RHEL 9 New Features

What's new?

Mike Pagan
Sr. Solutions Architect

Key New Features in RHEL 9

Detailed Discussion in Subsequent Slides

- Developer
- Security
- Automation & Management
- Containers
- Performance
- Identity Management
- RHEL for Edge
- RHEL in the Cloud

Red Hat

RHEL 9 for Developers

RHEL 9.0

RHEL 9.later

| NEW in RHEL 9 | Maven 3.6
LLVM Toolset in DevTools 2021.4
nginx 1.20 in RHEL8 AppStream
Add PHP 8.0 to RHEL9 AppStream
Ruby 3.0 | **java-17-openjdk for RHEL 9**
Updates to performance tools and debuggers
Perl 5.32
glibc 2.32+
GCC 11 will be system compiler in RHEL9
Rust Toolset in DevTools 2021.4
Go Toolset in DevTools 2021.4 |

Providing developers with the language, library, & tool versions they require

Red Hat

RHEL 9 Automation

RHEL 9 and RHEL 8

RHEL 9 only

NEW in RHEL 9	· New role for web console deployment and configuration · Enhancements to existing roles and expand support to include RHEL 9 · Module for managing the Redfish management interface · New firewall system role · HA Cluster role improvements	· Integration with Ansible Execution Environments · New role for Subscription Management · Enhancements for tlog (session recording) role · Enhancements to SQL Server role for Availability Groups support · Enhancements to SQL Server role for AD authentication support · Additional System Roles

RHEL 9 Automation and Management Features

New in RHEL 9	GA Postfix RHEL System Role Storage system role LVM VDO support and Percentage-based volume sizes **Image Builder multi-version support** Simple RHEL graphical performance analysis experience System Role for VPN
New in RHEL 9 and Supported in RHEL 8.x	Superior SQL Server user experience for RH Insights Automation for hardware management interfaces in redhat.rhel_mgmt collection Storage system role LVM VDO support and Percentage-based volume sizes **RHEL System Role for MS SQL** GA Postfix RHEL System Role System Role for VPN Image based RHEL deployments on bare metal Image Builder multi-version support Image Builder Support for flexible filesystem layouts Image Builder builds images for Google Cloud

RHEL 9 Security Features

New in RHEL 9 only	Release RHEL-9 with OpenSSL 3.0 Continuous support of compliance profiles in next major version (RHEL 9) Disable Root Password Login in SSH SHA-1 deprecation and removal from RHEL Allow Smart Card authentication for SUDO and SSH from Cockpit **SELinux** performance improvements One safe way of disabling SELinux (Integrity Measurement Architecture) IMA
New in RHEL 9 and Supported in RHEL 8.x	Introduce ACSC Information Security Manual (ISM) compliance profile Web Console can manage Kernel Live Patching (kpatch)* Verify Signatures of Container Images by Default **Network Time Security (NTS) for NTP**

RHEL 9 Container Features

New in 9	**Test Beta UBI9 container base images** **Check out UBI8 based containers on RHEL 9 Beta** Better Delegation of Resource Constraints with Containers (cgroup v2) Native Overlayfs as a Rootless User Verify Signatures of Container Images by Default
New in RHEL 9 and Supported in RHEL 8.x	**Updated container-tools:rhel8** for RHEL 8.5.0 **Containerized Podman** Generally Available Native Overlayfs as a Rootless User Better Delegation of Resource Constraints with Containers (cgroup v2) Verify Signatures of Container Images by Default

RHEL 9 Performance Tuning &
Monitoring Features

New in RHEL 9	Targeting Kernel 5.14 **PCP and Grafana analysis tools** Enable link time optimization (LTO) by default for building packages across the RHEL 9 distribution
Existing RHEL 8 features enhanced in RHEL 9	eBPF **Web console performance metrics** Simple RHEL graphical performance analysis experience Update PCP and Grafana analysis tools with bugfixes and new features for RHEL 8.5

RHEL 9 Identity Management Features

New in RHEL 9	**SSSD health analyser**
New in both RHEL 9 and RHEL 8	RHEL 8 – use of **system role for ease of setup** and integration across multiple RHEL major releases (and AD integration)

RHEL 9 for Edge Features

New in RHEL 9	**lightweight UI** Integrity Measurement and Attestation
New in both RHEL 9 and RHEL 8.x	**Existing Edge features** ● Create (Image Builder) ● Deploy ● Roll back (Greenboot)

RHEL 9 for Public Cloud Features

New in RHEL 9	**RHEL 9 Imagebuilder support**
New in both RHEL 9 and RHEL 8.5	**Cloud provider marketplace images at GA**

RHEL 9 Additional Features

Further topics	RHEL HA RHEL for SQLserver enhancements RHEL for SAP enhancements RHEL for Real Time enhancements Smart NIC/FPGA support Virtualization Smart Management Satellite

RHEL 8 Features

Reasons to upgrade from RHEL 6 and 7

Mike Pagan
Sr. Solutions Architect

RHEL 6, 7 and 8 At A Glance

	RHEL 6	RHEL 7	RHEL 8
KERNEL VERSION	2.6+	3.10+	4.18+
SYSTEM COMPILER	GCC 4.4+	GCC 4.8+	GCC 8.2, LLVM 6.0
HARDWARE ARCHITECTURES	Intel/AMD 64-bit, IBM Power BE, IBM z Systems	Intel/AMD 64-bit, IBM Power LE, IBM z Systems, ARM 64-bit	Intel/AMD 64-bit, IBM Power LE, IBM z Systems, ARM 64-bit
SERVICES MGMT	init	systemd	systemd
DEFAULT FILE SYSTEM	ext4	XFS	XFS
PACKAGE MANAGEMENT	Yum	Yum	Yum v4
TIME SYNCHRONIZATION	ntp	ntp	Chrony
NETWORKING	ifcfg	NetworkManager	NetworkManager

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RHEL 6, 7 and 8 Feature Table

	RHEL 6	RHEL 7	RHEL 8
CONTAINER ENGINE	Docker 1.13	Docker 1.13, Podman	podman
fIREWALL	iptables	Iptables + firewalld	Nftables + firewalld
DEV TOOLS	Software Collections (SCL)	Software Collections (SCL)	AppStreams
IN_PLACE UPGRADE	No	Yes	Yes (LEAPP)
IMAGE BUILDER	No	No	Yes
ANSIBLE SYSTEM ROLES	No	Yes	Yes
UNIFIED FILESYSTEM MGMT	No	No	Stratis

Red Hat

RHEL 6, 7 and 8 Feature Table

	RHEL 6	RHEL 7	RHEL 8
HA CLUSTERING	Corosync	Pacemaker	Pacemaker
DEBUGGING	Systemtap	Systemtap	ebpf
TERMINAL SESSION RECORDING	No	No	Yes
STORAGE ENCRYPTION	LUKS 1.0	LUKS 1.0	LUKS 2.0
NBDE SUPPORT	No	Yes	Yes
ROLLBACK	No	Relax and Recover (ReAR) with thinsnapshot	Relax and Recover (ReAR)

RHEL 6, 7 and 8 Feature Table

	RHEL 6	RHEL 7	RHEL 8
GUI MANAGEMENT	None	Web Console	Web Console
PERFORMANCE	Good	Good	Better
End of Life	Nov. 2020	June 2024	May 2029
Extended Lifecycle Support end date	June 2024	TBD	TBD
Bug fixes?	No	Yes	Yes
New Feature Enablement?	No	No	Yes
Critical Security patches?	Yes (requires ELS)	Yes	Yes

RHEL 6, 7 and 8 Feature Table

	RHEL 6	RHEL 7	RHEL 8
Enhance container security: udica	No	No	Yes (RHEL 8.2)
Enhanced container portability: **CRIU**	No	No	Yes (RHEL 8.2)
Containerized container tools	No	No	Yes (RHEL 8.2)
Cgroups v2	No	No	Yes (RHEL 8.2)

RHEL 6, 7 and 8 Ecosystem

	RHEL 6	RHEL 7	RHEL 8
nVIDIA DGX SUPPORT	No	Yes	Yes, + precompiled libraries
OPENSHIFT SUPPORT	3.x	3.x, 4.x worker node	3.X, $.x
CoreOS Support	no	No	Yes
MICROSOFT SQLSERVER SUPPORT	No	Yes	Yes

New Feature (RHEL 8): **Application streams**

Time of support

PostgreSQL 12 stream

PostgreSQL 10 stream

PostgreSQL 9.6 stream

Red Hat® Enterprise Linux® 8

Red Hat Enterprise Linux 7
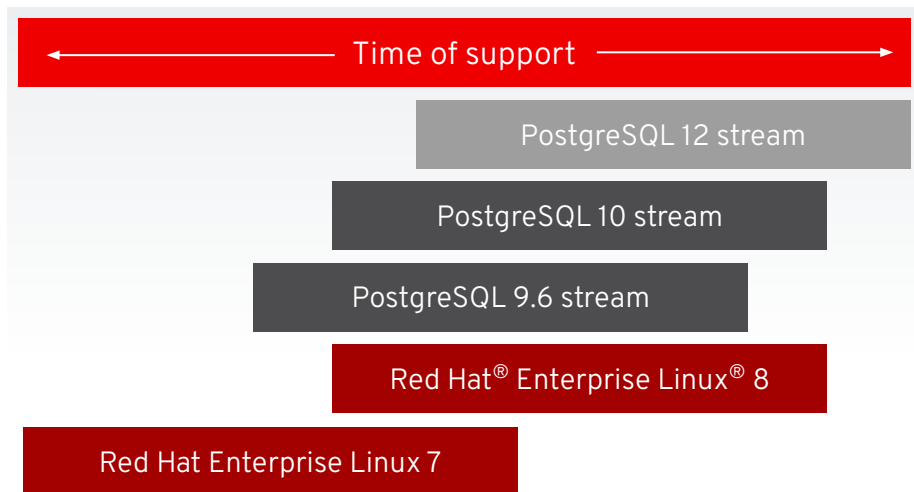
More choice
Offers versions of the open source tools and frameworks developers need

Newer versions
Provides access to newer versions as they stabilize

Simpler access
Maintains standard locations for tools and libraries

App Streams (RHEL 8): Simplified access to software

Red Hat Enterprise Linux 7 repositories

| extras | rhscl | dotnet | devtools | supplementary | optional |

| server |

Red Hat Enterprise Linux 8 repositories

| appstream | supplementary | codeready-builder |

| baseos |

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Application Compatibility Resource
(in-house applications)

Red Hat API & ABI Compatibility Guarantee:
- API and ABI compatibility is guaranteed between minor releases
- ...but not for "blacklisted" APIs (very few of these)
- API and ABI compatibility is NOT guaranteed between major releases
- See compatibility checklists linked below

RHEL 6 ➜ RHEL 7 API and ABI compatibility checklist
https://access.redhat.com/articles/rhel-abi-compatibility

RHEL 7➜ RHEL 8 API and ABI compatibility checklist
https://access.redhat.com/articles/rhel8-abi-compatibility

New Feature (RHEL 8): **yum version 4**

Repository
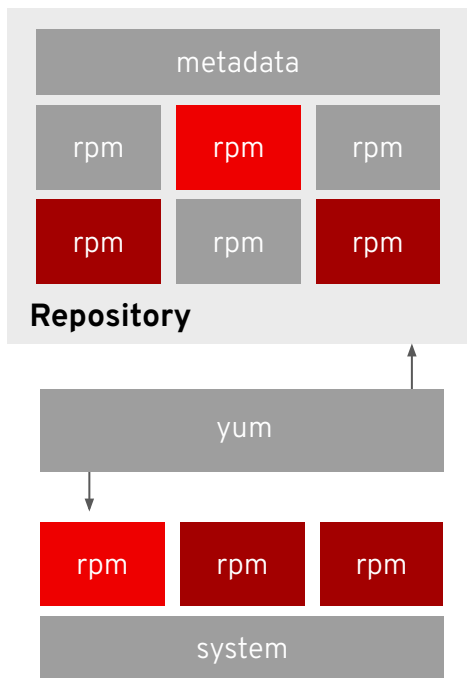
New technology
Maintains the same experience while adding new tools

Better dependency management
Offers faster resolution and easier minimization of what's installed

Stable API
Provides new application programming interface (API) for extending yum that will progress into the future

Lighter Weight
Enables smaller (<40 MB) system images

New Feature: Detect and fix issues with **Red Hat Insights**
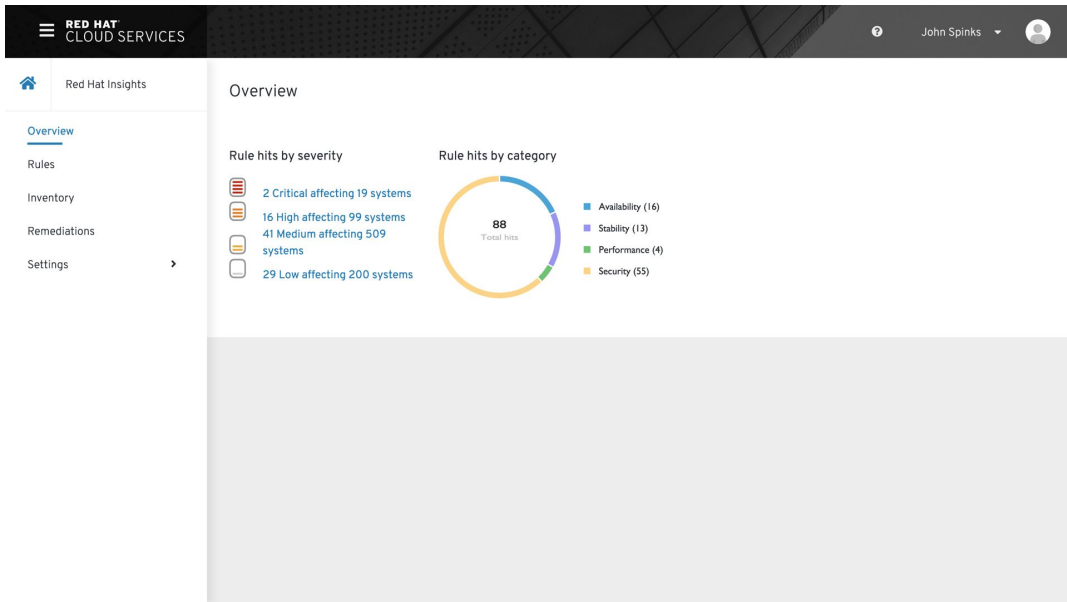
Proactive advice
Identification of issues before they become problems

Continuous assessment
Real-world results to help find new risks

Simpler remediations
Tailored results at the host level

New and improved Red Hat Insights

Still included with Red Hat Enterprise Linux subscription, now with more value

New and expanded services provide additional security and operational efficiency.

*Active RHEL subscriptions versions 6.4 & higher

Value of experience

DISCOVER

1,000,000+
solved cases

VALIDATE

100,000+
unique solutions

RESOLVE
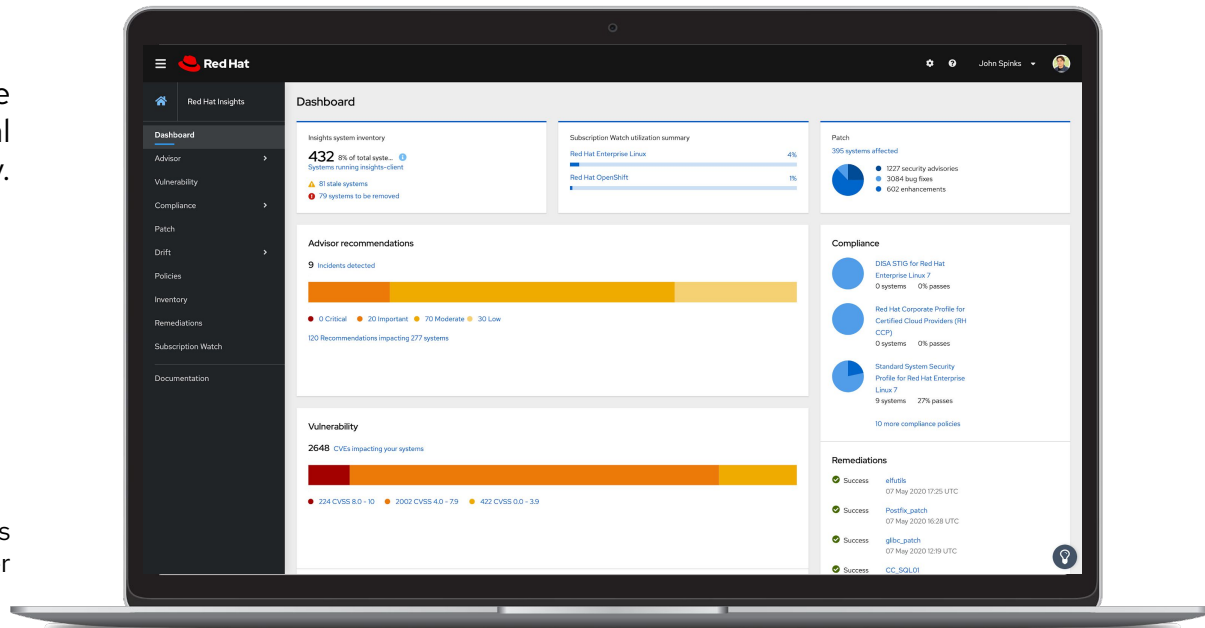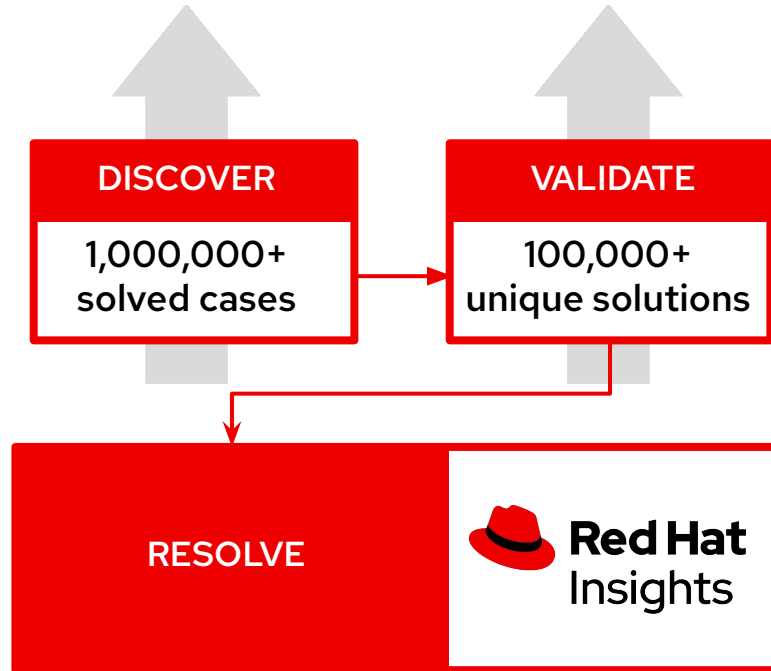
Red Hat
Insights

" 85% of critical issues raised to Red Hat® support are already known to Red Hat or our partners."

– RED HAT GLOBAL SUPPORT SERVICES

Continuous identification of new risks driven by unique industry data

Based on real-world results from millions of enterprise deployments

Red Hat

Red Hat Insights

- Dashboard
- Advisor >
- Vulnerability
- Compliance >
- Patch
- Drift >
- Policies
- Inventory
- Remediations
- Subscription Watch
- Documentation

Dashboard

Insights system inventory
432 8% of total syste... ⓘ
Systems running insights-client
⚠ 81 stale systems
❗ 79 systems to be removed

Subscription Watch utilization summary
Red Hat Enterprise Linux — 4%
Red Hat OpenShift — 1%

Patch
395 systems affected
- 1227 security advisories
- 3084 bug fixes
- 602 enhancements
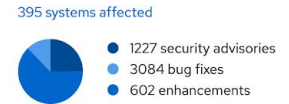
Advisor recommendations
9 Incidents detected

- 0 Critical
- 20 Important
- 70 Moderate
- 30 Low

120 Recommendations impacting 277 systems

Compliance
- DISA STIG for Red Hat Enterprise Linux 7
  0 systems   0% passes
- Red Hat Corporate Profile for Certified Cloud Providers (RH CCP)
  0 systems   0% passes
- Standard System Security Profile for Red Hat Enterprise Linux 7
  9 systems   27% passes

10 more compliance policies

Vulnerability
2648 CVEs impacting your systems

- 224 CVSS 8.0 - 10
- 2002 CVSS 4.0 - 7.9
- 422 CVSS 0.0 - 3.9

Remediations
- ✓ Success elfutils 07 May 2020 17:25 UTC
- ✓ Success Postfix_patch 07 May 2020 16:28 UTC
- ✓ Success glibc_patch 07 May 2020 12:19 UTC
- ✓ Success CC_SQL01

Overview of expanded Red Hat Insights services

Advisor
Availability, performance, and stability risk analysis

Vulnerability
Assess, remediate and report on Red Hat Enterprise Linux Common Vulnerability and Exposures (CVEs)

Compliance
Assess and monitor regulatory compliance, built on OpenSCAP

Subscription Watch
Track progress of your Red Hat subscription usage efficiently and confidently.

Drift
Create baselines and compare system profiles

Policies
Define and monitor against your own policies to identify misalignment

Patch
Analyze for Red Hat product advisory applicability to stay up to date

Red Hat

Expanded Red Hat Insights Services

Advisor
Availability, performance, stability, and security risk analysis

Vulnerability
Assess Common Vulnerabilities and Exposures (CVEs) with advisories

Compliance
Assess and monitor compliance, built on OpenSCAP

Subscriptions
Track progress of your Red Hat subscription usage efficiently and confidently

Drift
Create baselines and compare system profiles

Policies
Define and monitor against your own policies to identify misalignment

Patch
Analyze for Red Hat product advisory applicability to stay up to date

Red Hat

Three steps to advanced RHEL management

Register

Install client for Red Hat instances on-premises, virtual, cloud.

Get started steps
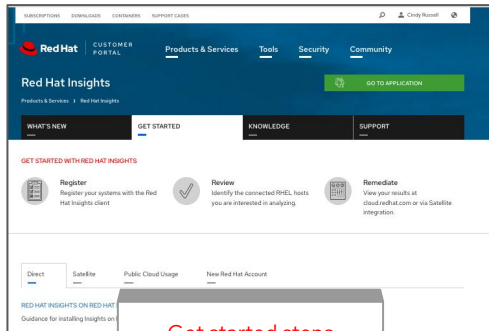
Review

Insights client runs and issues found are reported in the Insights dashboard at cloud.redhat.com

Browse results
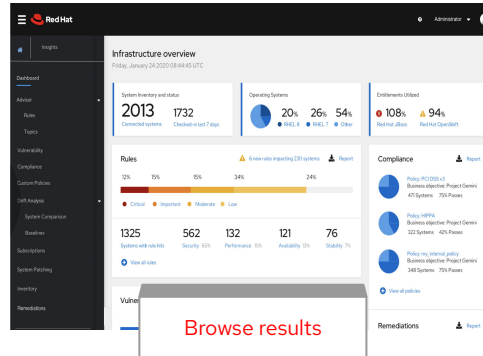
Remediate

Review issues and results in the dashboard and choose which you would like to remediate. Leverage guidance, and remediation options.

Remediation guidance

Red Hat
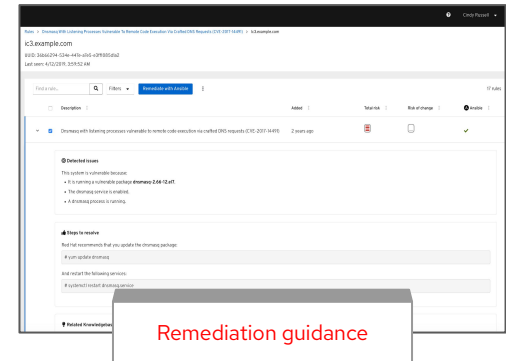
New Feature (RHEL 7 & 8): Create images for all your environments with **image builder**

Bare metal

Hypervisors

Public clouds

Private clouds
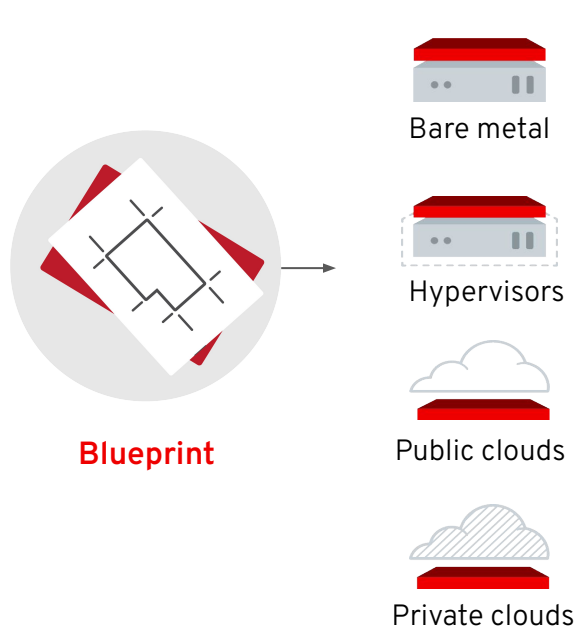
Blueprint

Single source
Lets you create gold images for any environment from the same blueprint increasing stability and consistency

Any footprint
Supports public cloud, private cloud, enterprise hypervisors, and bare metal

Simple interface
Provides web-based view within the web console for selecting packages and creating blueprints

New Feature (RHEL 7 & 8): Speed automation creation with **system roles**

timesync

network

SELinux

webserver

dbserver

Red Hat
Ansible
Automation
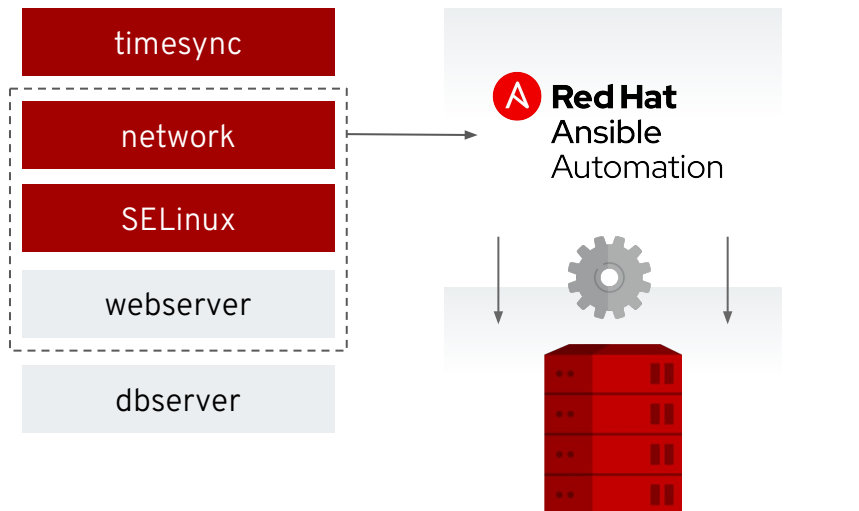
Common automation
Manage multiple versions of
Red Hat Enterprise Linux from a
single role

Reduced rework
Import provided roles to eliminate
task creation in playbooks

Easy switching of providers
Change between default and optional
tools quickly and safely

RHEL System Role List

New in RHEL 8.3

- certificates
- kernel_settings
- logging
- metrics
- NBDE_client
- NBDE_server
- tlog

Fully Supported in RHEL 8.2 & earlier

- kdump
- postfix
- network
- selinux
- storage
- timesync

in package rhel-system-roles-sap.noarch from RHEL for SAP offering

- sap-hana-preconfigure
- sap-netweaver-preconfigure
- sap-preconfigure

New Feature (RHEL 8): Optimized experiences for mission-critical databases

Microsoft SQL Server

- Red Hat Enterprise Linux is the reference platform for SQL Server on Linux

- Benchmark-breaking performance

- Fast deployment and portability via containers

SAP HANA

- Red Hat Enterprise Linux is 1 of only 2 certified Linux distributions

- More than 20 years of Red Hat and SAP joint engineering collaboration

- Exceptional performance and scalability —the largest SAP install in the world runs on Red Hat Enterprise Linux

New Feature (RHEL 7 & 8): Manage containers with

Podman

Kernel
RunC
Podman
Images
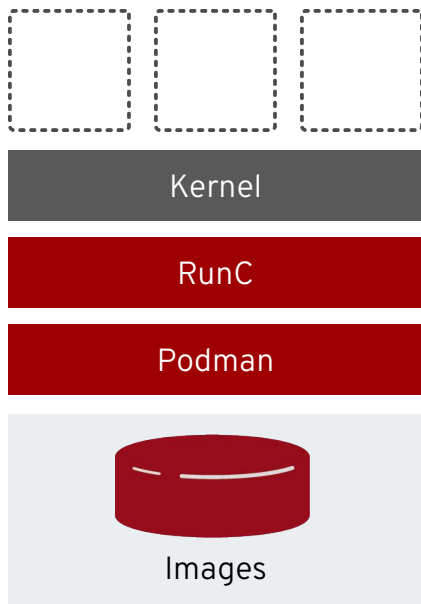
Fast and lightweight
No daemons required

Advanced namespace isolation
Rootless operations for container run
and build

Open standards compliant
Creates and maintains any standard
Open Containers Initiative (OCI)
-compliant containers and pods

No root privileges required
Greater security

Red Hat

Create images with Buildah

Application layer

Java™ runtime layer

OS update layer

Base Red Hat
Enterprise Linux

From base, multilayer

Java runtime and
dependencies, and
application

From scratch, single layer
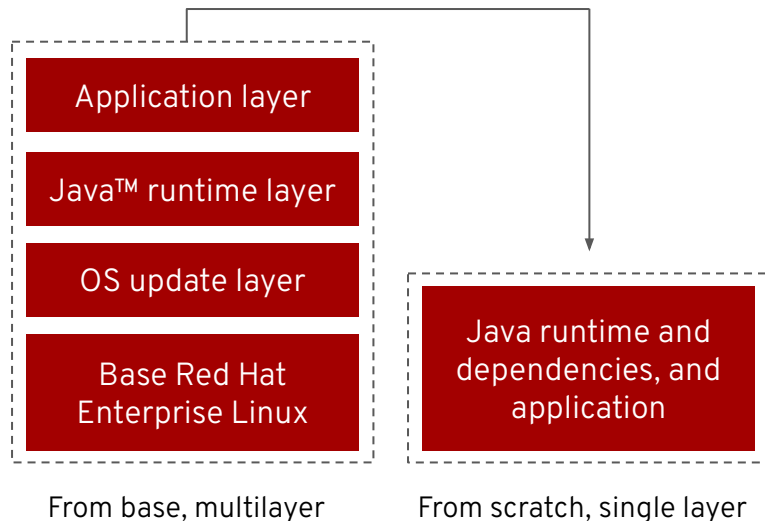
More control
Scriptable tooling for fine-grained
image control, and maximum control
starting from base or scratch images

Minimization of images
Elimination of unneeded dependencies
by using host-based tools

Inspect and transport images with Skopeo
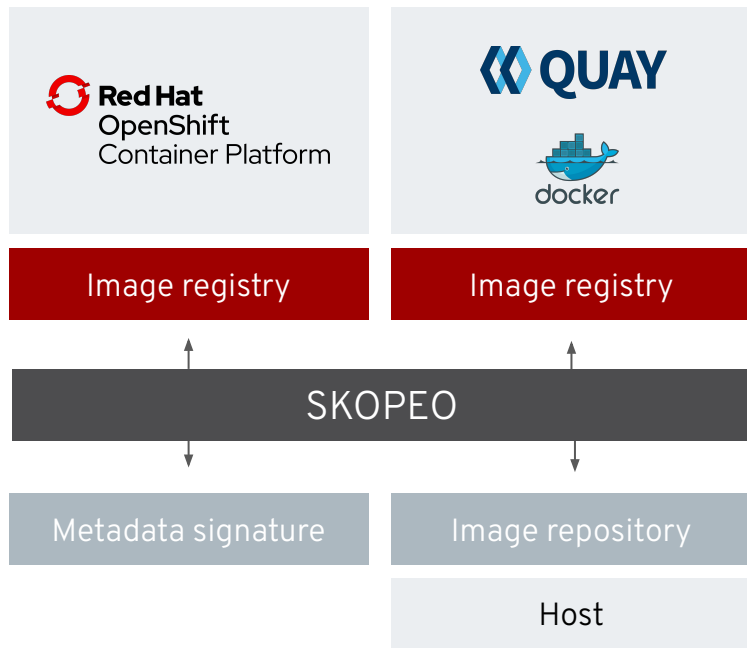
Inspect images remotely
Examine image metadata without needing to download

Publish and transfer images
Copy images from registries to hosts or directly between registries

Sign and verify images
Supports GPG key signing on publish

New Feature (RHEL 8.2): **udica**: a new container tool for security

- Craft an SELinux Policy for specific containers

- Manage access to host system resources
  (logs, network components, files, etc.)

- Reduce risk from processes 'breaking out' of a container

base
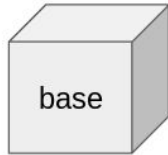
Required for every container

net
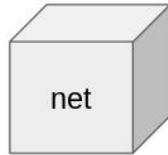
+ Allowing bind on ftp_port_t (21)

home
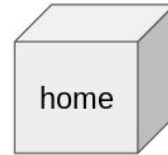
+ Add only read/write perms

New Feature(RHEL 8.2): **CRIU** container tool for portability

Checkpoint
a container, including it's current state

Restore
that container to the same or different host

In Userspace
userspace tools are used to perform these operations

Why?

❏   Migrate containers, complete with preserve state, to different hosts

❏   Drastically reduce container start time

❏   Supported in RHEL 8.2 (Tech Preview in previous releases)

New Feature (RHEL 8.2): Containerized container tools

Containerized Container Tools [Tech Preview]

Available with 8.2:
- buildah
- skopeo

On the roadmap:
- podman

Helping the non-Red Hat container tool developer work with Red Hat native containers

New Feature in RHEL 8.2: Improved cgroups

cgroupsv2

Advanced Memory Controller

Hard and soft memory registrations

Adjust or disable swap

Unified Hierarchy

Controllers now align to groups rather than groups being subjugated to controllers

systemd Integration

systemd can now utilize all controllers when defining a cgroup for a service

More details and examples from Marc Richter's blog:
World domination with cgroups in RHEL 8: welcome cgroups v2!

Red Hat

New Feature (RHEL 8): Configuring **system wide cryptographic policies**

Legacy			

| Default | Encryption algorithm | httpd / OpenSSL | Secured communications | Client |

Future

Central configuration
Set acceptable algorithms from a single tool

Improved consistency
Covers multiple cryptographic providers and consumers like TLS, kerberos, and Java

Built-in policies
Including legacy systems requiring 64-bit security and FIPS allowed or approved algorithms

New Feature (RHEL 8): **Recording user terminal sessions**

Audit activities
Create a record of actions taken for review against security policies

Create visual guides
Build run books and training materials with demonstrations

Record and play back
Logged via standard channels with multiple playback options

New Feature (RHEL 8): Improved firewall management with **nftables**
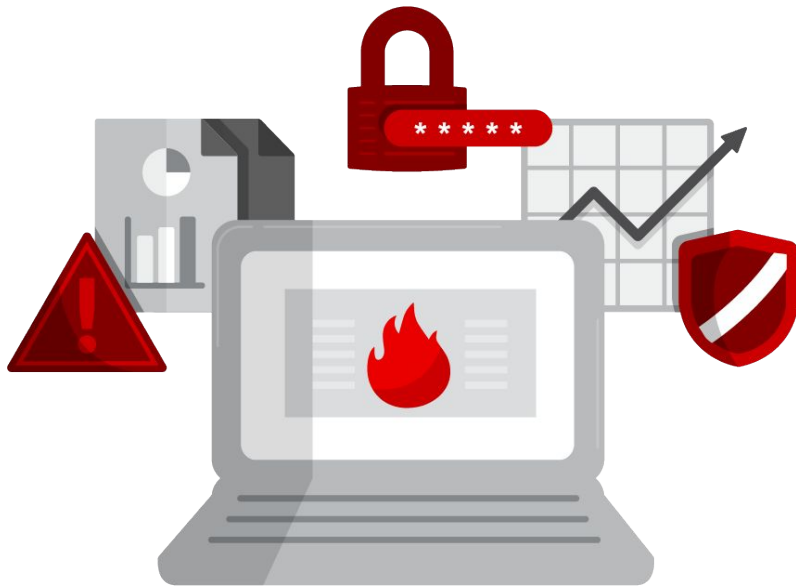
Consolidated filtering
Supports IPv4, IPv6, ARP, and Bridge filtering in a single tool

Simpler rule creation
Multiple matches and actions reduce the number of rules required

Improved tracing
Provides easier debugging and verification of actions taken on any packet

Using **nftables vs. iptables**

Userspace compatibility toolsl

- p(6)tables-translate (it's useful)
- ip(6)tables-compat (deprecated)
- iptables-apply
- xtables-monitor
- nfbpf_compile

Similarities

- Use netfilter framework, such as hooks and nomenclature (e.g. tables, chains, ...)
- reuse connection tracking and NAT parts

Differences

- Kernel: nftables provides a network-specific Virtual Machine (VM)
- Userspace: ip(6)tables, ebtables, arptables, ipset -> nftables
- Userspace: iptables-restore, iptables-save -> nft -f [rulefile], nft list ruleset > [rulefile]

New Feature (RHEL 8): Modernized time sync with **chrony**
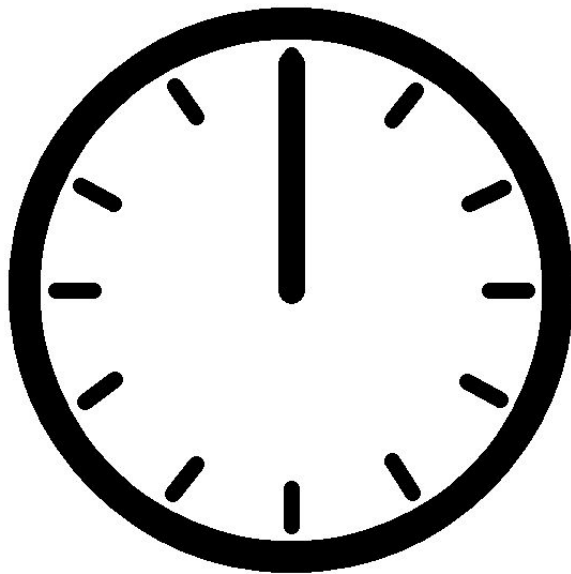
Full client-side compatibility
For client-side configuration, chrony reads and understands existing ntp files

Server-side compatibility
Configuration details here:
https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/7/html/system_administrators_guide/ch-configuring_ntp_using_the_chrony_suite

Chrony vs. NTP

What Chrony does better

- chrony can perform usefully with intermittent access to time reference sources

- chrony can usually synchronise the clock faster and with better time accuracy.

- chrony better adapts to sudden changes in the rate of the clock

- chrony can perform well even when the network is congested for longer periods of time.

- chrony in the default configuration never steps the time to not upset other running programs.

- chrony can adjust the rate of the clock in a larger range, which allows it to operate even on machines with broken or unstable clock (e.g. in some virtual machines).

- 47 chrony is smaller, it uses less memory and it wakes up the CPU only when necessary, which is better for power saving.

Chrony vs. NTP

What Chrony does that NTP can't

- chrony supports the Network Time Security (NTS) authentication mechanism.

- chrony supports hardware timestamping on Linux, which allows an extremely stable and accurate synchronisation in local network.

- chrony provides support for isolated networks whether the only method of time correction is manual entry (e.g. by the administrator looking at a clock). chrony can look at the errors corrected at different updates to work out the rate at which the computer gains or loses time, and use this estimate to trim the computer clock subsequently.

- chrony provides support to work out the gain or loss rate of the real-time clock, i.e. the clock that maintains the time when the computer is turned off. It can use this data when the system boots to set the system time from a corrected version of the real-time clock. These real-time clock facilities are only available on Linux, so far.

Chrony vs. NTP
What NTP does that Chrony can't

- ntp supports all operating modes from RFC 5905, including broadcast, multicast, and manycast server/client. However, **the broadcast and multicast modes are inherently less accurate and less secure** (even with authentication) than the ordinary server/client mode, and should generally be avoided.

- ntp supports the Autokey protocol (RFC 5906) to authenticate servers with public-key cryptography. Note that **the protocol has been shown to be insecure** and has been obsoleted by NTS (RFC 8915).

- ntp has been ported to more operating systems.

- ntp includes a large number of drivers for various hardware reference clocks. chrony requires other programs (e.g. gpsd or ntp-refclock) to provide reference time via the SHM or SOCK interface.

Improved **Security** (ongoing, RHEL 7 & 8)

DESIGN

BUILD

Security policy,
process, and
procedures

ADAPT

RUN
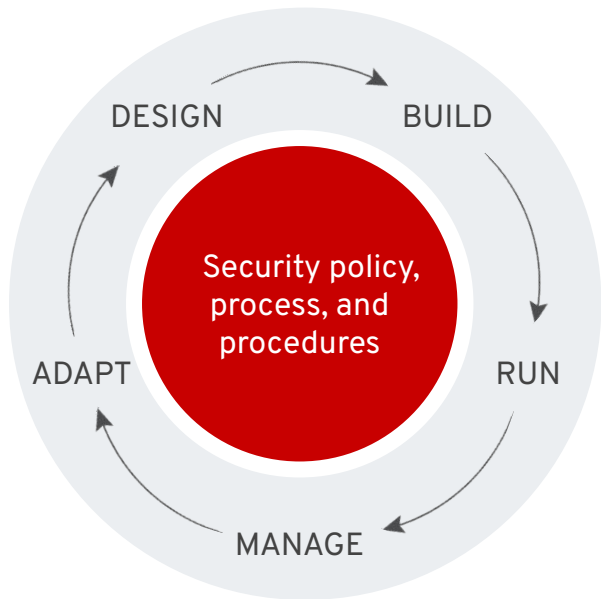
MANAGE

Latest protocol support
Including TLS 1.3 via OpenSSL 1.1.1

Hardened code
Including PIE and RELRO binaries and code analysis
in our pipelines

Integrated identity management
As a stand-alone provider or trusted member of an
Active Directory, with expanded integrations to tools
like the web console

Updated tools
Including the LUKS v2 on-disk format for encryption

Remote single-system views in the web console

Browser-based interface
Offers remotely accessible user interface using host security mechanisms

Consolidated view
Provides single view of tasks to speed understanding and completion

Standard management tools
Uses system tools to change state, not a separate workflow

New in the web console

Virtual machines
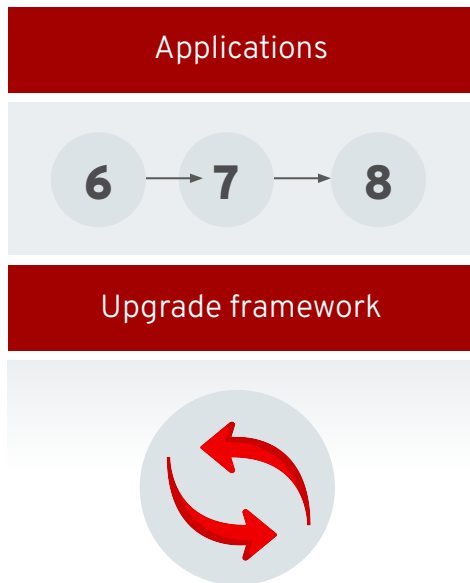Create and manage virtual machines

Network-bound disk encryption
Enroll disks with Tang server and manage LUKS keys

Single sign-on configuration
Automatically configure when joining a domain

New Feature (RHEL 7 & 8): **In-place upgrades** for your systems

Applications

6 → 7 → 8

Upgrade framework

Reduced migrations
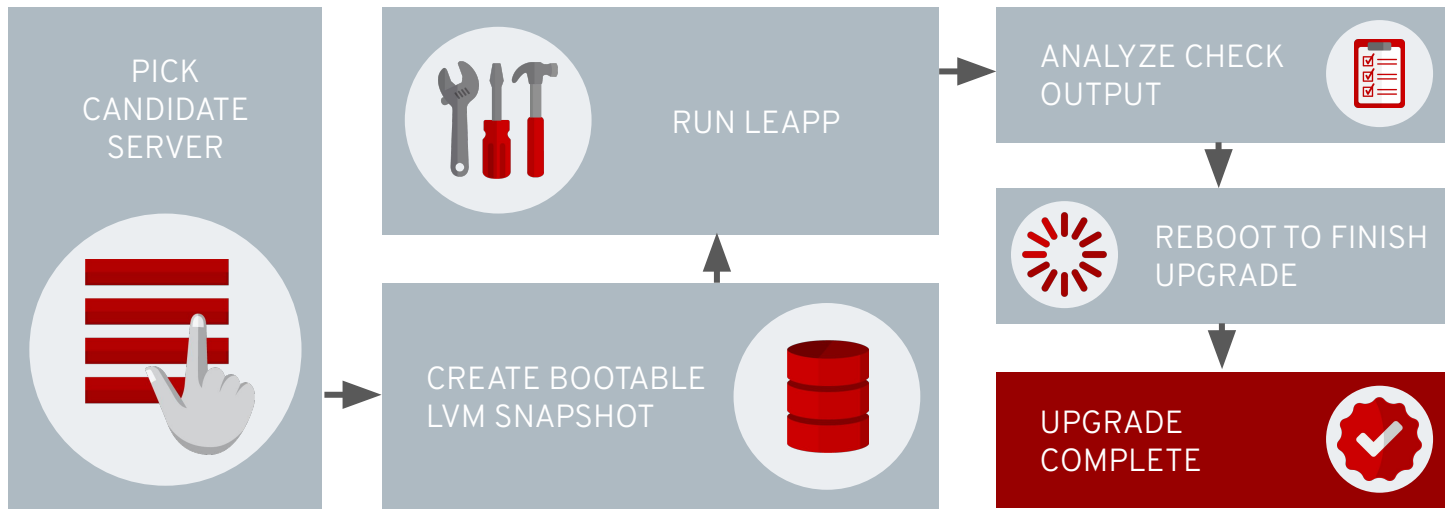Analyze systems to determine if upgrading in place can avoid a costly migration

Easy rollback options
Combine with bootable LVM snapshots for safety

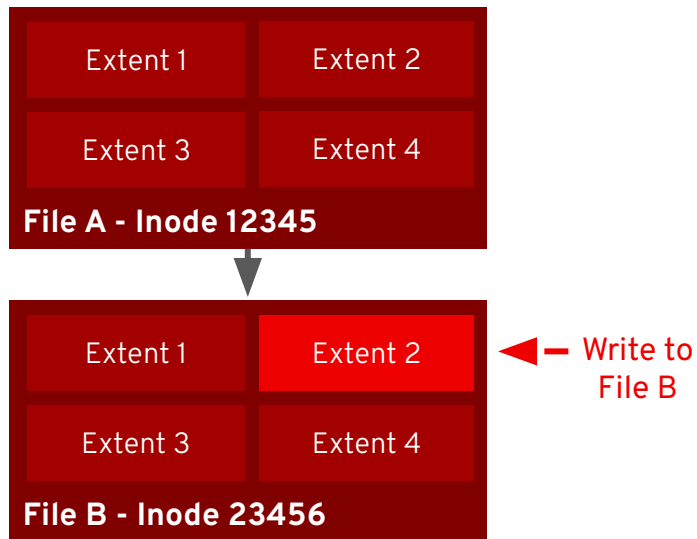**Improved framework**
Get better analysis and a simplified process with a more extensible framework

Can I upgrade this host?

PICK CANDIDATE SERVER

CREATE BOOTABLE LVM SNAPSHOT

RUN LEAPP

ANALYZE CHECK OUTPUT

REBOOT TO FINISH UPGRADE

UPGRADE COMPLETE

Now Included (RHEL 7 & 8): **Fast file copy with XFS**
shared data extents

Filesystem level copy-on-write
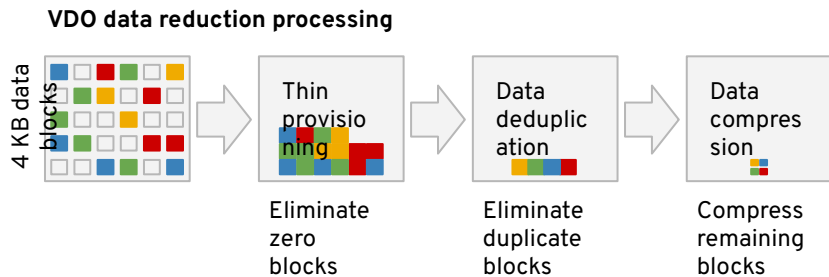XFS creates new extents when data is changed in a copy without additional application integrations

Separate metadata
Copies have unique file system metadata allowing for owner, group, and permission changes

Fast operations
XFS creates new inode and metadata instead of full data copy

Now Included (RHEL 8): **VDO** disk dedup and compression

VDO data reduction processing

4 KB data blocks

| Thin provisio ning | Data dedupli cation | Data compres sion |

Eliminate zero blocks

Eliminate duplicate blocks

Compress remaining blocks

Proven technology
Built on Permabit, now a Red Hat company, used by major disk array manufactuers

Implemented in device mapper
Usable across XFS, ext4, and all other RHEL filesystems, compression and deduplication done at the block device level

Onnline, On-the-fly data reduction
Typical data reduction of 50-83%

New Feature (RHEL 8) Easier ML/AI and data anlytics with **precompiled nVidia drivers**

Direct support from nVidia
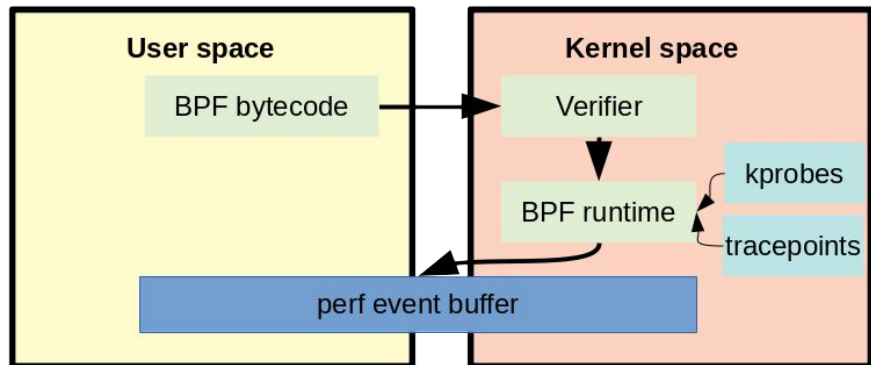Provided by nVidia and supported by nVidia (propiretary, non-open-source code)

Simplifies adoption of latest GPU
No more need to compile and build drivers for GPU support

Supports common ML/AI & Data analytics frameworks
Tensorflow, Caffe, Apache Spark...

New Feature (RHEL 8) better tracing, troubleshooting, and monitoring with **ebpf**
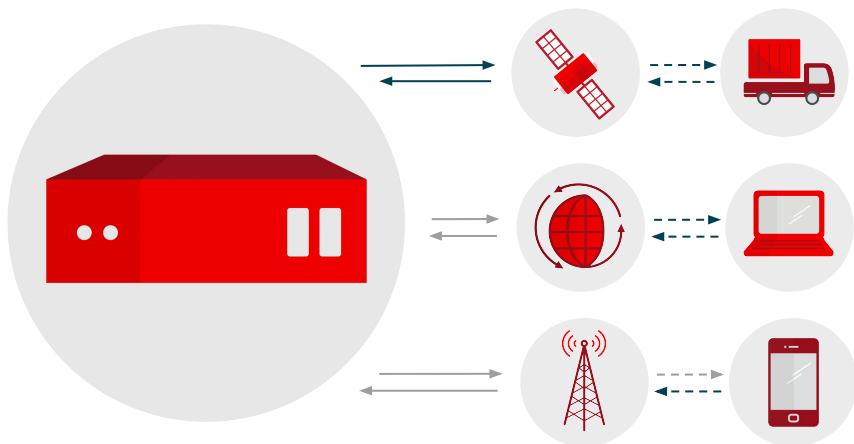

Ebpf = Enhanced Berkely Packet Filter
Dynamic and static tracing at kernel and user level running in a safe kernel pseudo-VM

Includes kernel level verifier for code safety

Bcc-tools examples shipped

PCP and systemtap support shipped

Improve network performance (RHEL 8) with bandwidth
and round-trip propagation time congestion algorithm

End-to-end performance
Link capacity calculation and management at server do not require client end modifications

High-latency links
Improved performance over other algorithms on networks with high latency and congestion

More choices
An improved network stack combined with BBR and other algorithms lets you select the highest performance combinations

NBDE (Network-Bound Disk Encryption):
Storage security in the hybrid cloud

Volume with locked crypto key

Server provides unlocking

60
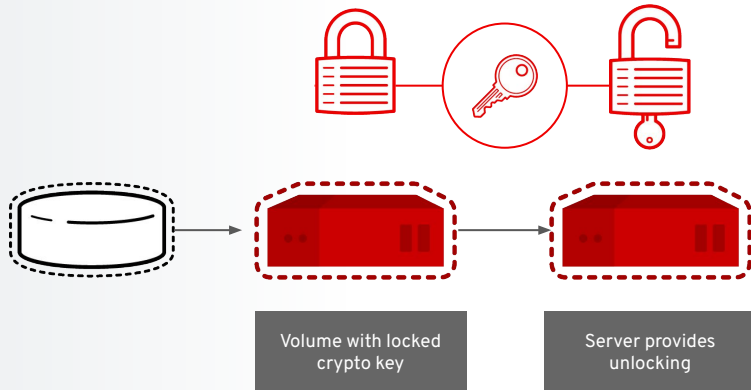
Network-bound disk encryption

Linux Unified Key Setup encrypted volumes allow you to transparently encrypt data at rest across flexible, software-defined disks.

The stateless server provides a public key to help the client unwrap the encryption key, and the client system continues its boot process, hands-free.

Thank you

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