Intel® Virtual RAID on CPU (Intel® VROC)

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Intel® VROC Product Set

Intel® VROC consists of 3 functional sub-products within the same software product. All can be used at the same time:

- **Intel® VROC (VMD NVMe RAID):** For platforms with CPU(s) that have Intel® Volume Management Device (Intel® VMD) architecture. Requires additional licensing

- **Intel® VROC (SATA RAID):** For platforms with chipset that include this functionality. Included in the chipset purchase

- **Intel® VROC Integrated Caching:** For any platform that supports Intel VROC (NVM NVMe RAID). Can be used with SATA RAID. Requires additional licensing

This presentation will cover Intel VROC (VMD NVMe RAID) and Integrated Caching.
For more details on Intel VROC (SATA RAID), please reference the Intel VROC User Guides
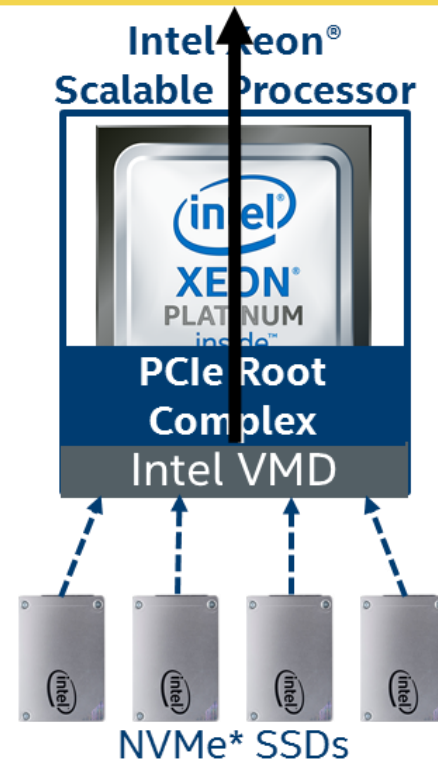
Intel® Volume Management Device (Intel® VMD)

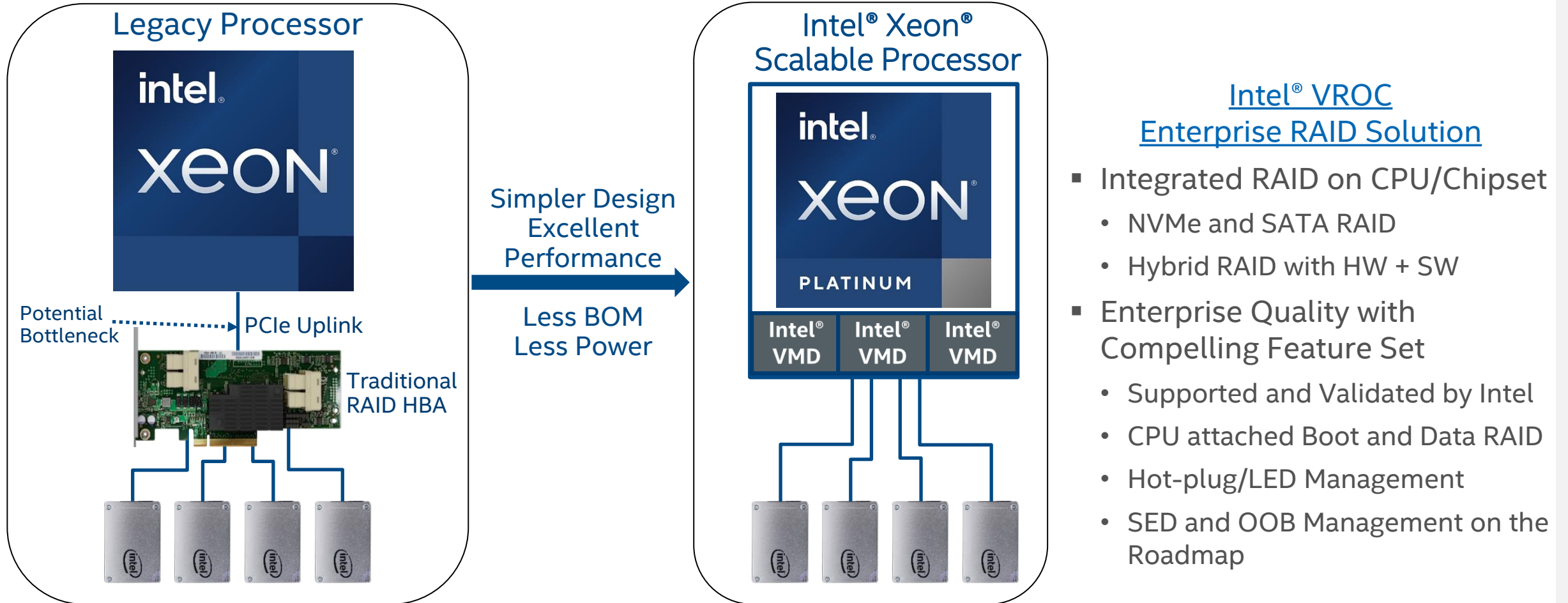**Before Intel® VMD**

Operating System

Legacy Intel Xeon® Processor

PCIe Root Complex
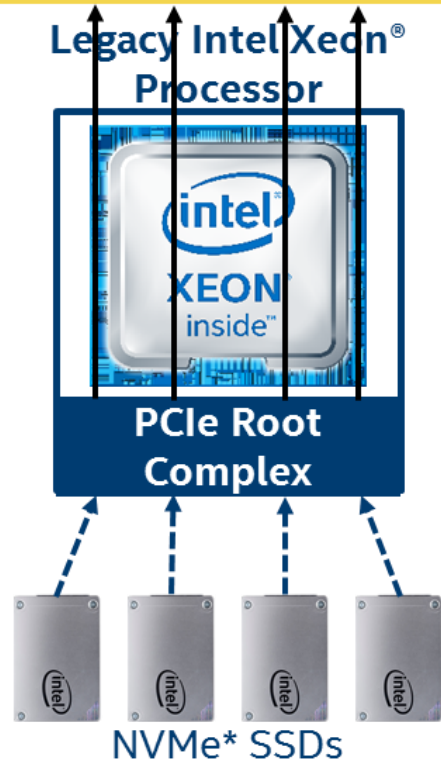
NVMe* SSDs

After Intel® VMD

Operating System

Intel Xeon® Scalable Processor

PCIe Root Complex

Intel VMD

NVMe* SSDs

- **Intel® VMD:** Intel® Xeon® Scalable CPU HW logic to manage NVMe SSDs

- Intel VMD acts like an integrated HBA to enumerate NVMe SSDs and own the communication up to the OS

- Each 1 VMD Domain is made up of x16 PCIe lanes

- # VMD Domains = # PCIe Lanes / 16

- Enables robust surprise hot-plug, status LED management and bootable RAID
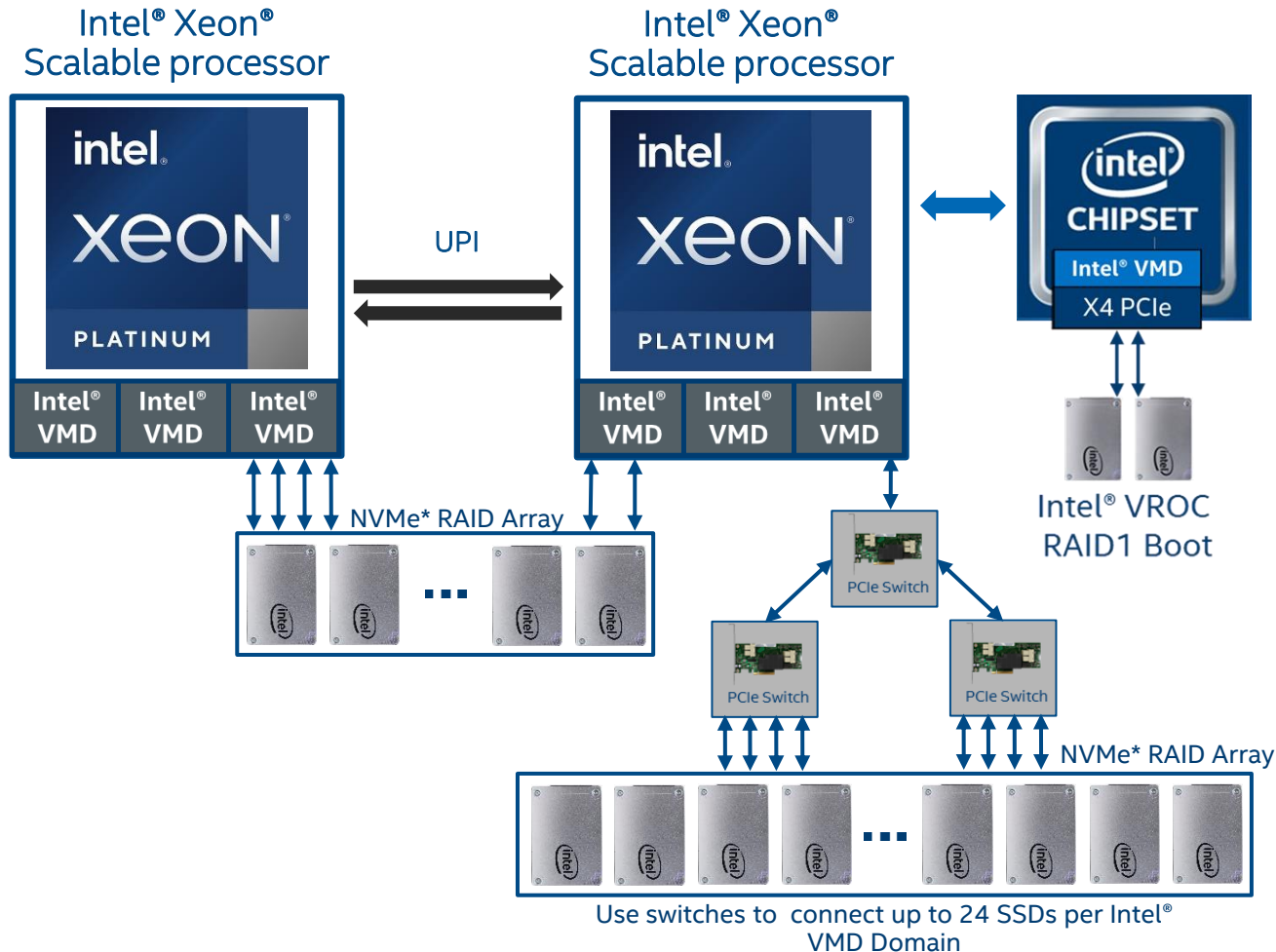
Intel® VROC is Integrated RAID

Legacy Processor

intel. **XEON**®

Potential Bottleneck ┈┈┈→ PCIe Uplink

Traditional RAID HBA

Simpler Design
Excellent
Performance

Less BOM
Less Power

Intel® Xeon® Scalable Processor

intel. **XEON**®

PLATINUM

| Intel® VMD | Intel® VMD | Intel® VMD |

Intel® VROC Enterprise RAID Solution

- Integrated RAID on CPU/Chipset
  - NVMe and SATA RAID
  - Hybrid RAID with HW + SW
- Enterprise Quality with Compelling Feature Set
  - Supported and Validated by Intel
  - CPU attached Boot and Data RAID
  - Hot-plug/LED Management
  - SED and OOB Management on the Roadmap

Intel® VROC onboards RAID HBA functionality onto Intel® Xeon® CPUs

Intel® VROC SKU

		Pass-thru (no license)	Standard SKU	Premium SKU	Intel® SSD SKU
Intel® VMD	CPU attached NVMe: • Hot-plug/Surprise Removal • LED Management • 3rd Part SSD Support (non-RAID)	√	√	√	√
Intel® VROC (VMD NVMe RAID)	3rd party SSD support (RAID)	-	√	√	-
	Bootable RAID	-	√	√	√
	RAID 0/1/10	-	√	√	√
	RAID 5	-	-	√	√
Intel VROC (SATA RAID)	SATA RAID on PCH • Bootable RAID • RAID 0/1/5/10	√	√	√	√
Integrated Caching	RAID Acceleration • Intel Optane SSD Cache	-	-	√	√

Windows and Linux: Supported Configurations

Intel® Xeon® Scalable processor

Intel® Xeon® Scalable processor

UPI

Intel® VMD   Intel® VMD   Intel® VMD

Intel® VMD   Intel® VMD   Intel® VMD

intel® CHIPSET
Intel® VMD
X4 PCIe

Intel® VROC RAID1 Boot

NVMe* RAID Array

PCIe Switch

PCIe Switch

PCIe Switch

NVMe* RAID Array

Use switches to connect up to 24 SSDs per Intel® VMD Domain

Intel VROC Configuration Guidelines

- RAID Level Support: 0, 1, 5, 10
- RAID Spanning
  - Data Volumes can span VMD Domains and CPUs
  - Boot Volumes must be within a single VMD Domain (e.g. PCH VMD)
- Max. 48 NVMe SSDs/platform
  - Up to 24 SSDs per RAID0/5 Array
  - Up to 4 SSDs per RAID10 Array
  - Up to 2 SSDs per RAID1 Array
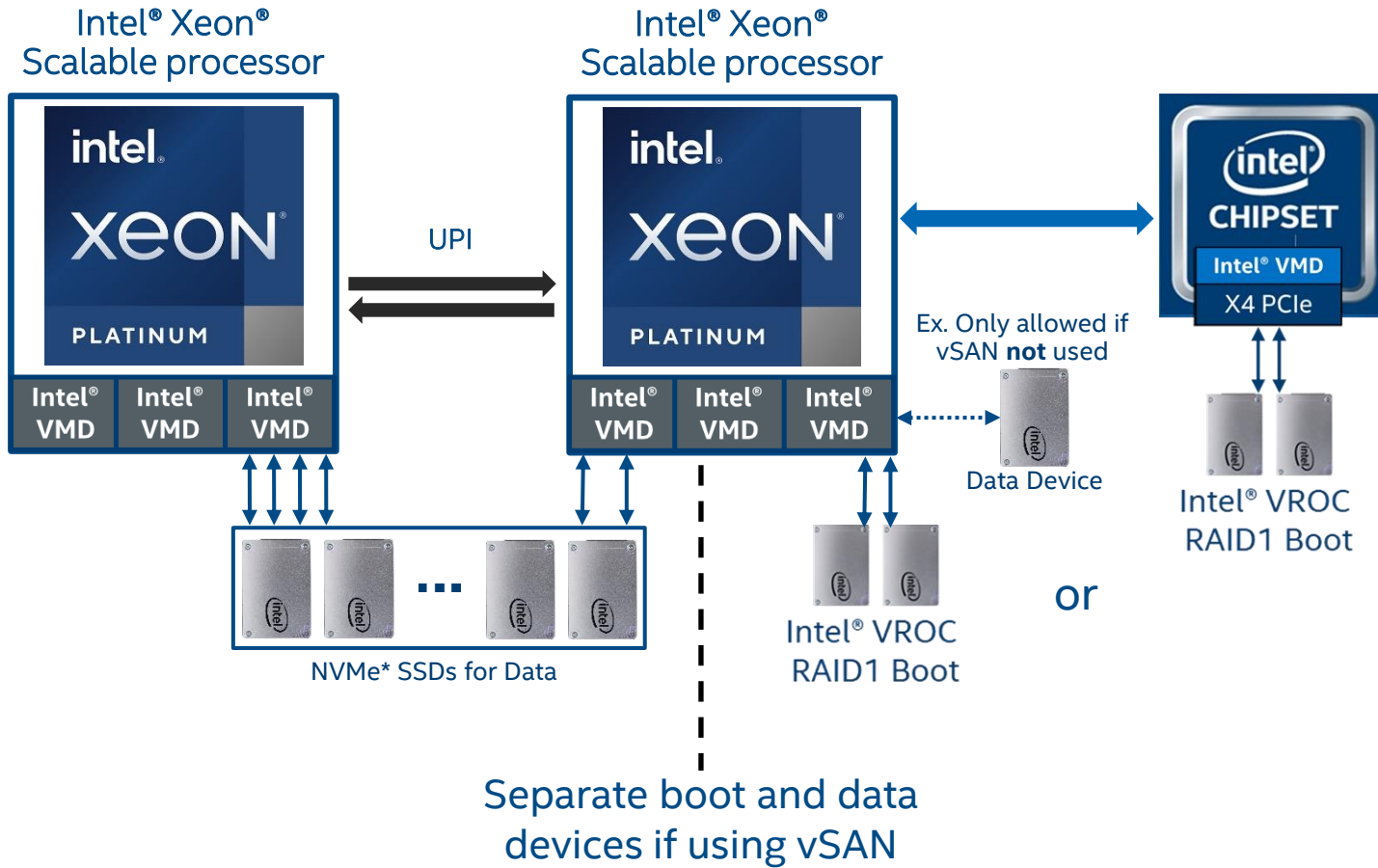
VMware ESXi: Supported Configurations
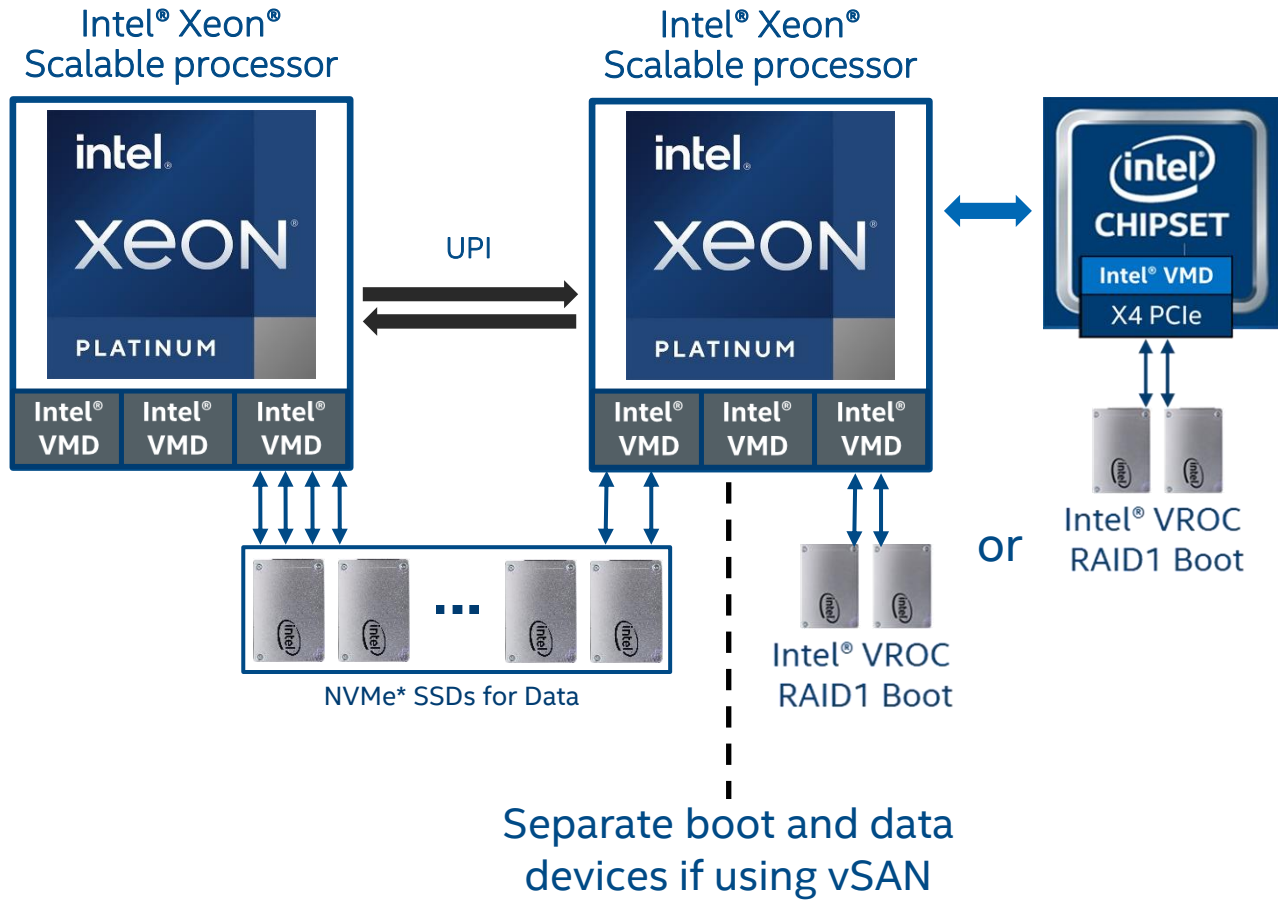
Intel® Xeon® Scalable processor

Intel® Xeon® Scalable processor

UPI

Intel® VMD | Intel® VMD | Intel® VMD

Intel® VMD | Intel® VMD | Intel® VMD

intel. XEON PLATINUM

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intel CHIPSET
Intel® VMD
X4 PCIe

NVMe* SSDs for Data

Separate boot and data devices if using vSAN

Intel® VROC RAID1 Boot

or

Intel® VROC RAID1 Boot
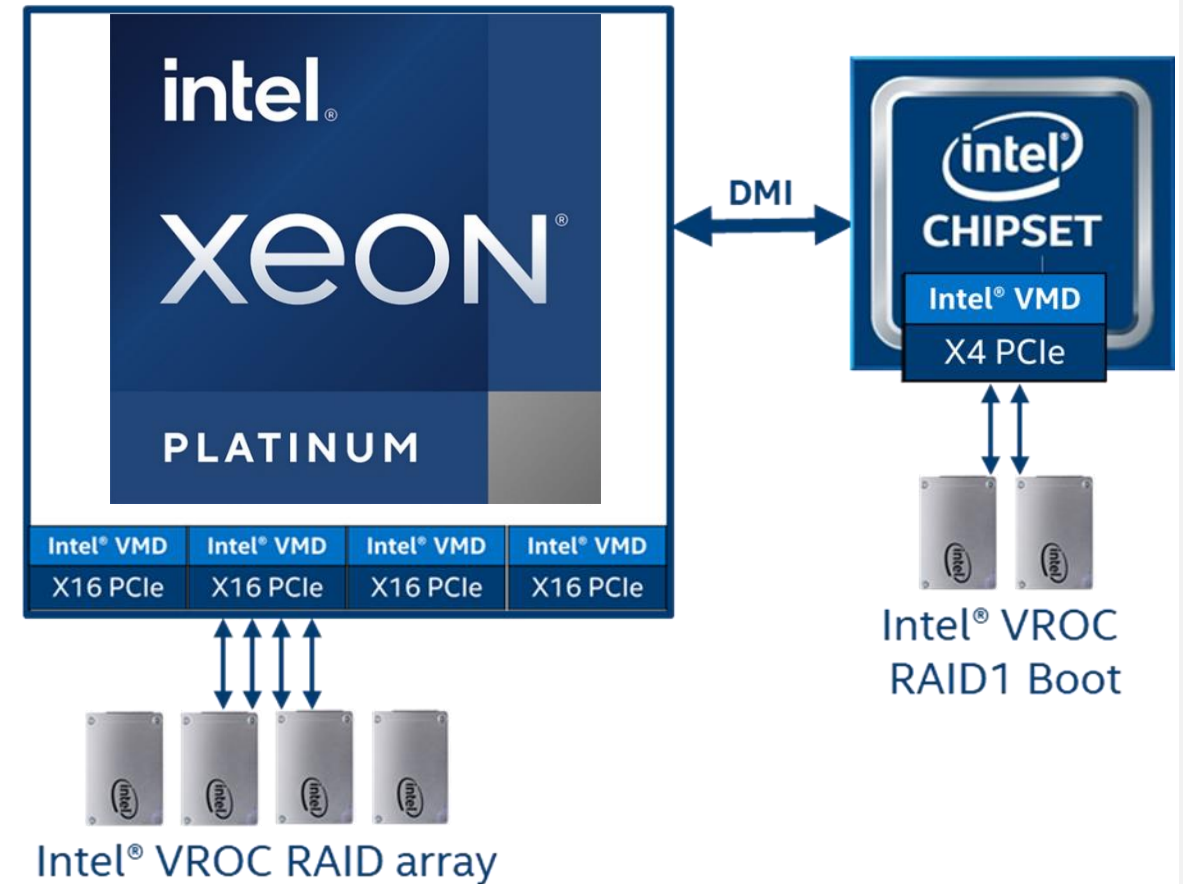
Intel VROC Configuration Guidelines

- RAID Level Support: 1
  - Boot Volumes must be within a single VMD Domain (e.g. PCH VMD)
  - If vSAN is being used: Boot volumes must be on separate controller (VMD Domain) from data devices
  - If vSAN is NOT being used: Boot volumes and data devices can share a VMD domain
  - Max. 48 NVMe SSDs/platform
  - Up to 24 SSDs per Intel VMD Domain

VMware ESXi: Supported Configurations

Intel® Xeon® Scalable processor

Intel® Xeon® Scalable processor

UPI

Intel® VMD | Intel® VMD | Intel® VMD

Intel® VMD | Intel® VMD | Intel® VMD

Ex. Only allowed if vSAN **not** used

Data Device

NVMe* SSDs for Data

Intel® VROC RAID1 Boot

or

Separate boot and data devices if using vSAN

Intel® VMD X4 PCIe

Intel® VROC RAID1 Boot

Intel VROC Configuration Guidelines

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New Intel VROC 7.5 Features[1]

Intel VROC 7.5 will add the below new features:

- Intel VROC Integrated Caching
  - Accelerate RAID volumes with Intel® Optane SSDs
- Intel VMD 2.0 Technology[2]
  - 4 Intel® VMD Domains per CPU (16 PCIe Lanes per domain)
  - 1 Intel® VMD Domain on the Chipset for NVMe RAID1 Boot volumes
  - Intel® VMD Direct-Assignment to VM
- Self Encrypting Drive (SED) OPAL Key Management via UEFI driver[3]
- NVMe RAID BMC OOB management via OS[1,2]
  - UEFI OOB management coming with Intel VROC 8.0
- Add support RAID1 Boot for ESXi

Intel® Xeon® Scalable Processor

intel. XEON® PLATINUM

DMI

intel CHIPSET

Intel® VMD X4 PCIe

Intel® VMD X16 PCIe | Intel® VMD X16 PCIe | Intel® VMD X16 PCIe | Intel® VMD X16 PCIe

Intel® VROC RAID array

Intel® VROC RAID1 Boot

1-Intel VROC feature support is platform specific. Please consult platform provider for details
2-Requires Generation 3 Intel Xeon Scalable Processor
3-Requires additional driver integration at platform level. May not be available on all Intel VROC enabled platforms

Integrated Caching Explained

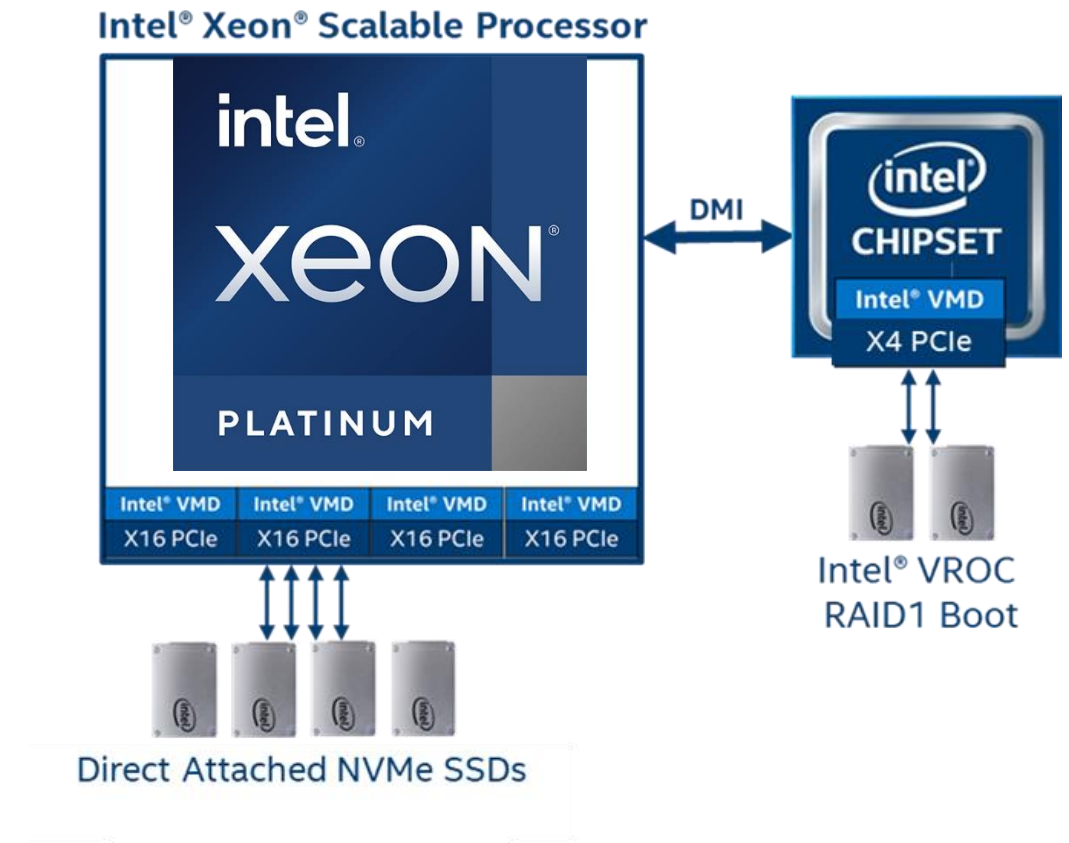## Intel® VROC adds RAID + Caching architecture:

- Intel® VROC Integrated Caching (Intel® VROC IC)
- Optimized for Intel® Optane™ SSDs:
  - Allows a persistent cache with more capacity than DRAM WB
- Enterprise Supported and Validated Caching
  - Part of the Intel® VROC supported feature set
- Platform Integrated
  - Easy for end-users to pull in as a platform upgrade
- Flexible Usage Models:
  - Caching for SATA and NVMe devices
  - RAID0/1/10 for cache layer to provide performance and capacity cache scaling
- Eliminate Singled Points of Failure:
  - Use Intel® VROC RAID1 for a redundant cache

Intel® Xeon® Scalable Processor

DMI

X16 PCIe — Intel® VMD
X16 PCIe — Intel® VMD
X16 PCIe — Intel® VMD
X16 PCIe — Intel® VMD

Intel® Chipset

Intel® VROC NVMe RAID array

NEW Intel VROC Caching Layer (w Intel® Optane™ SSDs)

Intel® VROC SATA RAID array
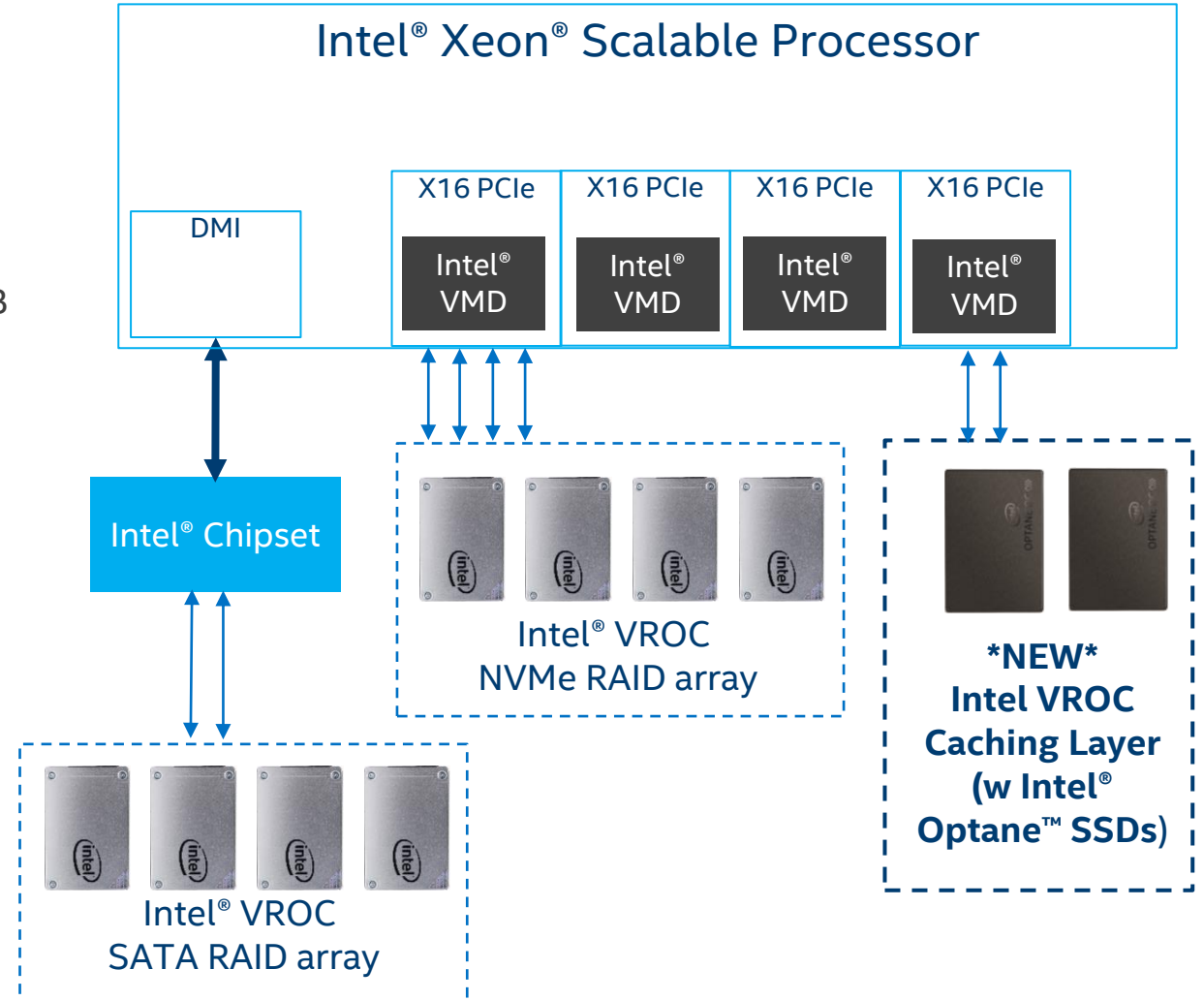
Intel® VROC for Boot

Simple, flexible, integrated RAID1 for boot

- Redundant OS and High Availability

- Pre-OS RAID configuration (UEFI/HII)

- CPU or PCH Intel VMD domains for boot attach points

- Broad OS Support:
  - Linux, Windows, VMware

- FF Flexibility: M.2, U.2, E1.S

- RAID0/10 configurations for larger boot volumes

Intel® Xeon® Scalable Processor

intel. XEON® PLATINUM

| Intel® VMD X16 PCIe | Intel® VMD X16 PCIe | Intel® VMD X16 PCIe | Intel® VMD X16 PCIe |

Direct Attached NVMe SSDs

DMI

intel CHIPSET
Intel® VMD
X4 PCIe

Intel® VROC RAID1 Boot

Intel® VROC SED Key Management[1]

- UEFI utility with HII interface for SED setup

- Automatic drive provisioning and unlock on system boot

- Boot from a secured RAID volume or secured single drive into any Intel VROC supported OS

- Secure sensitive data volumes with SED

- Support for multiple key managers:

  - OASIS based KMIP – industry standard KMS

  - Local Security Chip/TPM

- Intel VROC SED itself does no encryption, just key management

Host

Appl.

SED VROC SW
- Key mgmt UI
- KMS access
- Intel VROC OPAL mgmt

Intel VROC-RAID mgmt

Platform services.

TPM Cryptographic Service Provider (Local Security Chip)

KMIP CSP (Remote KMS Server)
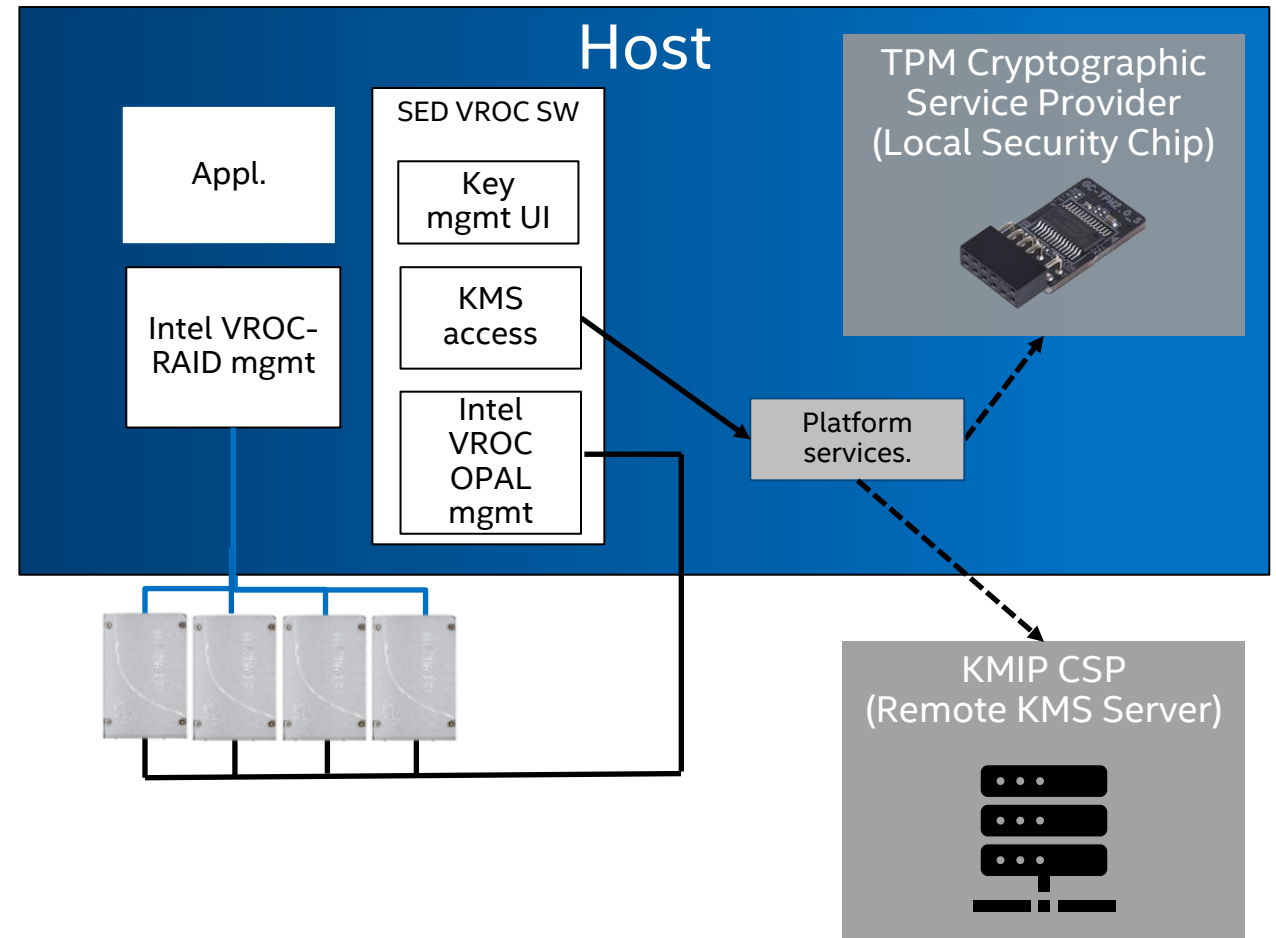
1-Requires additional driver integration at platform level. May not be available on all Intel VROC enabled platforms. Specific functionality depends on platform provider integration into their preferred KMS

Intel® VROC vs HBA

Major RAID Features	HW RAID	VROC	SW RAID	Intel® VROC Comment
Error Handling Isolation	√	√	X	Intel® VMD isolates SSD error/event handling from OS to reduce system crash or reboot due to error
Reliable data storage	√	√	X	Enterprise data protection, even when power loss occurs
Boot support	√	√	X	Redundant system volume = less down-time/crashes
Complete Management Tools	√	√	X	UEFI, GUI, CLI, RESTful API, remote web, OOB (full solution coming with Intel VROC8.0)
Dedicated I/O processor for RAID	√	1	X	1. Uses powerful Intel® Xeon® CPU to RAID the fast NVMe* SSDs. Long term option for dedicated storage cores
Protected write back cache	√	√	X	Replace DRAM WB Cache + BBU with persistent Optane media (VROC IC)
SED Key Management	√	√	X	Xeon-based Platform integrated Key Management solution
Easily upgraded	X	√	√	Software update vs new HW purchase
Less hardware required	X	√	√	No need for HBA, BBU. Save power and PCIe* lanes

Biggest Advantages of Intel VROC over RAID HBA

Intel® Xeon Integrated for great performance, less HW

Intel® VROC Resources and Support Docs

- **Intel.com/VROC** for:
  - Product Brief
  - FAQ
  - Supported OS/HW Information
  - Related Links
- **Intel® VROC Support Page for:**
  - User Guides
  - Tech Briefs
  - Performance Documentation
- Technical Docs on RDC