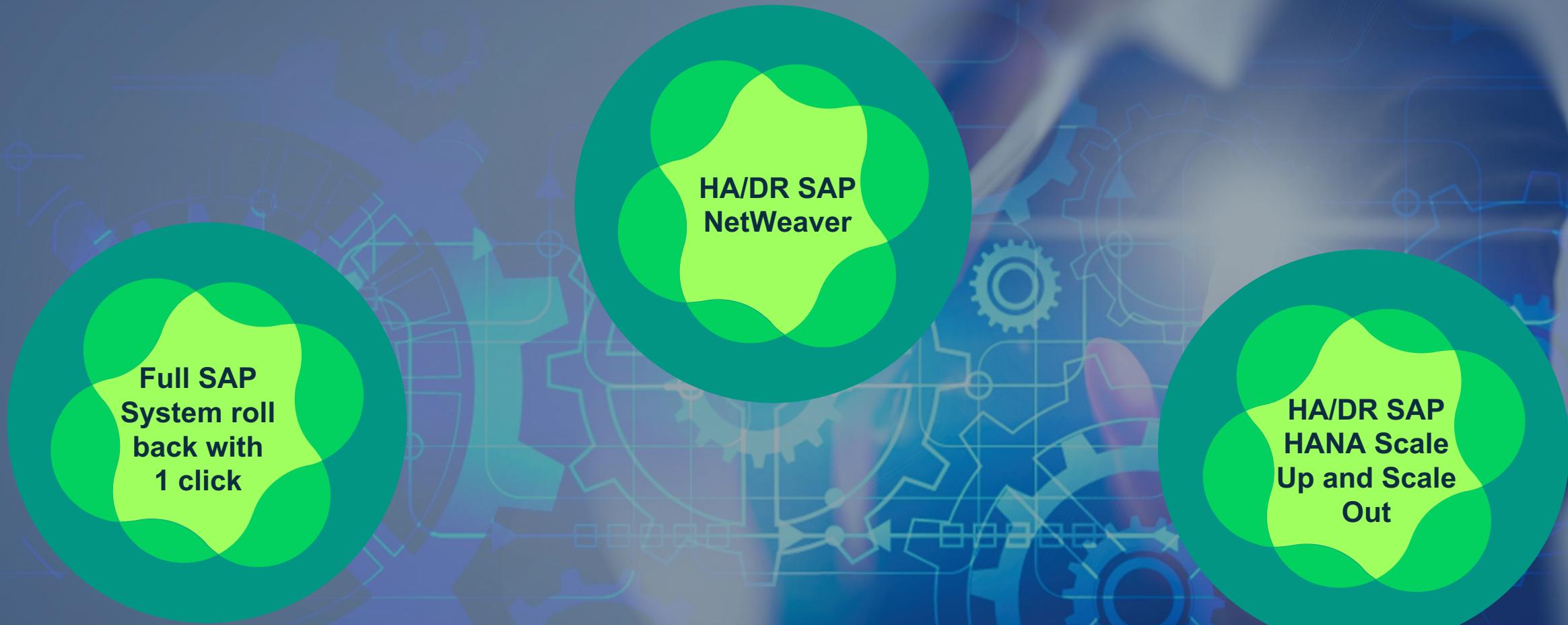
Thousands of customers worldwide choose SUSE for HANA – the world's #1 choice for your ease of mind

### 3. Can You Say Live Patching?



Today is Your Day to Be a SAP HANA Superhero on Your IBM Power System, ready, set, go ... Patching Complete

## 4. How Do You Like Zero Downtime?



**When your business can't afford any downtime, planned or unplanned – IBM Power + SUSE is your winning combination**

## 5. SUSE Manager for HANA on IBM Power



Single Pane  
of Glass for  
Your SAP  
System



Automated  
Install,  
Configure,  
Management



Now Available  
on Power

Best-in-class Open Source IT Infrastructure Management for SAP HANA on IBM Power, integrate into your existing tools and workflows for ease of management

## 6. ONLY Linux solution to be HA certified for HANA

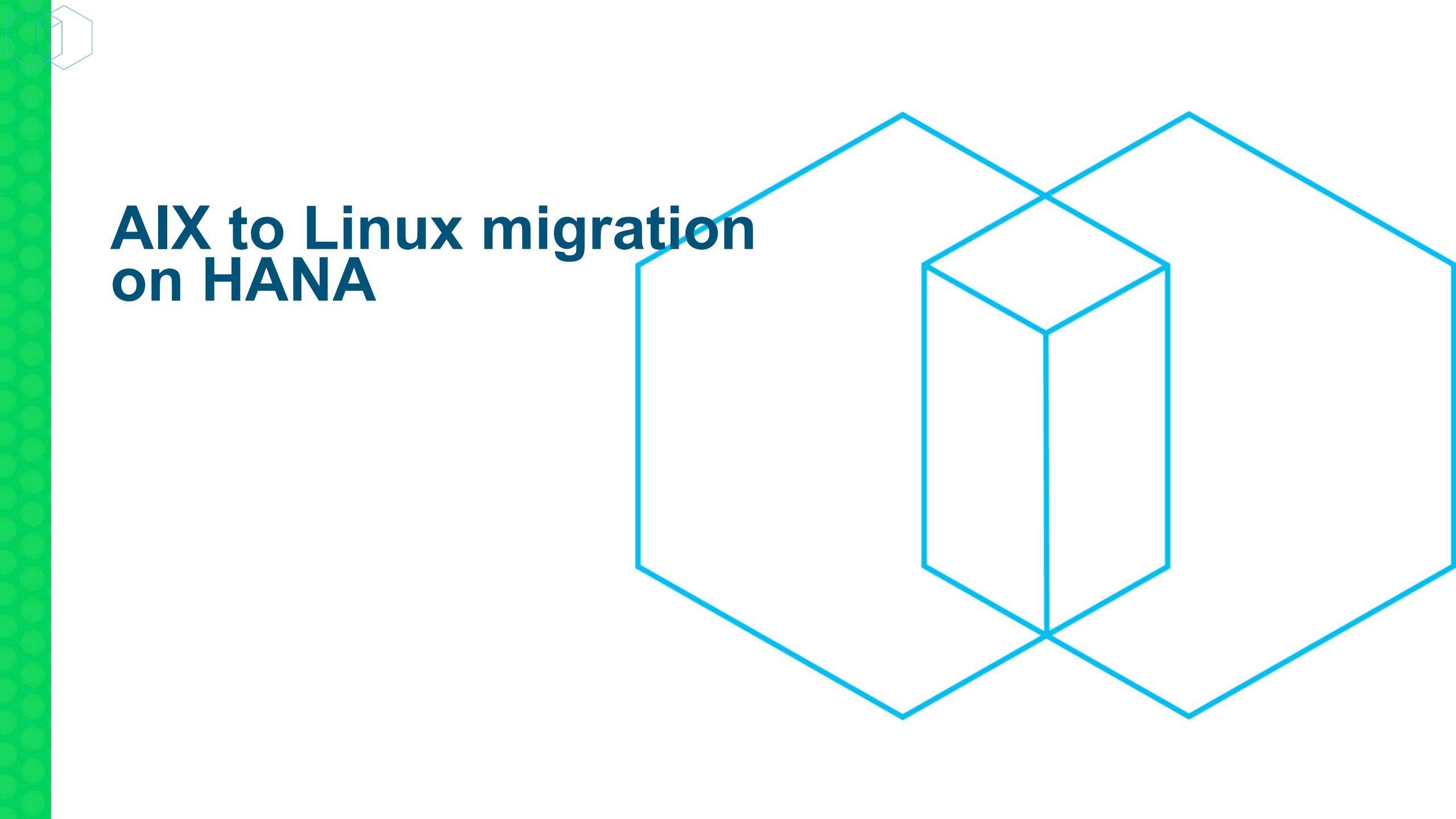


True High Availability for Your Most Mission Critical SAP Workloads

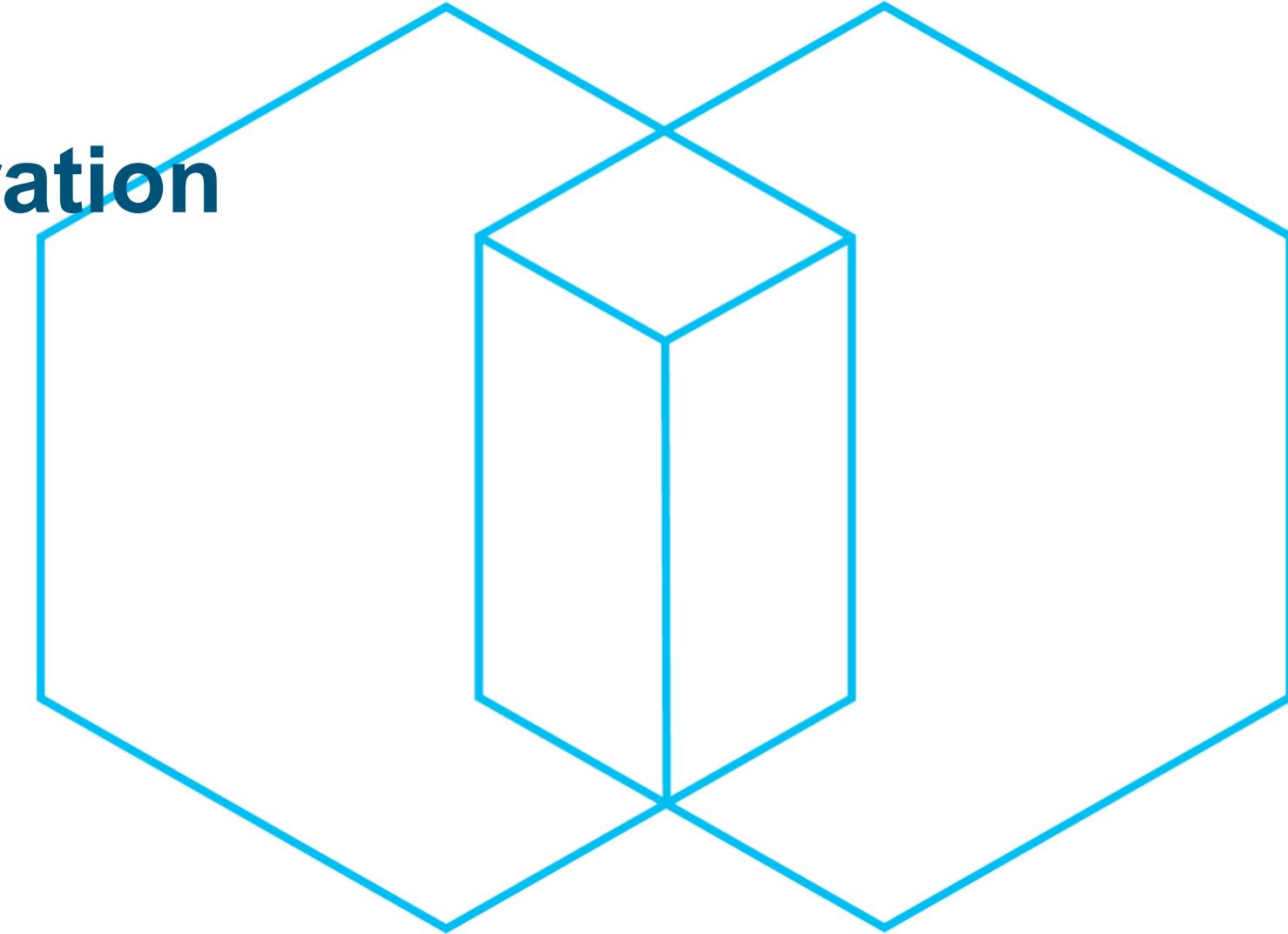
## 7. Superior Support



Decades of partnership, joint innovation and cross training =  
The best support experience



# AIX to Linux migration on HANA



# Migrating from AIX to SUSE on IBM Power Systems

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- ✓ Reliability
- ✓ Availability
- ✓ Serviceability

# IBM, SUSE and SAP: Longtime Partnerships

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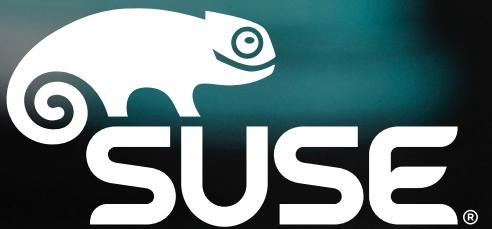
The first Linux for  
IBM Power Systems  
...and still the best.



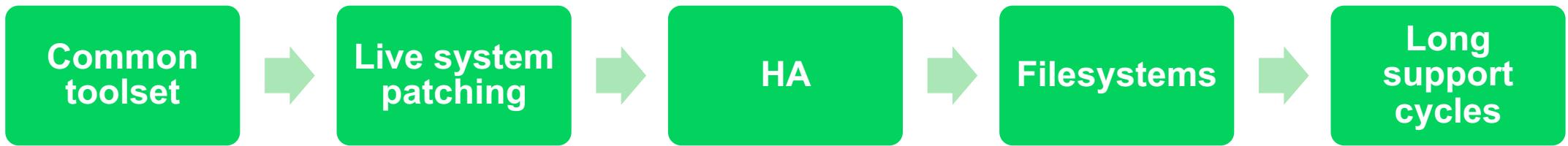
More than 1,000 customers  
run SAP HANA on IBM  
systems and SUSE® Linux  
Enterprise Server.

# Transfer AIX Skills to Run SUSE

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# Common places for AIX admins



# SAP deployment scenarios



# SAP deployment scenarios innovation

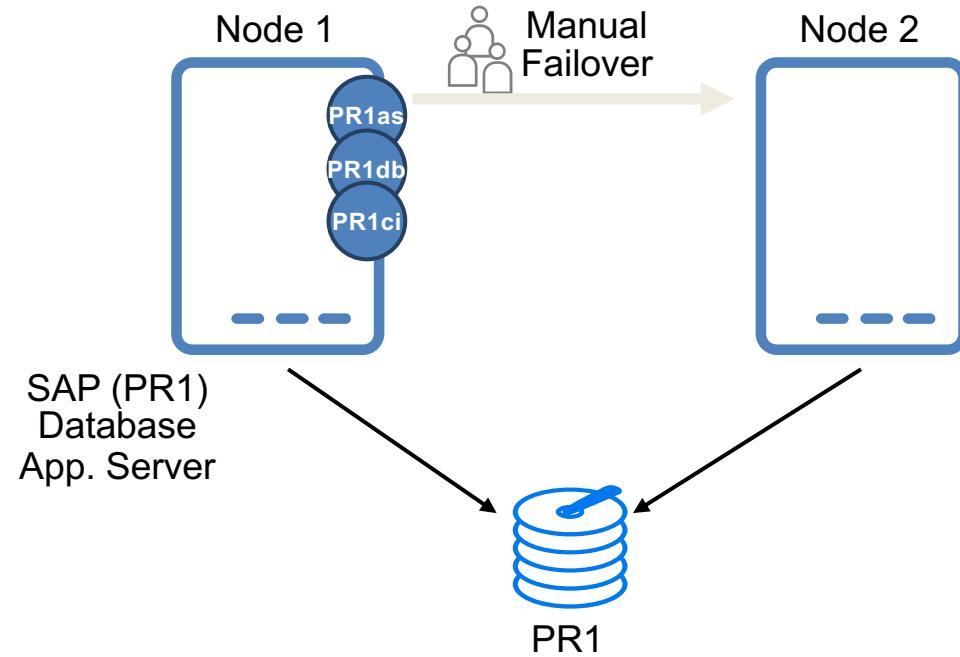
- ✓ Joint engineering from SAP & SUSE
- ✓ Well documented and tested
- ✓ Replicated on SAP's Linux Lab



Widest scenarios support plus IBM's POWER physical and virtual architecture allows to fine tune solutions to meet customer expectations with adjusted budgets

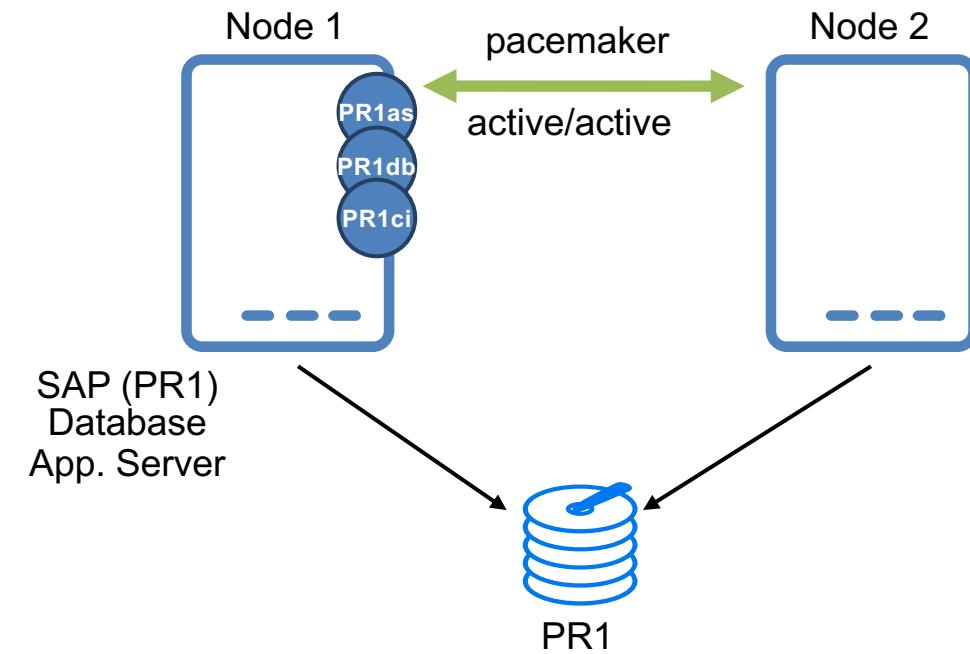
# SAP NetWeaver: Manual Failover

|                                 |  |
|---------------------------------|--|
| <b>Take-over decision:</b>      | Manual monitoring and situation analysis               |
| <b>Take-over process:</b>       | Manual   |
| <b>Take-over reaction time:</b> | Variable   |
| <b>Take-over speed:</b>         | Middle since services need to restart on failover node |



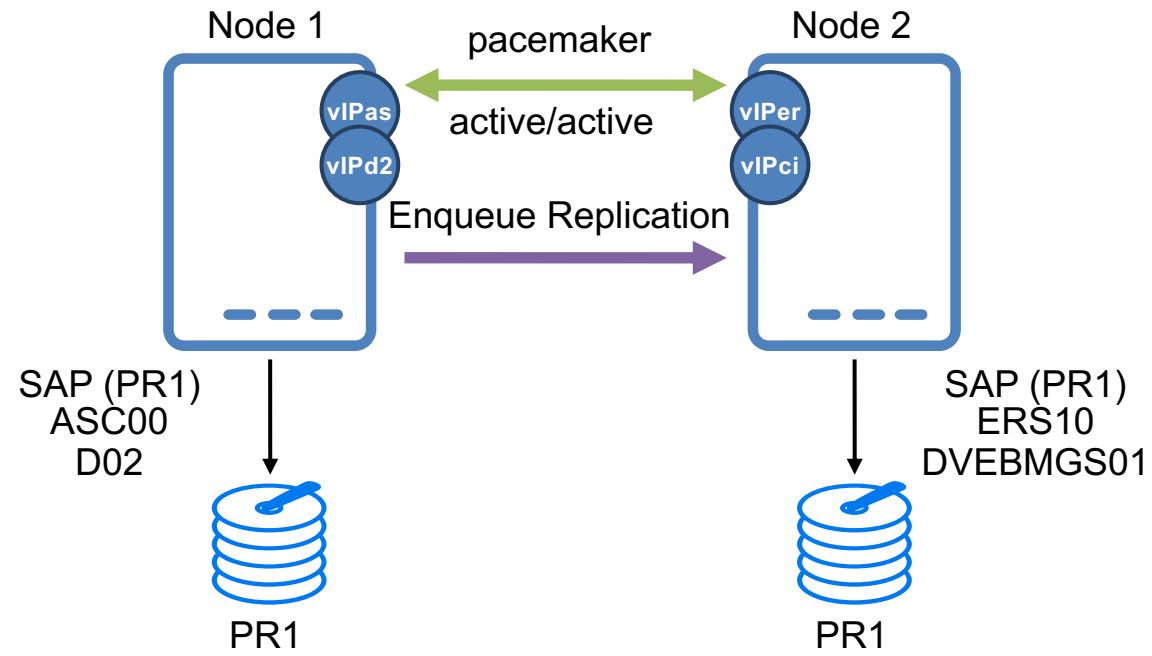
# SAP NetWeaver: Simple Stack

|                                 |  |
|---------------------------------|--|
| <b>Take-over decision:</b>      | Fully automated by SUSE cluster solution               |
| <b>Take-over process:</b>       | Fully automated by SUSE cluster solution               |
| <b>Take-over reaction time:</b> | Fast due to pacemaker heartbeat                        |
| <b>Take-over speed:</b>         | Middle since services need to restart on failover node |



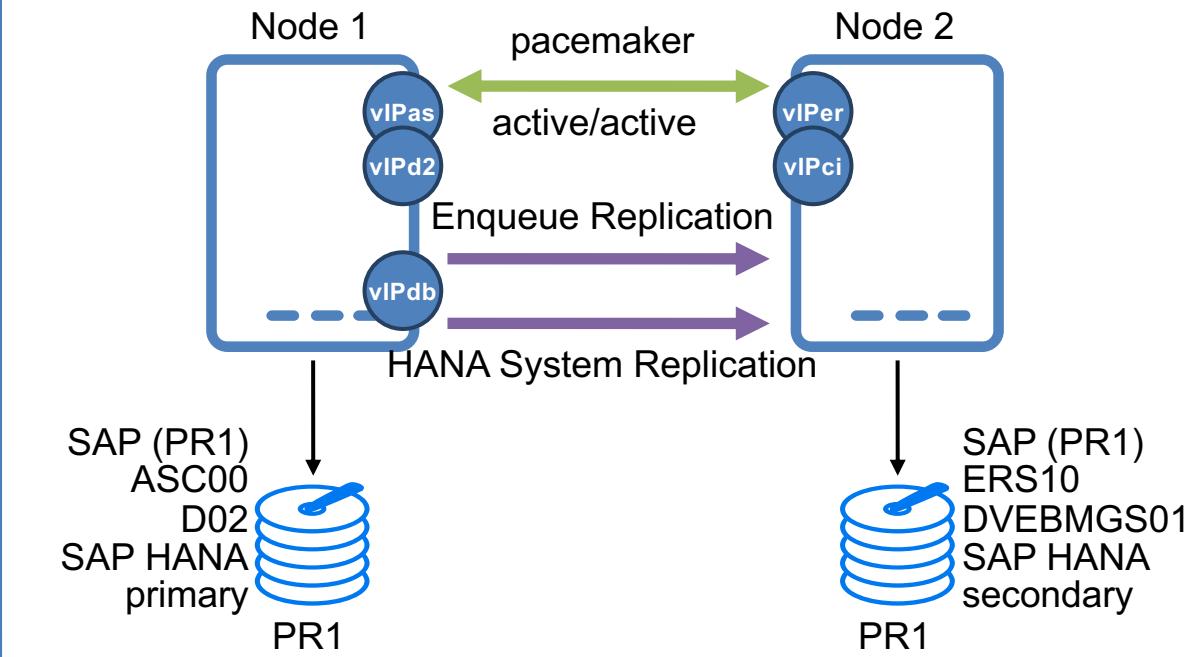
# SAP NetWeaver: Enqueue Replication (excl. DB)

|                                 |  |
|---------------------------------|--|
| <b>Take-over decision:</b>      | Fully automated by SUSE cluster solution |
| <b>Take-over process:</b>       | Fully automated by SUSE cluster solution |
| <b>Take-over reaction time:</b> | Fast due to pacemaker heartbeat          |
| <b>Take-over speed:</b>         | Fast since enqueue table pre-loaded      |



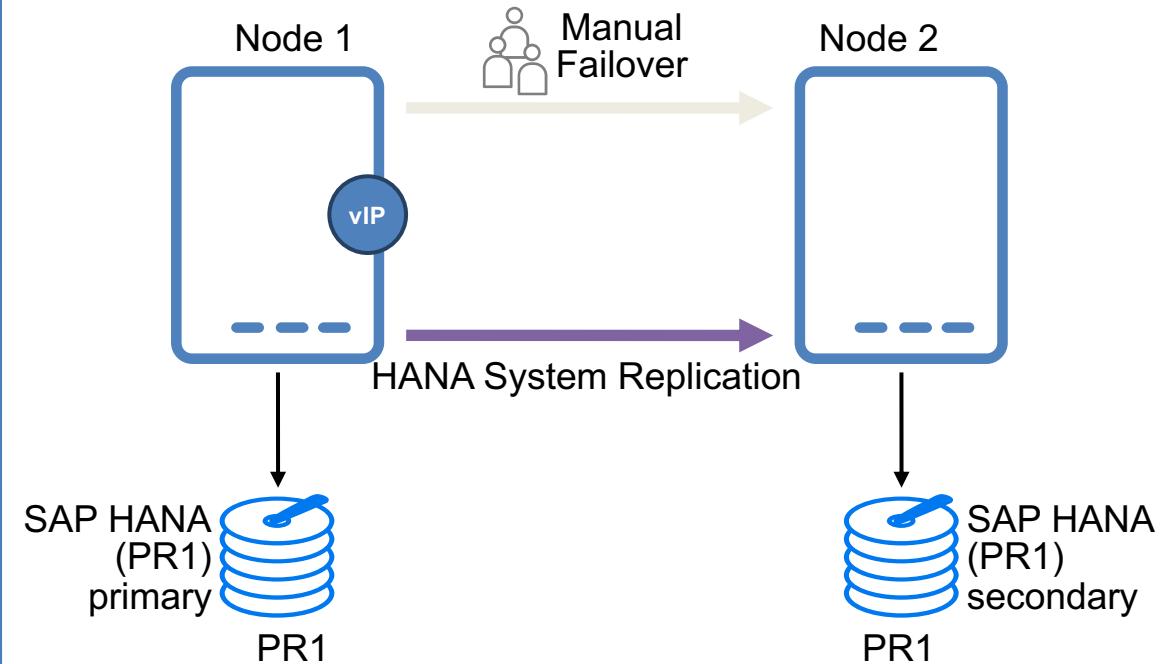
# SAP NetWeaver: Combined Stack (HANA SR)

|                                 |  |
|---------------------------------|--|
| <b>Take-over decision:</b>      | Fully automated by SUSE cluster solution |
| <b>Take-over process:</b>       | Fully automated by SUSE cluster solution |
| <b>Take-over reaction time:</b> | Fast due to pacemaker heartbeat          |
| <b>Take-over speed:</b>         | Fast since enqueue table pre-loaded      |



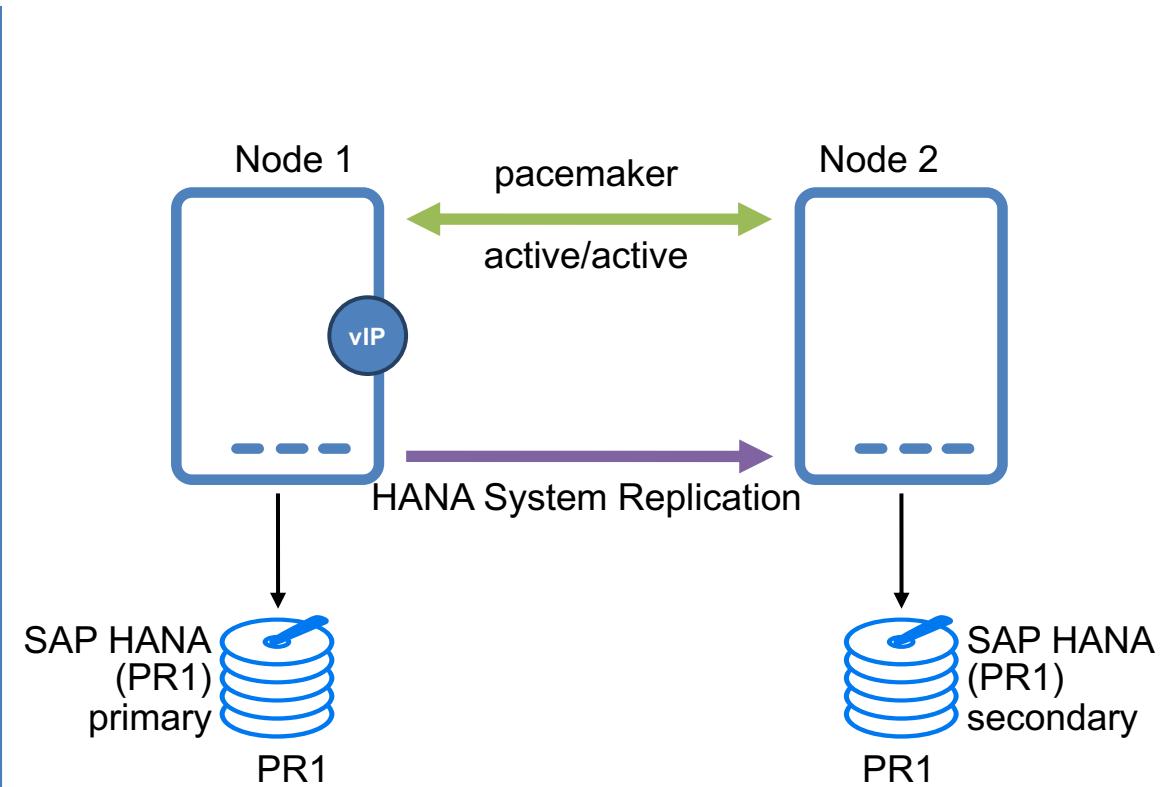
# SAP HANA Scale-Up: Manual Take-over

|                                    |  |
|------------------------------------|--|
| <b>Node 2 Usage:</b>               | Dedicated                                |
| <b>Data pre-load on Secondary:</b> | Yes                                      |
| <b>Take-over decision:</b>         | Manual monitoring and situation analysis |
| <b>Take-over process:</b>          | Manual                                   |
| <b>Take-over reaction time:</b>    | Variable                                 |
| <b>Take-over speed:</b>            | Fast since data pre-loaded               |



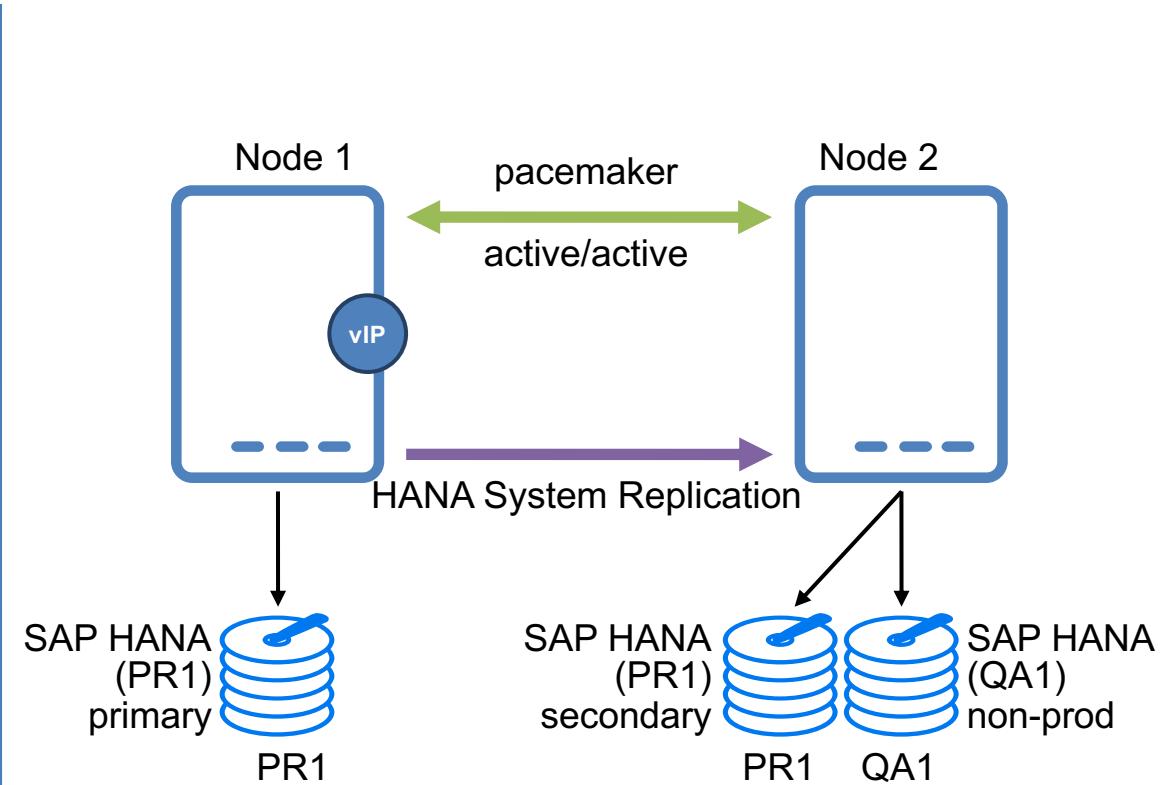
# SAP HANA Scale-Up: Performance Optimized

|                                    |  |
|------------------------------------|--|
| <b>Node 2 Usage:</b>               | Dedicated                                |
| <b>Data pre-load on Secondary:</b> | Yes                                      |
| <b>Take-over decision:</b>         | Fully automated by SUSE cluster solution |
| <b>Take-over process:</b>          | Fully automated by SUSE cluster solution |
| <b>Take-over reaction time:</b>    | Fast due to pacemaker heartbeat          |
| <b>Take-over speed:</b>            | Fast since data pre-loaded               |



# SAP HANA Scale-Up: Cost Optimized

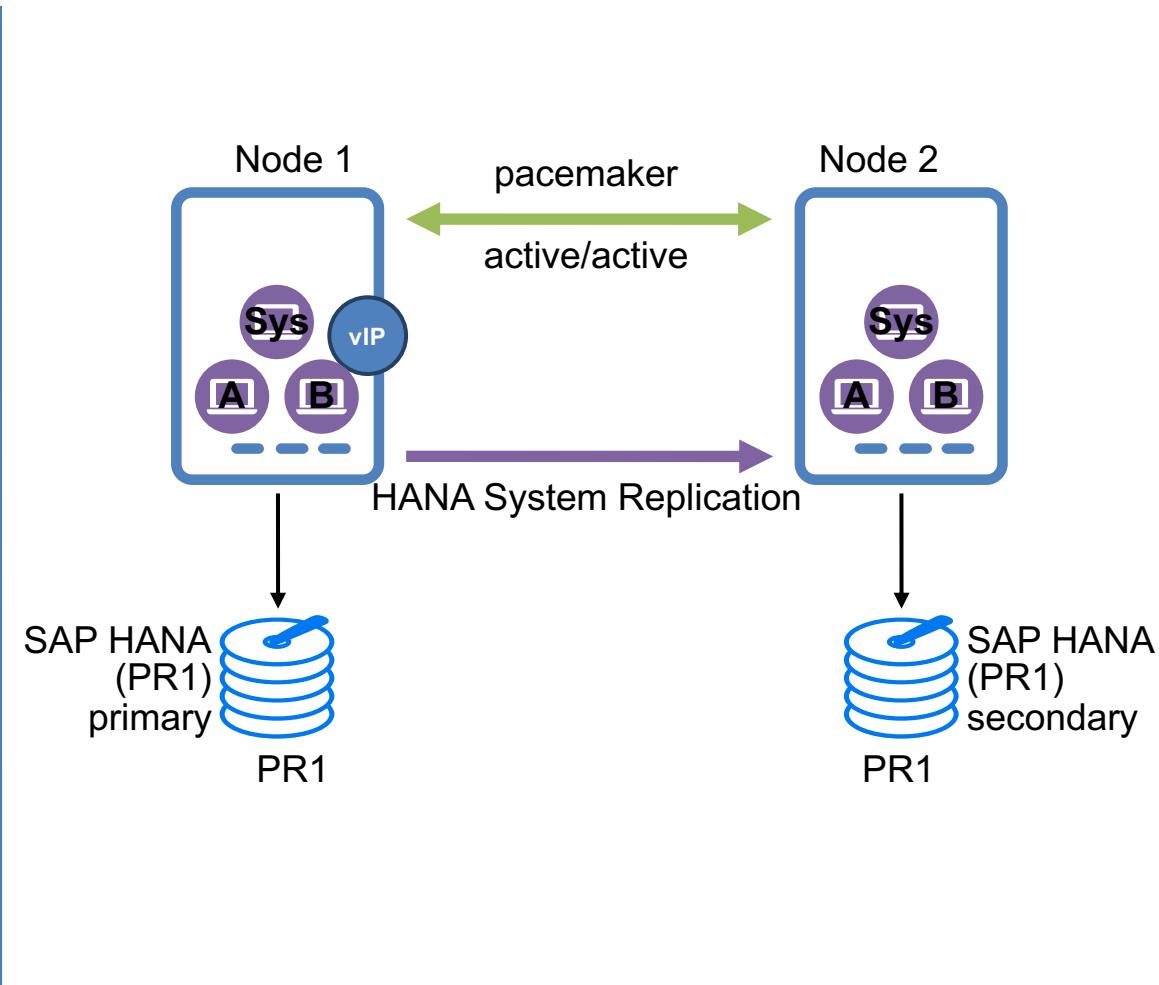
|                                    |  |
|------------------------------------|--|
| <b>Node 2 Usage:</b>               | Shared with other system (e.g. QA1). Additional storage required for QA1 |
| <b>Data pre-load on Secondary:</b> | No   |
| <b>Take-over decision:</b>         | Fully automated by SUSE cluster solution                                 |
| <b>Take-over process:</b>          | Fully automated by SUSE cluster solution                                 |
| <b>Take-over reaction time:</b>    | Fast due to pacemaker heartbeat  |
| <b>Take-over speed:</b>            | Slow: stop QA1 (meaning QA1 downtime) + completely load PR1 into memory  |



# SAP HANA Multitenant Database Containers (MDC)

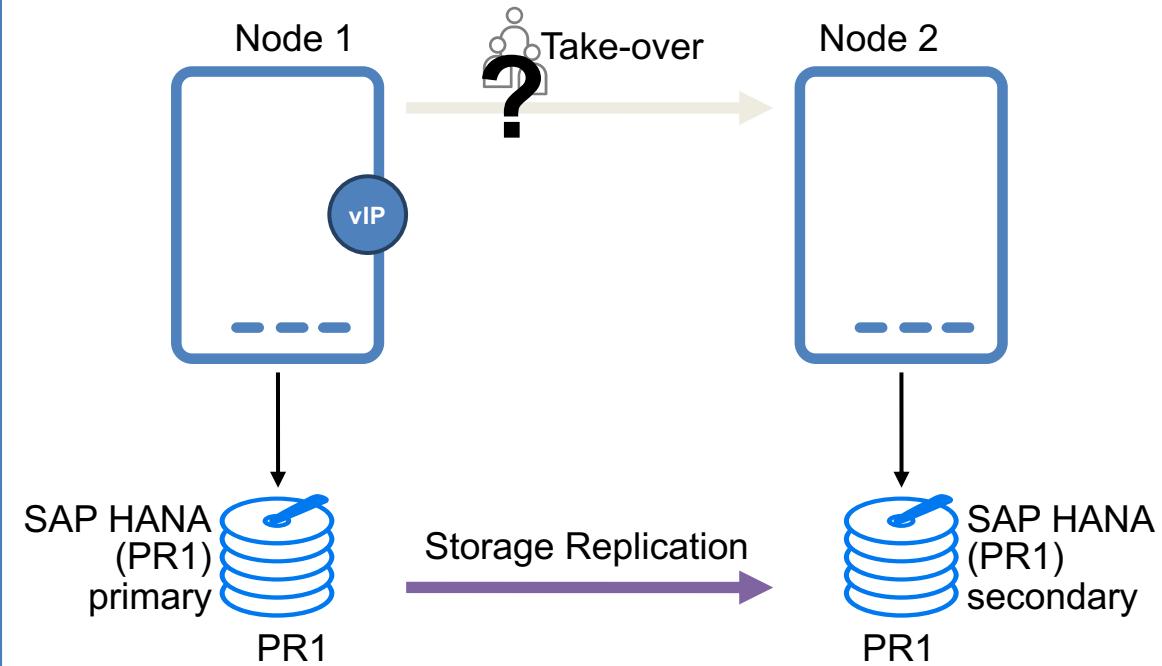
## MDC Considerations:

- Can apply “Performance Optimized” or “Cost Optimized” scenarios
- A take-over acts on the parent HANA Database.
- All tenant database containers and associated services and therefore affected by a take-over.



# SAP HANA Scale-Up: Storage Replication

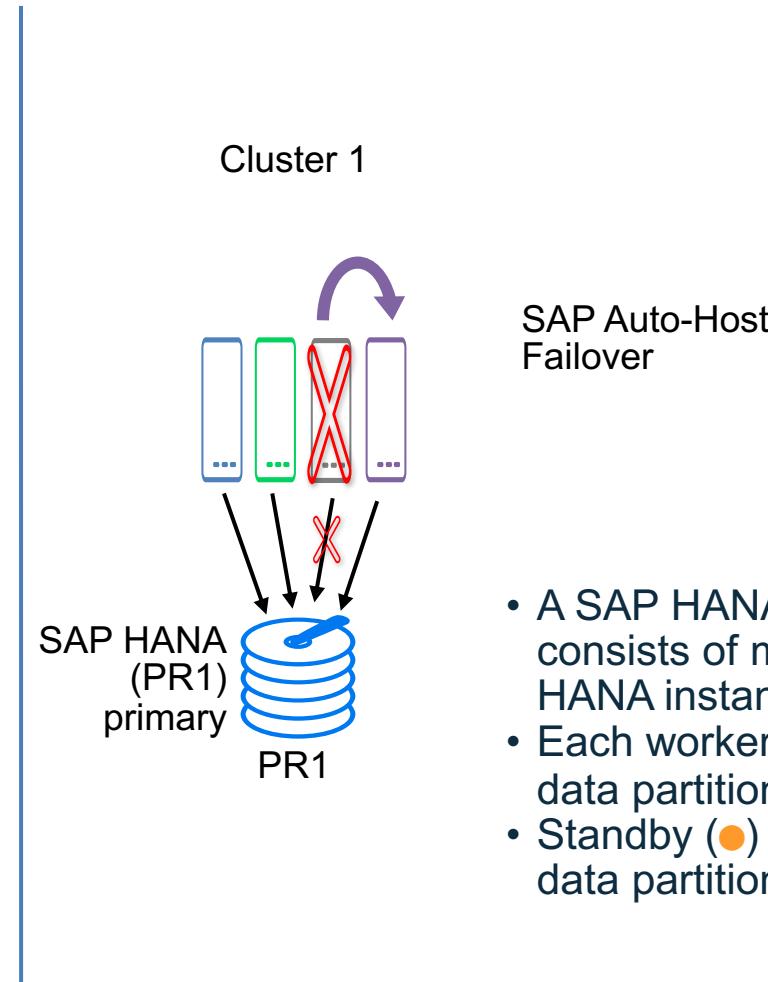
|                                    |   |
|------------------------------------|---|
| <b>Node 2 Usage:</b>               | Dedicated   |
| <b>Data pre-load on Secondary:</b> | No  |
| <b>Take-over decision:</b>         | Depends on storage vendor   |
| <b>Take-over process:</b>          | Depends on storage vendor   |
| <b>Take-over reaction time:</b>    | Depends on storage vendor   |
| <b>Take-over speed:</b>            | Slower since secondary copy must be completely loaded into memory |



(See SAP Note 1755396 for solutions)

# SAP HANA Scale-Out: Auto Host Failover

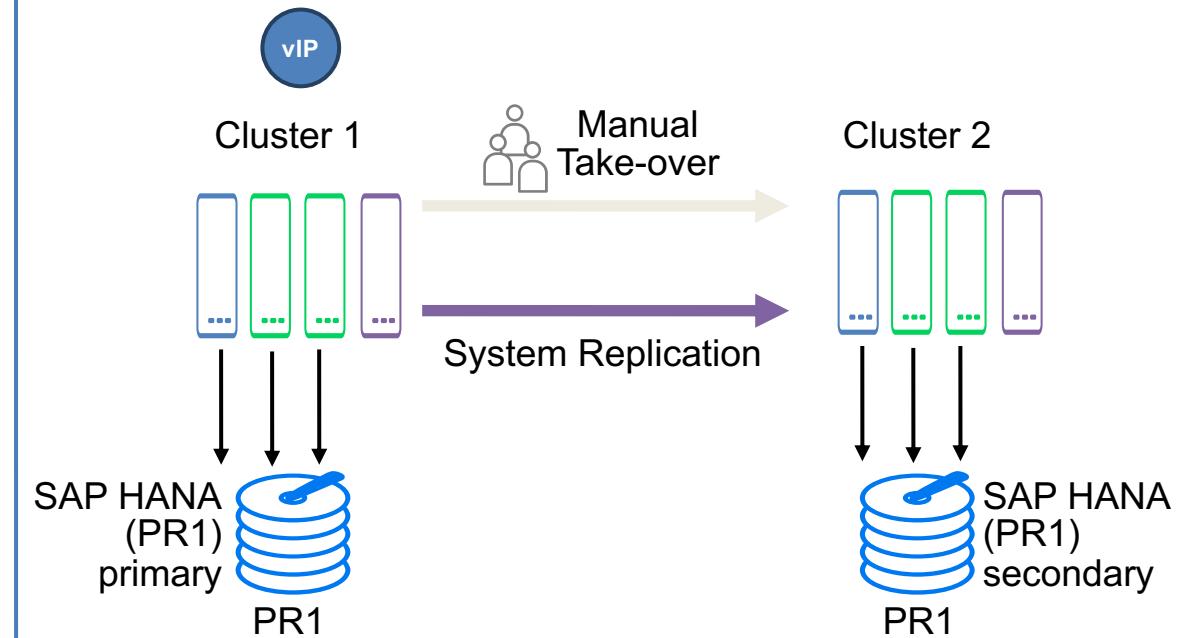
|  |  |
|--|--|
| <b>Cluster 2 Usage:</b>                    | n/a  |
| <b>Data pre-load on Secondary:</b>         | No   |
| <b><del>Fail Take-over decision:</del></b> | SAP HANA   |
| <b><del>Fail Take-over process:</del></b>  | Automated by SAP HANA  |
| <b>Take-over reaction time:</b>            | Fast   |
| <b>Take-over speed:</b>                    | Slower since failed node must completely loaded into memory of standby |



- A SAP HANA scale-out database consists of multiple nodes and SAP HANA instances.
- Each worker (●) node has its own data partition.
- Standby (○) nodes do not have a data partition.

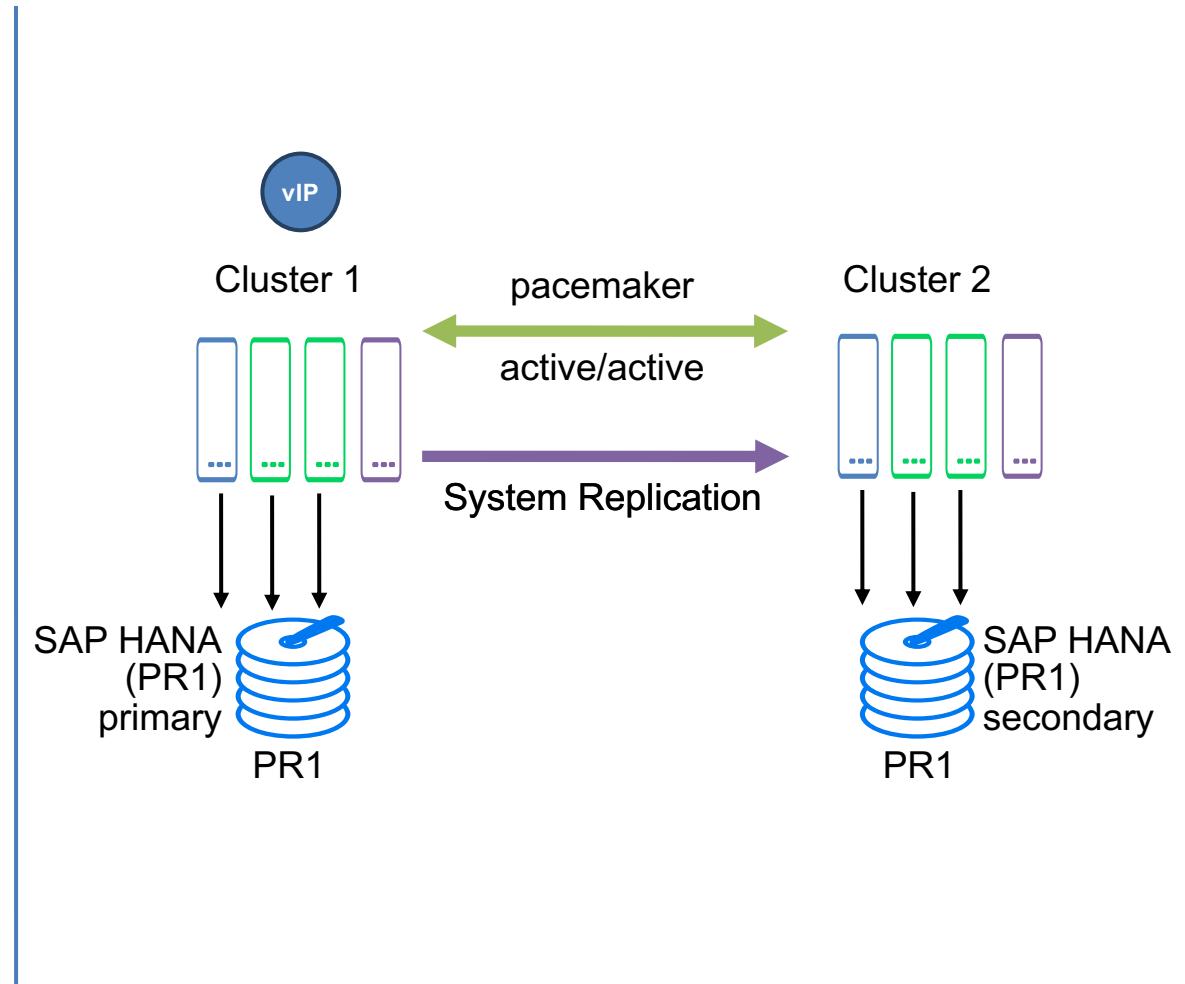
# SAP HANA Scale-Out: Manual Take-over

|                                    |  |
|------------------------------------|--|
| <b>Cluster 2 Usage:</b>            | Dedicated                                  |
| <b>Data pre-load on Secondary:</b> | Yes  |
| <b>Take-over decision:</b>         | Manual monitoring and post-mortem analysis |
| <b>Take-over process:</b>          | Manual                                     |
| <b>Take-over reaction time:</b>    | Variable                                   |
| <b>Take-over speed:</b>            | Fast since data pre-loaded                 |



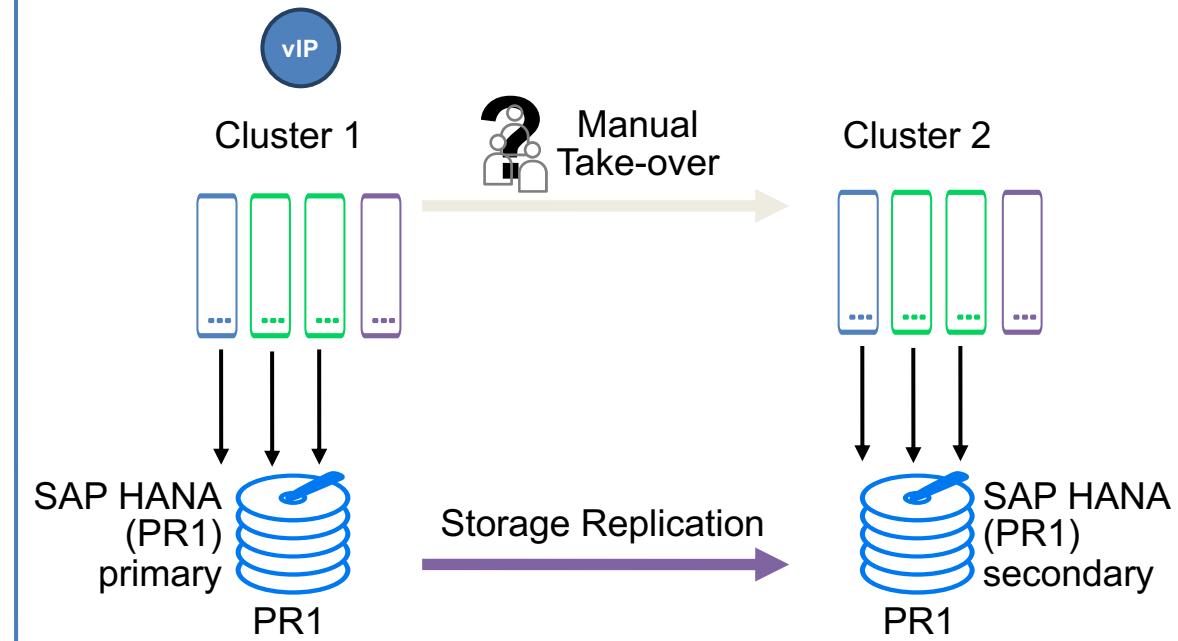
# SAP HANA Scale-Out: Performance Optimized

|                                    |  |
|------------------------------------|--|
| <b>Cluster 2 Usage:</b>            | Dedicated                                |
| <b>Data pre-load on Secondary:</b> | Yes                                      |
| <b>Take-over decision:</b>         | Fully automated by SUSE cluster solution |
| <b>Take-over process:</b>          | Fully automated by SUSE cluster solution |
| <b>Take-over reaction time:</b>    | Fast due to pacemaker heartbeat          |
| <b>Take-over speed:</b>            | Fast since data pre-loaded               |



# SAP HANA Scale-Out: Storage Replication

|                                    |   |
|------------------------------------|---|
| <b>Cluster 2 Usage:</b>            | Depends   |
| <b>Data pre-load on Secondary:</b> | No  |
| <b>Take-over decision:</b>         | Depends on storage vendor   |
| <b>Take-over process:</b>          | Depends on storage vendor   |
| <b>Take-over reaction time:</b>    | Depends on storage vendor   |
| <b>Take-over speed:</b>            | Slower since secondary copy must be completely loaded into memory |



(See SAP Note 1755396)

# Summary of SAP scenarios

## SAP NetWeaver

- Manual Failover
- Simple Stack
- Enqueue Replication
- Combined Stack

## SAP HANA ScaleUp

- Manual Failover
- Performance Optimized
- Cost Optimized
- Multitenant Database Containers
- Storage Replication
- Public Cloud
- Others

## SAP HANA ScaleOut

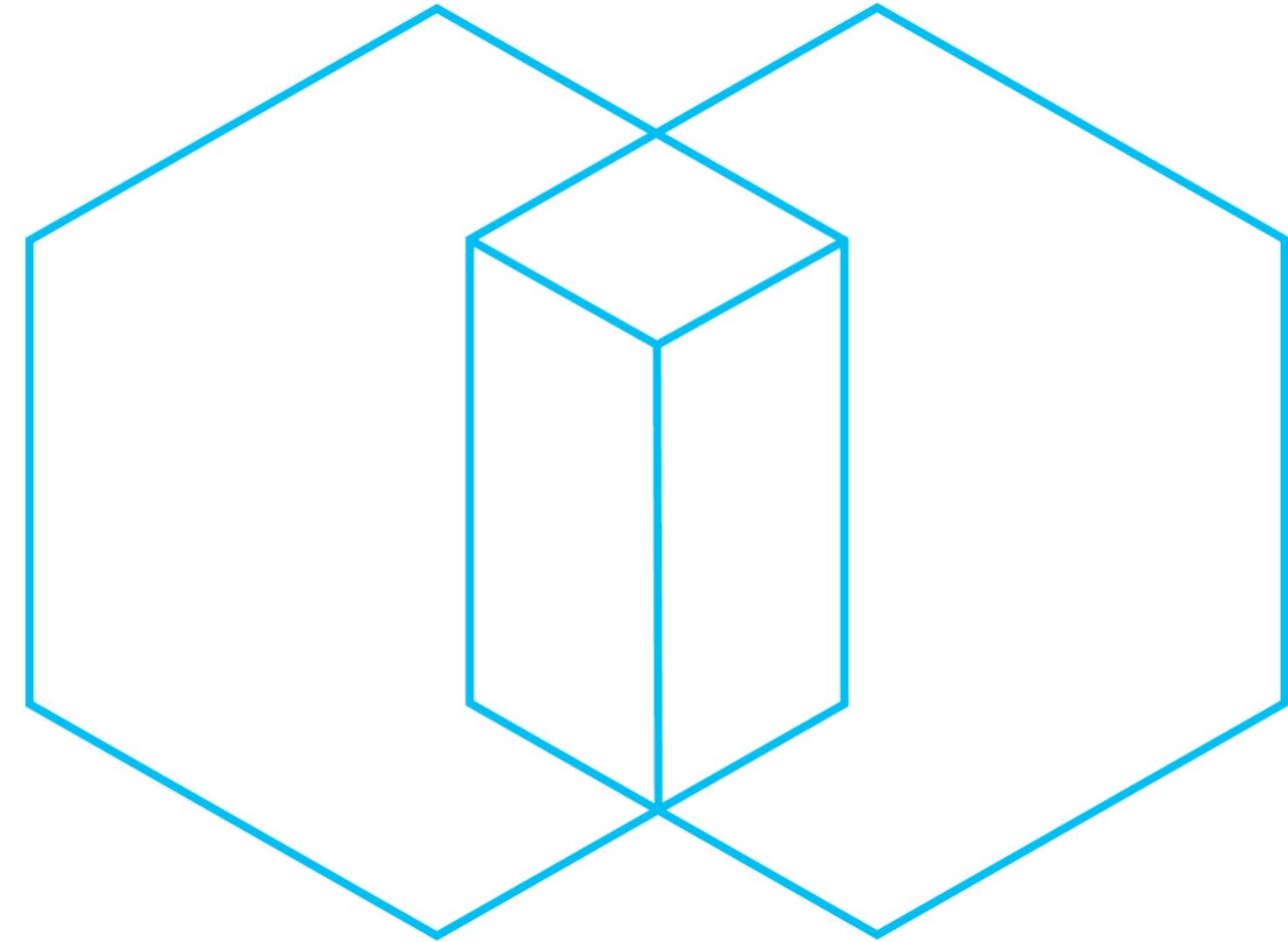
- Auto-Host Failover
- Manual Takeover
- Performance Optimized
- Storage Replication
- Public Cloud
- Others

# Match costs and availability

|                       | Cost  | Downtime | Comment |
|-----------------------|---|----------|---------|
| Auto-Host Failover    |   |          |         |
| Manual Take-over      |   |          |         |
| Performance Optimized | How does each scenario affect cost and downtime |          |         |
| Storage Replication   |   |          | ?       |
| Public Cloud          |   |          |         |
| Other                 |   |          |         |



# Configuration Management with **SUSE Manager**

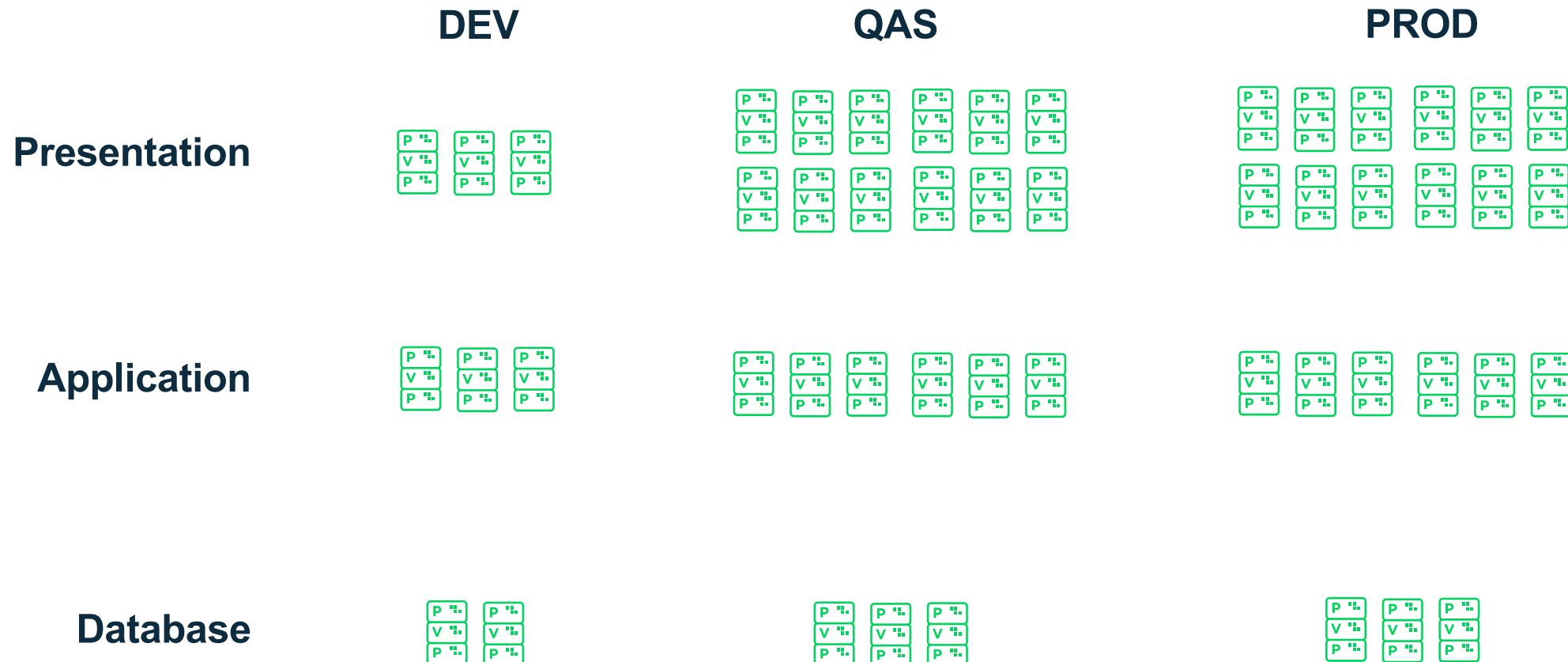


# SAP deployments are more then SAP HANA



**What about  
these layers  
in the SAP  
stack?**

# A more realistic SAP Landscape deployment



# Daily operations of your SAP Landscape

## Important tasks for Linux and SAP Basis Admins

- Installation of new PowerVM LPARs and other physical and virtual systems
  - Linux (SLES and other Linux distributions)
  - SAP Applications (HANA, NetWeaver, ...)
- Inventory reporting of Linux systems
- Patch Management of Linux
- Configuration Management of Linux and SAP Applications
- Linux security vulnerability remediation
- Linux security compliance verification and reporting

# Using SUSE Manager\* to manage your SAP Landscape

**Automate installation, configuration and management** of SAP systems from a single pane of glass with an OS & HW agnostic approach



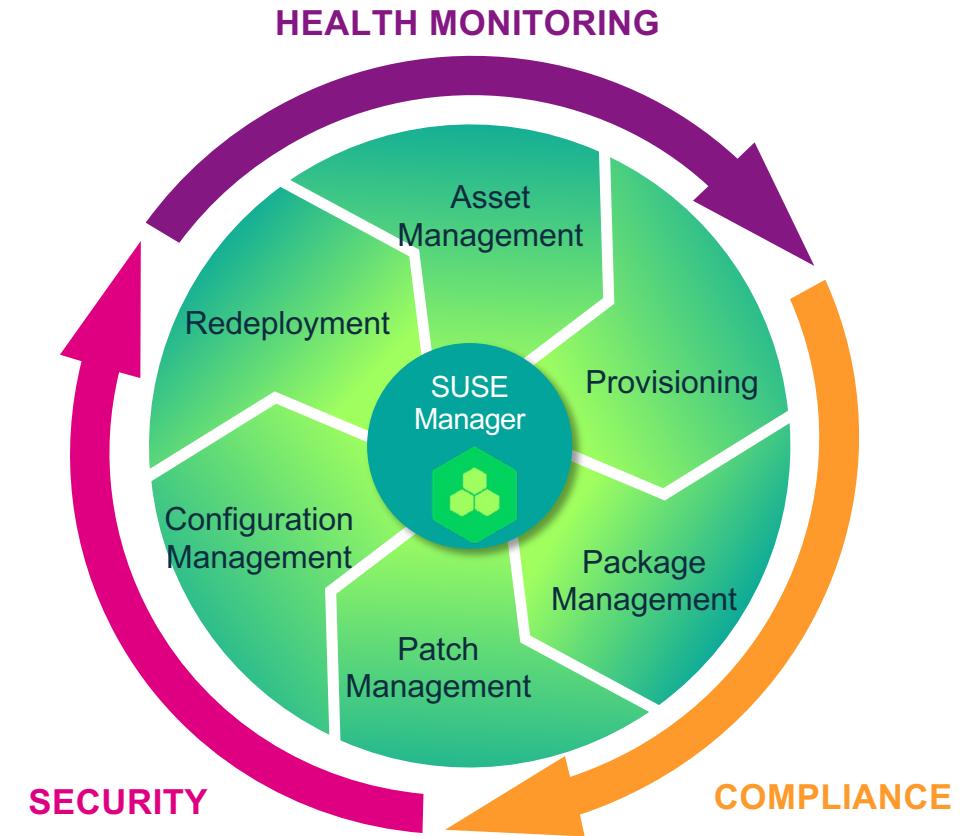
\* Separate subscription required for SUSE Manager



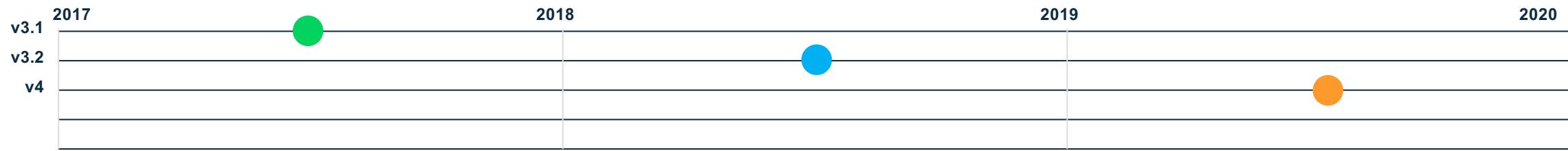
# Address the 3 “Cs” with SUSE Manager

**Best-in-class open source infrastructure management solution** designed to help your enterprise SAP Basis and IT Operations teams to:

- Optimize operations while reducing **costs**
- Reduce **complexity** and regain control of IT assets
- Ensure **compliance** with internal security policies and external regulations



# SUSE Manager



v3.1.x

## General

- Major UI/usability refresh

## Configuration Management

- Salt 2016.11.x
- Salt formulas with forms (e.g. Locale, SAP\*\*\*)
- Basic UI for Salt-based config file management\*\*\*

## SDI Management

- Infrastructure visualization (virtual machine hosts, Kubernetes clusters)

## Security & Compliance

- Allow CVE search and patch audit for containers (images and running instances\*\*\*)

## Containers & Cloud

- Build container images
- VMware with Salt Cloud
- SUSE CaaS Platform integration\*\*\*

Requires SUSE Linux Enterprise Server 12 SP2/SP3

\*\* Item delivered post GA

\* Information is forward looking and subject to change at any time.

v3.2

## Configuration Management

- Full UI for Salt-based config management

## Product Integration & Supported Platforms

- SUSE Linux Enterprise 15 (client) support
- SUSE Manager for retail (PXE with image support, KIWI-based image building)
- Single sign-on support

## Security & Compliance

- Improved patch channel staging UI

## SDI Management

- Maintenance windows
- Improved virtualization management\*\*\*

## Monitoring

- Basic Prometheus/Grafana "self-monitoring"\*\*\*

## Containers & Cloud

- VM building with Salt & KIWI
- Proxy Server shipped as container

Requires SUSE Linux Enterprise Server 12 SP2/SP3

v4

## Configuration Management

- Config drift management with Snapper integration
- Support for cluster orchestration (HA, SUSE CaaS Platform, SUSE Enterprise Storage)

## Product Integration

- Integration with the complete SUSE SDI stack (SUSE CaaS Platform, SUSE Cloud Application Platform, SUSE Enterprise Storage, SUSE OpenStack Cloud)

## Security & Compliance

- Salt compliance (HubbleStack, TBD)

## SDI Management

- Manage and monitor the complete SDI stack
- Automated inventory management

## Subscription Management

- Public cloud data gatherer

## Monitoring

- Complete Prometheus-based monitoring stack
- ELK-based log management (TBD)

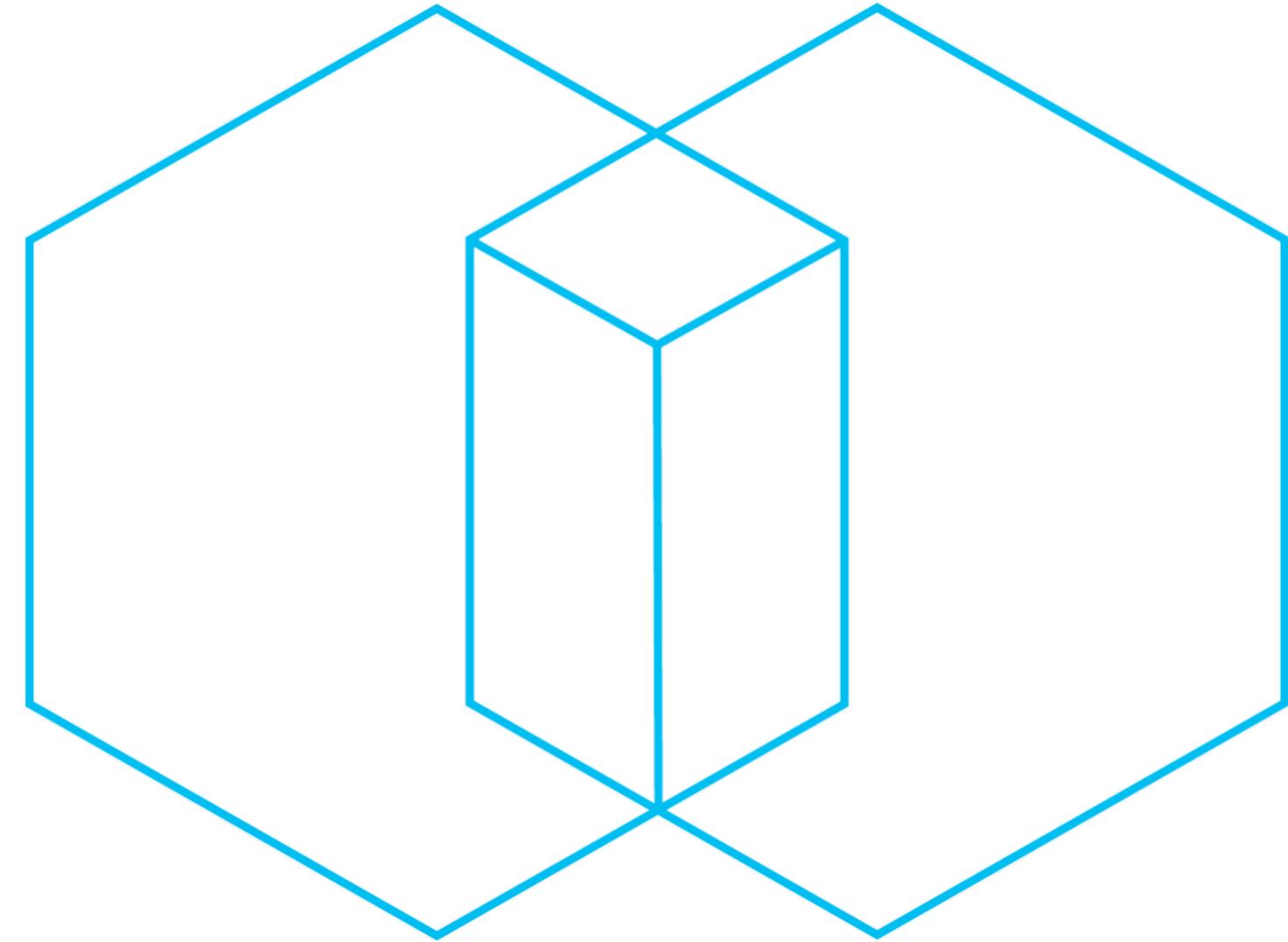
## Containers & Cloud

- All components shipping as containers (TBD)

Requires SLES 15 GA or SP1 (TBD)



# SUSE Manager demonstration



# The SUSE Manager server is running on ppc64le

```
psuma:~ # hostname -f  
psuma.geeko.land  
psuma:~ # uname -a  
Linux psuma 4.4.103-6.38-default #1 SMP Mon Dec 25 20:44:33 UTC 2017 (e4b9067) ppc64le ppc64le ppc64le GNU/Linux  
psuma:~ #
```

The screenshot shows the SUSE Manager web interface. At the top, there is a terminal window displaying system information. Below it is the browser window.

**Browser Headers:**

- Not secure | <https://psuma.geeko.land/rhn/YourRhn.do>

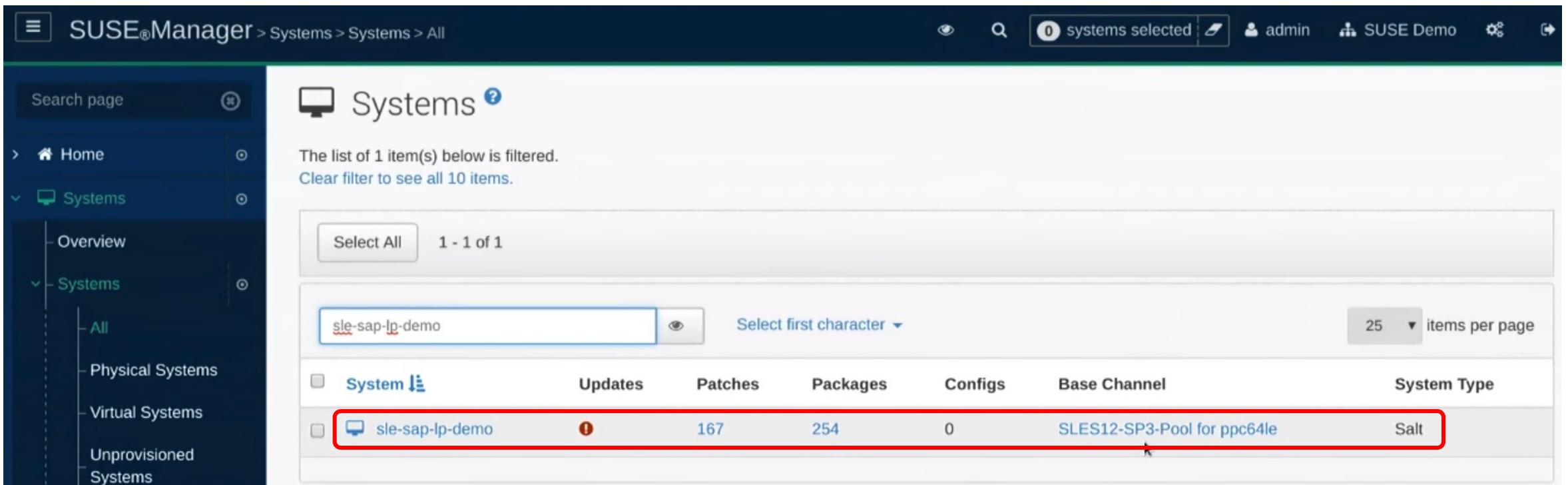
**SUSE Manager - Home**

**Overview**

**Tasks**

- Manage System Types: My Organization
- Register Systems
- Manage Activation Keys
- Manage Autoinstallations
- Manage Configuration Files

# Finding an IBM POWER system to manage



The screenshot shows the SUSE Manager web interface for managing systems. The top navigation bar includes links for Home, Systems, and All, along with user information for admin and SUSE Demo. The main title is "Systems" with a subtitle "The list of 1 item(s) below is filtered. Clear filter to see all 10 items." Below this, there's a search bar with the placeholder "Select first character" and a dropdown for "items per page" set to 25. A table lists one system: "sle-sap-ip-demo". The table columns are: System, Updates, Patches, Packages, Configs, Base Channel, and System Type. The "sle-sap-ip-demo" row is highlighted with a red border. The "System" column shows a monitor icon and a blue link to the system details.

| System          | Updates | Patches | Packages | Configs                     | Base Channel | System Type |
|-----------------|---------|---------|----------|-----------------------------|--------------|-------------|
| sle-sap-ip-demo | 167     | 254     | 0        | SLES12-SP3-Pool for ppc64le | Salt         |             |

# Getting more information about the system

SUSE®Manager > Systems

sle-sap-lp-demo

Details Software Configuration Provisioning Groups Virtualization Audit States Formulas Events

Overview Properties Remote Command Hardware Migrate Notes Custom Info

System Status

Software Updates Available Critical: 69 Non-Critical: 98 Packages: 254

System Info

|                         |  |
|-------------------------|--|
| Hostname:               | sle-sap-lp-demo  |
| IP Address:             | 151.155.15.233   |
| IPv6 Address:           | fe80::287c:acff:fe99:2204                                |
| Kernel:                 | 4.4.82-6.9-default                                       |
| SUSE Manager System ID: | 1000010010   |
| Activation Key:         | 1-sle-12-sp3-ppc64le                                     |
| Installed Products:     | SUSE Linux Enterprise Server for SAP Applications 12 SP3 |

Visualization Advanced Search Activation Keys Stored Profiles Custom System Info Autoinstallation Software Crashes Virtual Host Managers

Salt Images Patches Software Audit Configuration Schedule Users

Delete System

SUSE®Manager > Systems

0 systems selected admin SUSE Demo

Registered: 11/01/2017

Last Booted: a day ago (Schedule System Reboot)

System Properties (Edit These Properties)

System Types: [Salt]

Contact Method: Default

Auto Patch Update: No

System Name: sle-sap-lp-demo

Description:

Location: (none)

Subscribed Channels (Alter Channel Subscriptions)

- SLES12-SP3-Pool for ppc64le
- IBM-DLPAR-utils SP3
- SLE-Manager-Tools12-Pool ppc64le SP3
- SLE-Manager-Tools12-Updates ppc64le SP3
- SLE-Module-Adv-Systems-Management12-Pool for ppc64le SP3
- SLE-Module-Adv-Systems-Management12-Updates for ppc64le SP3
- SLE-Module-Containers12-Pool for ppc64le SP3
- SLE-Module-Containers12-Updates for ppc64le SP3
- SLE-Module-Legacy12-Pool for ppc64le SP3
- SLE-Module-Legacy12-Updates for ppc64le SP3

# What systems are affected by Spectre?

SUSE®Manager > Audit > CVE Audit

Search page

- > Home
- > Systems
- > Salt
- > Images
- > Patches
- > Software
- > Audit
  - CVE Audit

## CVE Audit

CVE 2017 5753

- ! Affected, patches available in channels which are not assigned
- ! Affected, at least one patch available in an assigned channel
- Not affected
- ✓ Patched

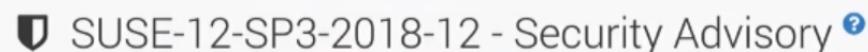
Audit Servers Audit Images

Items

TECHNICAL INFORMATION

| System          | Status | Action   |
|-----------------|--------|--|
| sle-sap-ip-demo | ⚠️     | Install a new patch on this system.<br>SUSE-12-SP3-2018-12 |
|                 | ⚠️     | Install a new patch on this system                         |

# Applying the patch for Spectre



Details Packages Affected Systems

## Affected Systems

Below is a list of systems affected by this patch. You can select one or more systems and apply this patch to them. Only systems with Management system type can be selected.

Select All Add Selected to SSM 1 - 2 of 2 (1 selected)

Filter by System Name:  Select first character

| System               | Status | Base Channel |
|----------------------|--------|--------------|
| avangrid1.geeko.land | N/A    | SLES12-SP    |
| sle-sap-lp-demo      | N/A    | SLES12-SP    |

**SUSE-12-SP3-2018-12 - Security Advisory**

Details Packages Affected Systems

### Confirm Patch Update: SUSE-12-SP3-2018-12

The following systems will have **SUSE-12-SP3-2018-12** applied to them:

If you are **certain** you wish to do this, you may apply the patches as soon as possible, or no earlier than a specified time:

Earliest:   MST

Add to:

1 - 1 of 1

| System          | Base Channel                |
|-----------------|-----------------------------|
| sle-sap-lp-demo | SLES12-SP3-Pool for ppc64le |

# Using Salt to apply a security configuration

```
mike@mdf-w530:~> ssh root@sle-sap-lp-demo
```

```
Password:
```

```
Last login: Wed Jan 31 07:21:56 2018 from 66.109.222.4
```

```
sle-sap-lp-demo:~ #
```

```
mike@mdf-w530:~> ssh root@sle-sap-lp-demo
```

```
Password:
```

```
Last login: Wed Jan 31 07:21:56 2018 from
```

```
sle-sap-lp-demo:~ # logout
```

```
Connection to sle-sap-lp-demo closed.
```

```
mike@mdf-w530:~> ssh root@sle-sap-lp-demo
```

```
Password:
```

```
Password:
```

```
Password:
```

```
mike@mdf-w530:~> ssh mfriesenegger@sle-sap-lp-demo
```

```
Password:
```

```
Last login: Wed Jan 31 07:22:09 2018 from 66.109.222.4
```

```
mfriesenegger@sle-sap-lp-demo:~> sudo -i
```

```
sle-sap-lp-demo:~ #
```

```
mike@mdf-w530:~> ssh root@sle-sap-lp-demo
```

```
Password:
```

```
Last login: Wed Jan 31 07:21:56 2018 from 66.109.222.4
```

```
sle-sap-lp-demo:~ #
```

SUSE®Manager > Systems

sle-sap-lp-demo

Details Software Configuration Provisioning Groups Virtualization Audit States Formulas Events

Highstate Packages Custom

Applying the custom states has been [scheduled](#)

Custom States

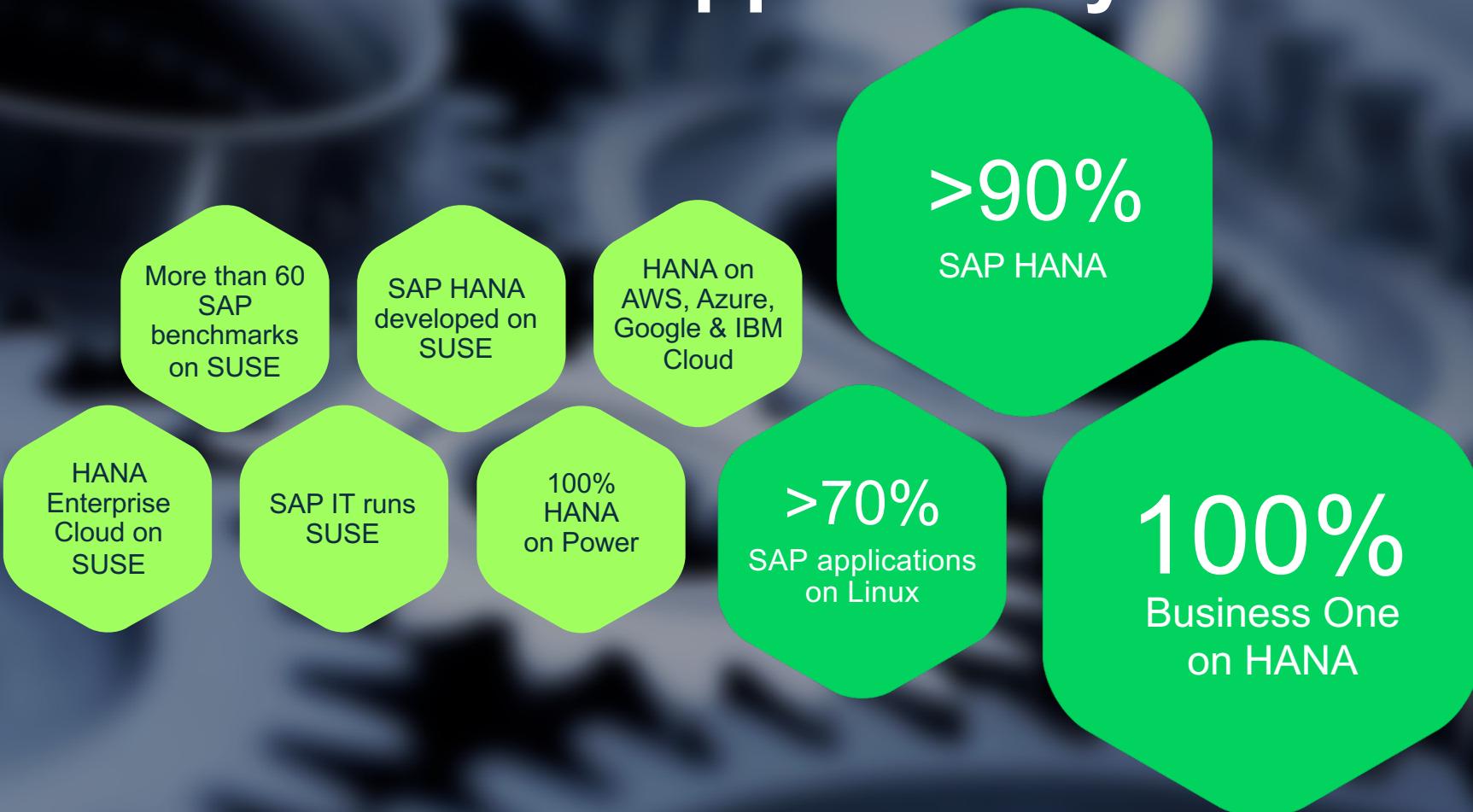
Save Apply

Search in state catalog Search System No Changes

State Name Assign

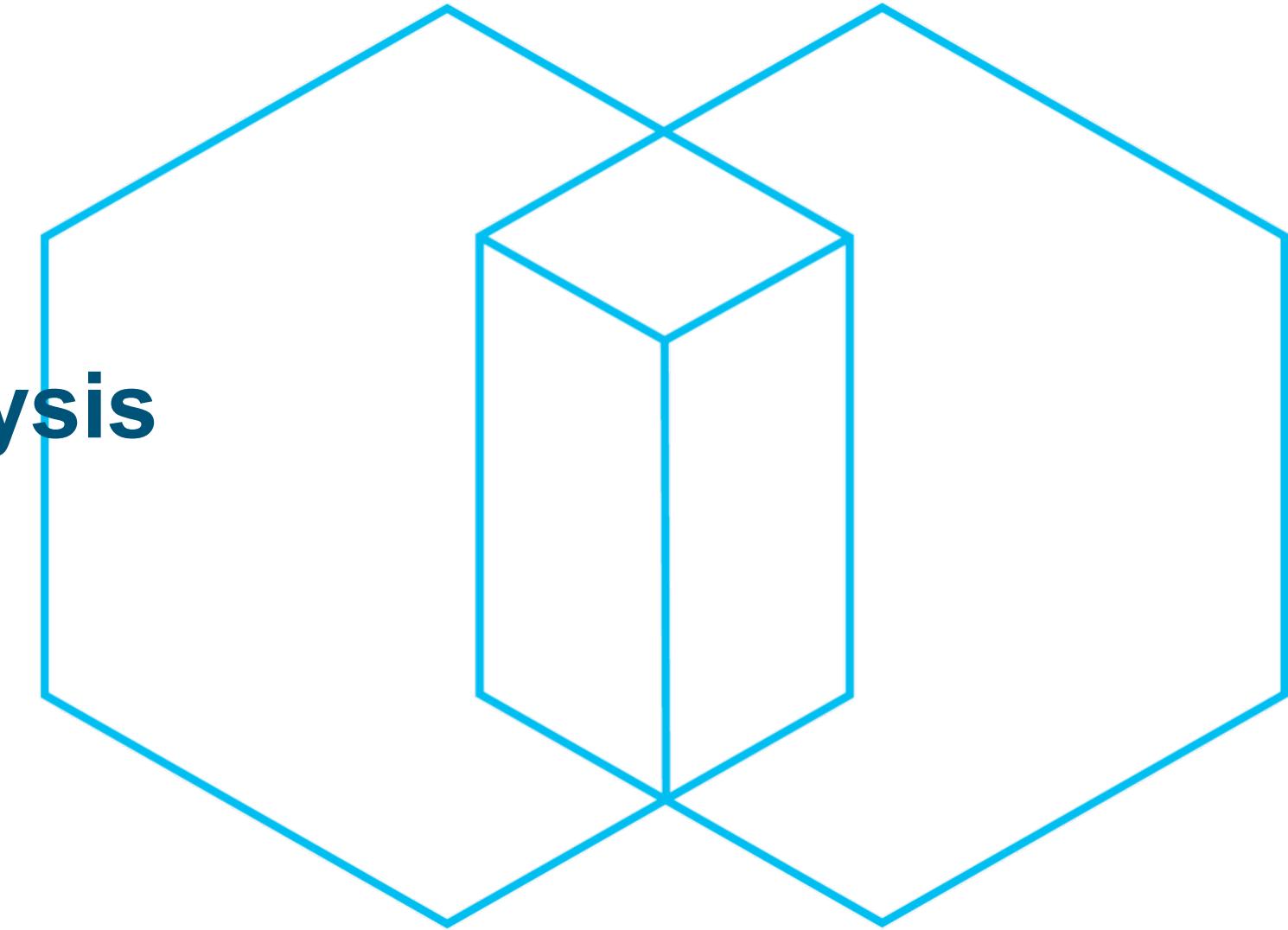
sshdNoPermitRoot

# SUSE Linux Enterprise Server for SAP Applications is recommended and supported by SAP





# Competitive Analysis



# Linux Offerings for SAP Solutions

## Prior to September 26, 2017

### SUSE

**SUSE Linux Enterprise Server for SAP Applications**

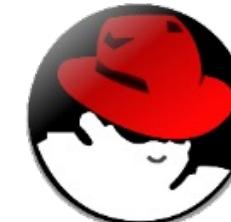


### Red Hat

**Red Hat Enterprise Linux for SAP**

**Red Hat Enterprise Linux for SAP HANA**

**Red Hat Enterprise Linux for SAP HANA with High Availability and Smart Management**



# Linux Offerings for SAP Solutions Today

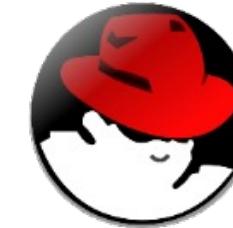
SUSE

SUSE Linux Enterprise Server for  
SAP Applications



Red Hat

Red Hat Enterprise Linux for SAP  
Solutions



# Product overview comparison

## SUSE Linux Enterprise Server for SAP Applications

- **Core products:**
  - SUSE Linux Enterprise Server
  - SUSE Linux Enterprise High Availability Extension
  - 24 x 7 Priority Support [with direct access to SUSE Level 3 Support](#)
  - [1 year Extended Service Pack Overlap Support](#)
  - SUSE Package Hub
- **Additional SAP-specific features:**
  - Automated SAP HANA failover and recovery agents
  - Automated configuration and tuning agents
  - [SAP HANA firewall](#)
  - [Remote storage encryption management](#)
  - [Page Cache Management](#)
  - [Installation Wizard](#)
  - [S/4HANA transition support](#)
  - [SUSE Connect](#)
- **Platforms:** x86-64, [ppc64](#) and ppc64le processor-based servers

## Red Hat Enterprise Linux for SAP Solutions

- **Core Products:**
  - Red Hat Enterprise Linux
  - High Availability Add-On
  - 24 x 7 Premium Support or [12 x 5 Standard Support \(non-production\)](#)
  - [4 years Extended Update Support](#)
  - Extra Packages for Enterprise Linux (EPEL)
- **Additional SAP-specific features:**
  - Automated SAP HANA failover and recovery agents
  - Automated configuration and tuning agents
  - High Availability
  - Smart Management Add-On
  - [Red Hat Insights](#)
- **Platforms:** x86-64 and ppc64le processor-based servers

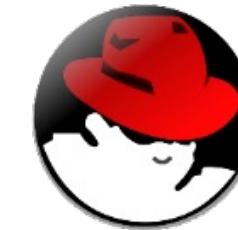
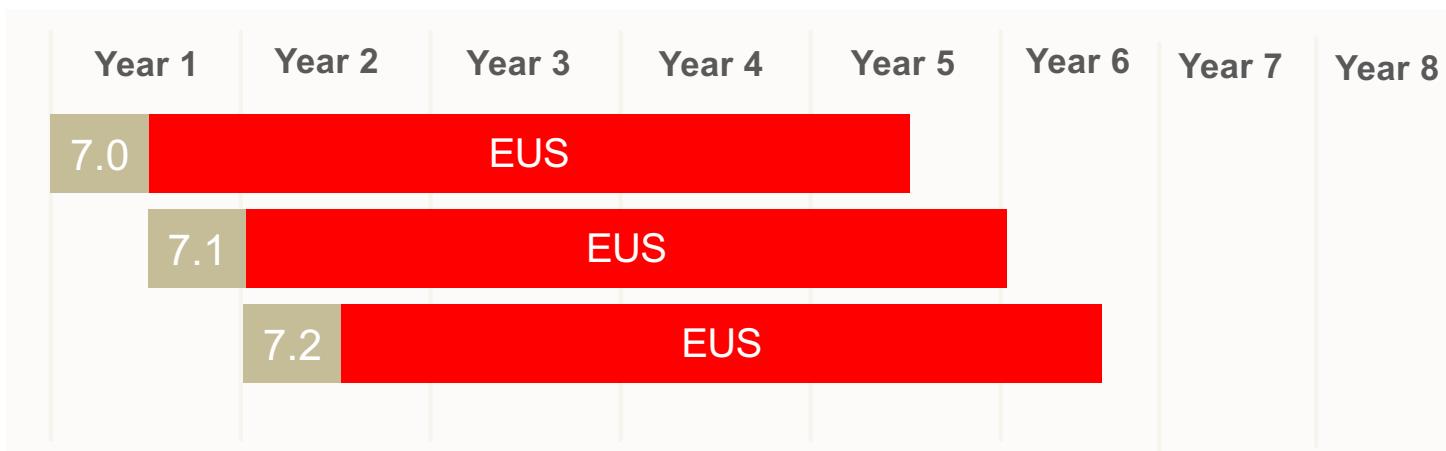
# Lifecycle Comparison

## SLES for SAP Applications vs. RHEL for SAP Solutions



4.5

years  
of support



4.5

years  
of support

# Feature comparison

| Technology / Feature                          | SUSE Linux Enterprise Server for SAP Applications               | Red Hat Enterprise Linux for SAP Solutions                  |
|---|---|---|
| Operating System                              | Core Distribution   | Core Distribution   |
| System management / Patching / Load balancing | Core Distribution   | N/A   |
| High Availability and Disaster Recovery       | Included  | Included  |
| Automated SAP HANA Failover and Recovery      | Included  | Included  |
| SAP HANA Firewall                             | Included  | N/A   |
| Remote Disk Encryption                        | Included  | N/A   |
| Page Cache Management                         | Included  | N/A   |
| Installation Wizard                           | Included  | N/A   |
| Automated configuration and tuning            | Included  | Included  |
| S/4HANA Transition Support                    | Included  | N/A   |
| 24 x 7 Support                                | Included  | Included  |
| Update Support                                | 1 year + Add-on (Long Term Service Pack Support)                | 4 years   |
| SUSE Connect                                  | Included  | N/A   |
| Server platform support                       | x86-64, ppc64, ppc64le  | x86-64, ppc64le   |
| Systems Management                            | Add-on (SUSE Manager)   | Add-on (Red Hat Satellite, Ansible, Cloudforms)             |
| Live Kernel Patching                          | Add-on (SUSE Linux Enterprise Live Patching)                    | N/A   |
| SAP-specific Public Cloud Images              | Amazon Web Services, Google Compute, IBM Cloud, Microsoft Azure | Amazon Web Services, Blackbird, CenturyLink Microsoft Azure |
| Predictive system analytics                   | N/A   | Included  |

# SAP Performance Benchmarks

as of April 27, 2018



66

- 16 – BW Edition for HANA
- 6 – BW Edition for HANA v2
- 17 – BW AML
- 9 – Cloud
- 18 – BW EML (obsolete)



0

- 0 – BW Edition for HANA
- 0 – BW Edition for HANA v2
- 0 – BW AML
- 0 – Cloud
- 0 – BW EML (obsolete)

BW Edition for HANA: [www.sap.com/about/benchmark/appbm/netweaver.sap-bw-edition-for-sap-hana-standard-application.html#sap-bw-edition-for-sap-hana-standard-application](http://www.sap.com/about/benchmark/appbm/netweaver.sap-bw-edition-for-sap-hana-standard-application.html#sap-bw-edition-for-sap-hana-standard-application)

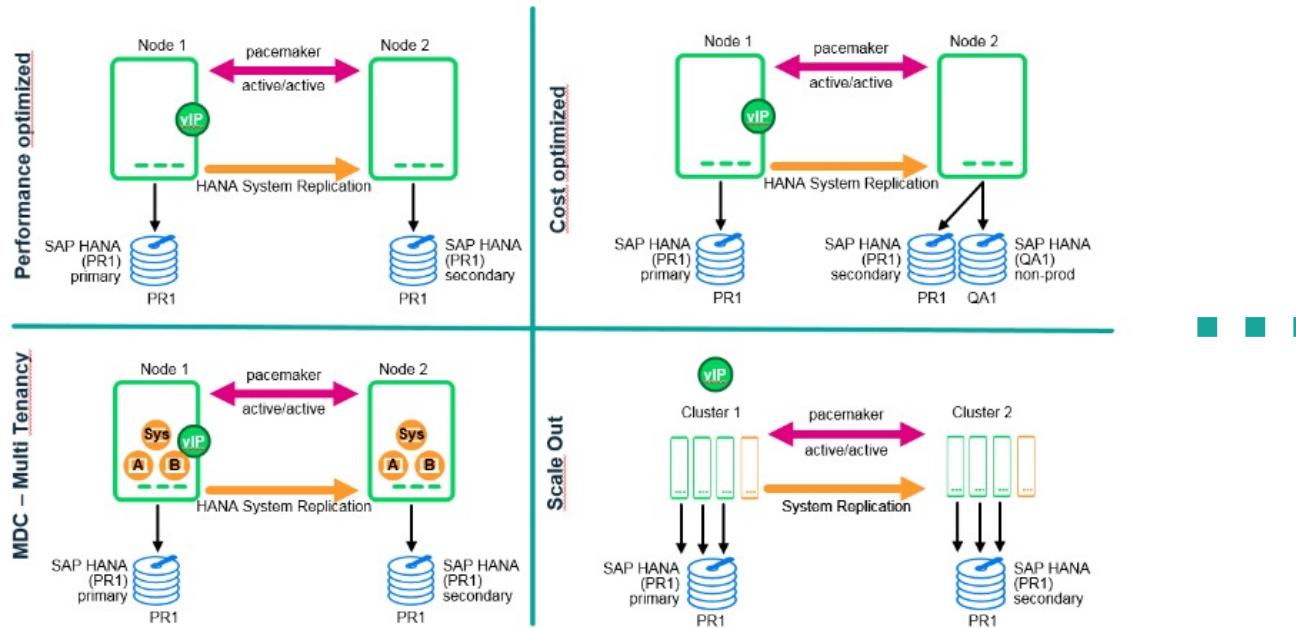
BW Edition for HANA v2: [www.sap.com/about/benchmark/appbm/netweaver.sap-bw-edition-for-sap-hana-benchmark-version-2.html](http://www.sap.com/about/benchmark/appbm/netweaver.sap-bw-edition-for-sap-hana-benchmark-version-2.html)

BW AML: [www.sap.com/about/benchmark/appbm/netweaver.sap-bw-advanced-mixed-load-bw-aml-standard-application.html#sap-bw-advanced-mixed-load-bw-aml-standard-application](http://www.sap.com/about/benchmark/appbm/netweaver.sap-bw-advanced-mixed-load-bw-aml-standard-application.html#sap-bw-advanced-mixed-load-bw-aml-standard-application)

Cloud: [www.sap.com/about/benchmark/appbm/cloud.html](http://www.sap.com/about/benchmark/appbm/cloud.html)

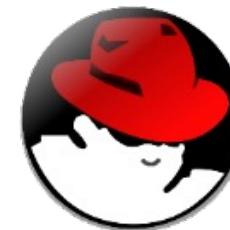
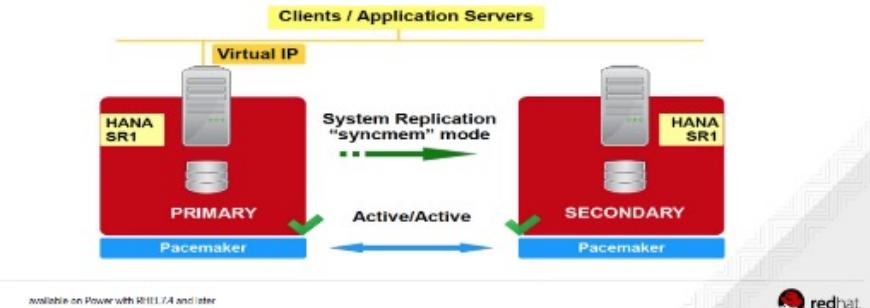
BW EML": [www.sap.com/about/benchmark/appbm/netweaver.sap-bw-enhanced-mixed-load-bw-eml-standard-application-obsolete.html#sap-bw-enhanced-mixed-load-bw-eml-standard-application-obsolete](http://www.sap.com/about/benchmark/appbm/netweaver.sap-bw-enhanced-mixed-load-bw-eml-standard-application-obsolete.html#sap-bw-enhanced-mixed-load-bw-eml-standard-application-obsolete)

# SAPHANASR scenarios supported



## High Availability with “RHEL for SAP Solutions”

- High Availability solutions for SAP HANA
  - Automated SAP HANA System Replication



# Things to consider with SLES for SAP Applications



- **Built-in high availability and security**
  - Graphical UI (HAWK) delivers faster set-up of clustering and recovery, with SAP HANA failover and recovery fully integrated in 4 different HA scenarios
  - SAP HANA Firewall and Remote Storage Encryption Management add data protection
- **Performance optimization**
  - SUSE Linux Enterprise Server is optimized for performance as a reference development platform for SAP applications
  - Page Cache Management prioritizes SAP application performance over the file system

# Things to consider with SLES for SAP Applications



- **Ease of use and deployment**
  - Installation and configuration wizards reduce SAP solution stack deployment time to hours vs. days
  - SAP S/4HANA transition support makes it easier for Windows Server admins to work in SAP Linux environments
  - Public Cloud deployments with Amazon, Google, IBM and Microsoft are consistent with on premise

# Things to consider with SLES for SAP Applications



- **SUSE innovation and collaboration**
  - First Linux for SAP HANA with ~95% of installed base, and first Linux for SAP HANA on Power Systems with 99,9% of installed base
  - Developed automated SAP HANA System Replication and recovery, and automated SAP application configuration
  - SAP HANA Express VMs are built on SLES for SAP Applications
  - SUSE Connect simplifies access to SUSE and SAP partner applications and services

# Things to know about RHEL for SAP Solutions



- **Less function than SLES for SAP Application**
  - No enhancements for security or data protection in SAP environments
  - No one-click rollback
  - The “Smart Management Add-on” is only useful with Red Hat Satellite. SUSE Manager delivers everything customers need for configuration management and updates.
  - Ansible add-on required for fast deployment of SAP applications and SAP HANA
  - Live kernel patching is not an option
- **Not preferred for SAP HANA performance benchmarks**
  - All 48 current and 18 obsolete SAP HANA benchmarks are on SLES for SAP Applications\*
  - IHVs and Cloud providers perform benchmark testing with SLES for SAP Applications for the best results

\* [www.sap.com/solution/benchmark/appbm/netweaver.sap-bw-edition-for-sap-hana-benchmark.html](http://www.sap.com/solution/benchmark/appbm/netweaver.sap-bw-edition-for-sap-hana-benchmark.html) and [www.sap.com/solution/benchmark/appbm/netweaver.sap-bw-edition-for-sap-hana-standard-application.html](http://www.sap.com/solution/benchmark/appbm/netweaver.sap-bw-edition-for-sap-hana-standard-application.html)

# Things to know about RHEL for SAP Solutions



- **Red Hat is a market follower**
  - No SAP solution-specific upstream development to the community
  - Adopted SUSE's automated SAP HANA System Replication agents and configuration package in 2016
  - Merged separate applications and database products, added HA, ppc64le support for HANA 2.0, and extended service pack support in 2017
  - It took two years for Red Hat to get a working solution for SAP HANA on IBM Power (ppc64le) due to technical challenges
- **Red Hat Insights predictive analytics requires sending IT data to Red Hat for analysis**
- **Red Hat has no visible collaborative innovation with SAP**

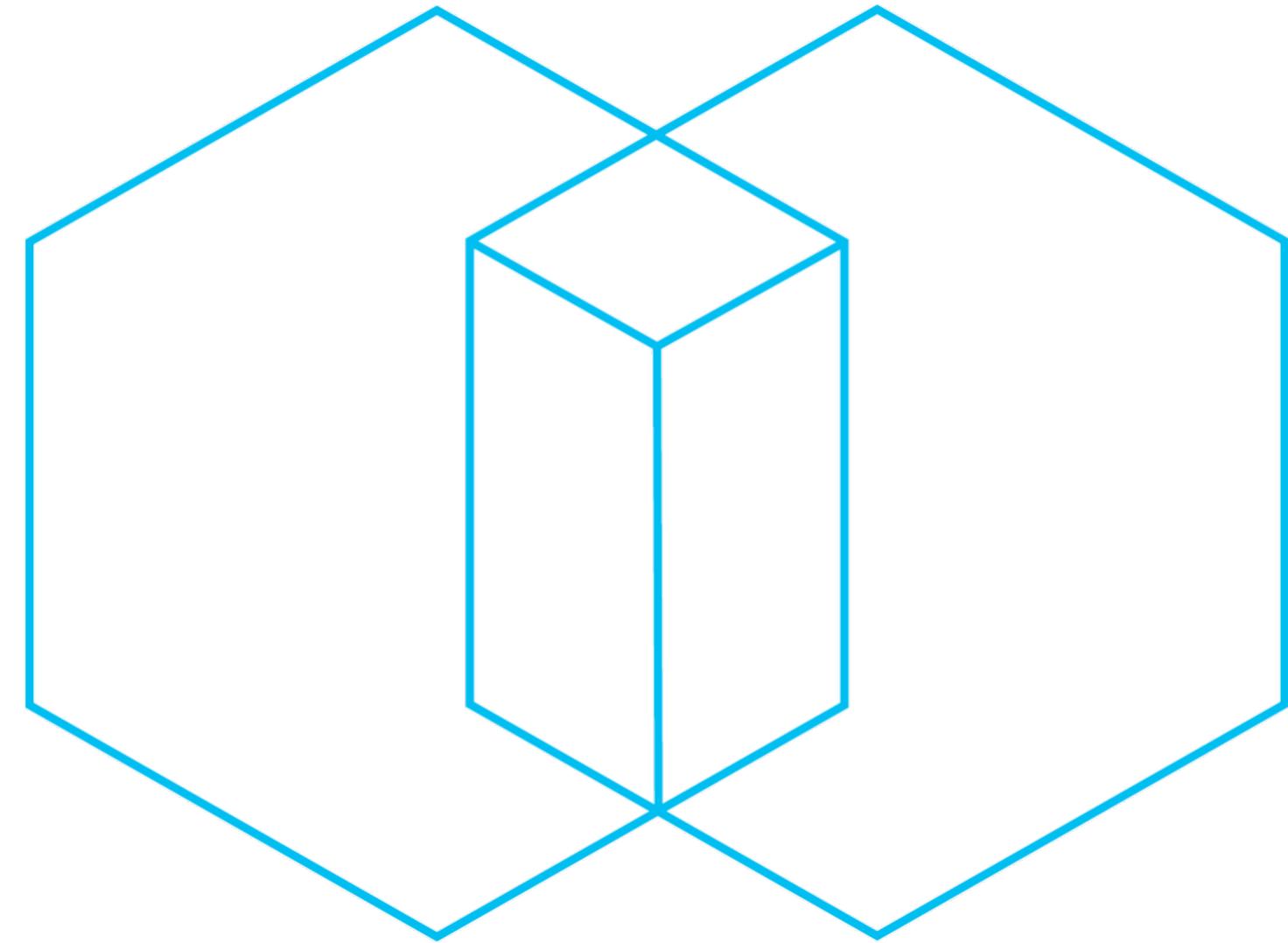
# POWER vs x86 on HANA



- **Best suited architecture for memory intensive workloads**
- **Simultaneous multi threading (up to 8 threads per core)**
- **Additional cache layer for increases responsiveness**
- **Up to 8 LPARs per system certified by SAP.**
- **Support for 99,999% availability**
- **Unrivaled TCO for any SCALE-UP scenario with best performance/\$ ratio.**



# Thanks!



## Summary

**SAP S/4HANA transition will drive the biggest investments on IT for the next 5 years**



**IBM POWER is rock solid for business critical on SAP S/4HANA**



**SUSE glues together a SAP tailored OS with the most resilient and flexible HW from IBM for reduced TCO on SAP projects**



# Resources

# Resources

- <https://www.suse.com/es-es/products/power/>
- [https://www.suse.com/docrep/documents/ox4qtvk5xg/suse\\_linux\\_enterprise\\_server\\_for\\_sap\\_applications\\_solutions\\_flyer.pdf](https://www.suse.com/docrep/documents/ox4qtvk5xg/suse_linux_enterprise_server_for_sap_applications_solutions_flyer.pdf)
- <https://www.suse.com/products/sles-for-sap/frequently-asked-questions/>
- [https://www.suse.com/documentation/sles-for-sap-12/singlehtml/book\\_s4s/book\\_s4s.html](https://www.suse.com/documentation/sles-for-sap-12/singlehtml/book_s4s/book_s4s.html)
- [https://www.suse.com/releasenotes/x86\\_64/SLE-SAP/12-SP2/](https://www.suse.com/releasenotes/x86_64/SLE-SAP/12-SP2/)
- <https://www.suse.com/products/sles-for-sap/resource-library/sap-best-practices/>
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- <https://susecon2016.smarteventscloud.com/connect/fileDownload/session/B0E055A71DEC7D7FF315BA6DCA88CED4/TUT91496.pdf>
- <https://www.suse.com/c/sap-hana-customer-adoption-supersonic-speed/?sf177076581=1>
- <http://www-03.ibm.com/software/businesscasestudies/us/en/gicss67sap?search=true&text=HANA&hw=CSHW114&dr=#search>

**GRACIAS** **THANK**  
**ARIGATO** **YOU**  
**SHUKURIA** **BOLZIN MERCI**

THANK YOU

THANK YOU